A. INTRODUCTION

This chapter assesses the potential for noise and vibration impacts from operation of the proposed MTA/LIRR East Side Access Project. Noise and vibration during construction are assessed separately in Chapter 17, "Construction and Construction Impacts."

Operation of the project could affect noise and vibration levels in a number of ways. In Manhattan, new rail service in a tunnel beneath existing residential and commercial buildings could increase vibration and ground-borne noise levels in those structures. In Queens, portions of the new tunnel along 41st Avenue in close proximity to existing structures could change existing levels. In addition, increased rail service through the approaches of the 63rd Street Tunnel that pass under developed portions of Manhattan and Queens may also result in increased vibration levels at nearby structures.

The project's Preferred Alternative would allow LIRR to increase train service throughout Long Island and Queens. This additional service would increase train passbys along most branches, creating a potential for adverse noise impacts at sensitive locations along the right-of-way.

In addition, the relocation of the MNR Madison Yard operations to Highbridge Yard and the relocation of the New York & Atlantic Railway (NYAR) freight operations from Yard A to alternate locations may result in adverse noise impacts at adjacent sites, as well as the provision for overnight storage at east end yards.

Each of these issues are addressed in the following sections of the chapter. This chapter examines the potential for impacts related to noise and vibration in two sections: B, "Noise," and C, "Vibration." Each of these sections includes a discussion of methodology and an evaluation of existing conditions and the future conditions predicted for the project alternatives.

B. NOISE

INTRODUCTION

The noise analysis for the proposed project was performed using procedures described in the Federal Transit Administration (FTA) guidance manual, *Transit Noise and Vibration Impact Assessment*, April 1995. This FTA guidance document provides a three-step process for analysis: a noise screening procedure, a general noise assessment methodology, and a detailed noise analysis methodology. The screening procedure is used to determine whether any noise sensitive receivers are within distances where impacts are likely to occur; the general noise assessment methodology is used to determine locations (or in the case of this project rail segments) where there is the potential for impacts; and the detailed noise analysis methodology is used to predict impacts and evaluate the effectiveness of mitigation with greater precision than can be achieved with the general noise assessment. For this project, in terms of rail noise, noise receptors are located in close proximity to the existing rail track, and consequently rail noise was evaluated using the general and detailed noise assessment methodologies.

The following section discusses noise fundamentals, standards, and impact criteria; general noise assessment methodology; detailed noise analysis methodology; existing noise levels, and noise levels for the project alternatives.

NOISE FUNDAMENTALS, STANDARDS, AND IMPACT CRITERIA

NOISE FUNDAMENTALS

Quantitative information on the effects of airborne noise on people is well documented. If sufficiently loud, noise may adversely affect people in several ways. For example, noise may interfere with human activities, such as sleep, speech communication, and tasks requiring concentration or coordination. It may also cause annoyance, hearing damage, and other physiological problems. Several noise scales and rating methods are used to quantify the effects of noise on people. These scales and methods consider such factors as loudness, duration, time of occurrence, and changes in noise level with time. However, it must be remembered that all the stated effects of noise on people vary greatly with the individual.

Sound is a fluctuation in air pressure. Sound pressure levels are measured in units called "decibels" (dB). The particular character of the noise that we hear (a whistle compared with a French horn, for example) is determined by the speed, or "frequency," at which the air pressure fluctuates, or "oscillates." Frequency defines the oscillation of sound pressure in terms of cycles per second. One cycle per second is known as one Hertz (Hz). People can hear over a relatively limited range of sound frequencies, generally between 20 and 20,000 Hz, and the ear does not perceive all frequencies equally well. High frequencies (that whistle, for example) are more easily discerned and therefore more intrusive than many of the lower frequencies (the lower notes on the French horn, for example).

"A"-Weighted Sound Level (dBA)

To bring a uniform noise measurement that simulates people's perception of loudness and annoyance, the decibel measurement is weighted to account for those frequencies most audible to the human ear. This is known as the A-weighted sound level, or "dBA," and it is the most often used descriptor of noise levels where community noise is the issue. As shown in Table 11-1, the threshold of human hearing is defined as 0 dBA; very quiet conditions (as in a library, for example) are approximately 40 dBA; levels between 50 dBA and 70 dBA define the range of acceptable daily activity; levels above 70 dBA would be considered noisy, loud, intrusive, and deafening as we move up the scale to 130 dBA. In considering these values, it is important to note that the dBA scale is logarithmic, meaning that each increase of 10 dBA describes a doubling of sound pressure. Thus, the background noise in an office, at 50 dBA, is perceived as twice as loud as a library at 40 dBA. A change of 3 dBA is needed for most people to perceive an increase in noise. A change of 5 dBA is generally readily noticeable.*

* Average ability to perceive changes in noise levels from Bolt Beranek and Neuman, Inc., *Fundamentals and Abatement of Highway Traffic Noise, Report No. PB-222-703.* Prepared for the Federal Highway Administration, June 1973.

Table 11-1
Common Noise Levels

Sound Source	(dBA)
Military jet, air raid siren	130
Amplified rock music	110
Jet takeoff at 500 meters	100
Train horn at 30 meters	95
Freight train at 30 meters	90
Heavy truck at 15 meters	
Busy city street, loud shout	80
Busy traffic intersection	
Vacuum cleaner at 1 meter	
Highway traffic at 15 meters, train	70
Predominantly industrial area	60
Phone ringing at 1 meter	
Light car traffic at 15 meters, city or commercial areas or residential areas close to industry	
Background noise in an office	50
Suburban areas with medium density transportation	
Public library	40
Soft whisper at 5 meters	30
Threshold of hearing	0

Note: A 10 dBA increase in level doubles the apparent loudness, and a 10 dBA decrease halves the apparent loudness.
Source: AKRF, Inc.

It is also important to understand that combinations of different noise sources are not additive. For example, two noise sources, a vacuum cleaner operating at approximately 72 dBA and a telephone ringing at approximately 58 dBA, do <u>not</u> combine to create a noise level of 130 dBA. That is the equivalent of a jet airplane or air raid siren, as shown in Table 11-1. In fact, the person vacuuming may very well simply not hear the phone ringing. On the logarithmic scale, the combination of these two noise sources would yield a dBA level of 72.2.

Effects of Distance on Noise

Noise varies with distance from the source. For example, at-grade rail transit at 50 mph at 50 feet will typically produce sound levels of approximately 75 dBA. The same noise will measure approximately 70.5 dBA at a distance of 100 feet. This decrease is known as "drop-off." The outdoor drop-off rate for moving noise sources, such as traffic or rail transit, is a decrease of 4.5 dBA for every doubling of distance between the noise source and receiver. For stationary noise sources, such as amplified rock music, the outdoor drop-off rate is a decrease of 6.0 dBA for every doubling of distance between the noise source and receiver.

Noise Descriptors Used in Impact Assessment

Because the sound pressure level unit of dBA describes a noise level at just one moment and very few noises are constant, other ways of describing noise over more extended periods have been developed. One way of describing fluctuating sound is to describe the fluctuating noise heard over a specific period as if it had been a steady, unchanging sound. For this condition, a descriptor called the "equivalent sound level," L_{eq}, can be computed. L_{eq} is the constant sound level that, in a given situation and period (e.g., 1 hour, denoted by $L_{eq(1)}$, or 24 hours, denoted as $L_{eq(24)}$), conveys the same sound energy as the actual time-varying sound. Statistical sound level descriptors such as L_1, L_{10}, L_{50}, L_{90}, and L_x are sometimes used to indicate noise levels that are exceeded 1, 10, 50, 90, and x percent of the time, respectively. Discrete event peak levels are given as L_{01} levels.

The relationship between L_{eq} and levels of exceedance is worth noting. Because L_{eq} is defined in energy rather than straight numerical terms, it is not simply related to the levels of exceedance. If the noise fluctuates very little, L_{eq} will approximate L_{50} or the median level. If the noise fluctuates broadly, the L_{eq} will be approximately equal to the L_{10} value. If extreme fluctuations are present, the L_{eq} will exceed L_{90} or the background level by 10 or more decibels. Thus, the relationship between L_{eq} and the levels of exceedance will depend on the character of the noise. In community noise measurements, it has been observed that the L_{eq} is generally between L_{10} and L_{50}. The relationship between L_{eq} and exceedance levels is used to characterize the noise sources and to determine the nature and extent of their impact at all receptor locations.

A descriptor for cumulative 24-hour exposure is the day-night sound level, abbreviated as L_{dn}. This is a 24-hour measure that accounts for the moment-to-moment fluctuations in A-weighted noise levels due to all sound sources during 24 hours, combined. Mathematically, the L_{dn} noise level is the average of all $L_{eq(1)}$ noise levels over a 24-hour period, where nighttime noise levels (10 PM to 7 AM) are increased by 10 dBA before averaging.

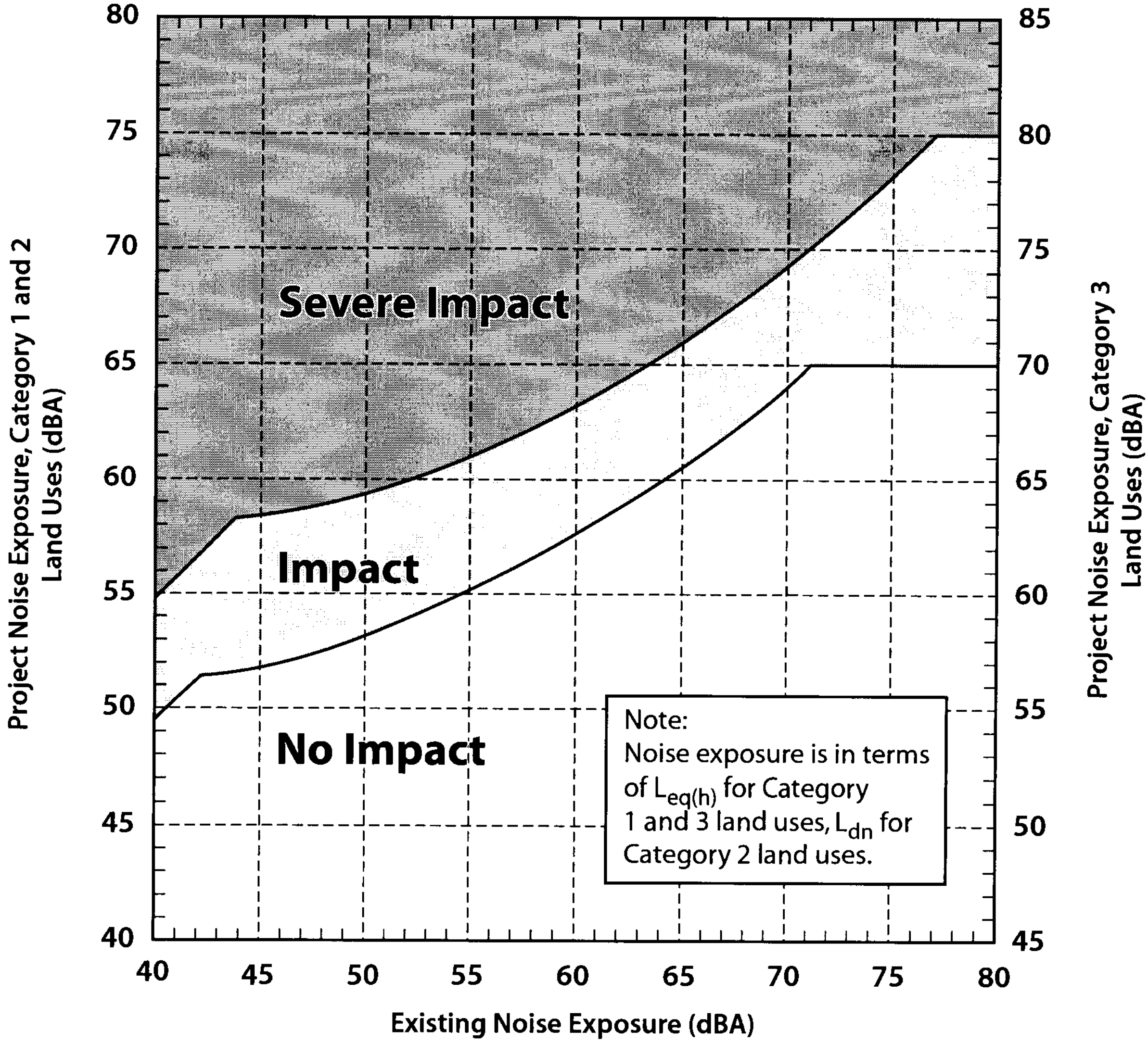
Following FTA guidance, the maximum 1-hour equivalent sound level ($L_{eq(1)}$) or the day-night sound level (L_{dn}) is used for impact assessment, depending on land use category as described below.

NOISE STANDARDS AND CRITERIA

Noise levels associated with the operation of the alternatives under consideration as part of the East Side Access Project are subject to the noise standards defined by FTA.

In April 1995, FTA issued its report, *Transit Noise and Vibration Impact Assessment*, as a guideline for the evaluation of noise and vibration levels resulting from mass transit projects, and the assessment of impacts that result. The noise analysis methodology in the FTA report determines operational noise impacts that result from mass transit projects based on peak-hour $L_{eq(1)}$ and 24-hour L_{dn} noise levels, depending on the land use category of the affected areas near mass transit projects. As described in Table 11-2, categories 1 and 3, which include land uses that are noise sensitive, but where people do not sleep, require examination of a one-hour L_{eq} for the noisiest peak hour. Category 2, which includes residences, hospitals, and other locations where nighttime sensitivity to noise is very important, use of L_{dn} is required.

Using these noise descriptors, the FTA impact criteria are keyed to the noise level generated by the project (called "project noise exposure") in locations of varying ambient noise levels. As shown in Figure 11-1, two types of impacts are defined for each land use category, depending



Source: Transit Noise and Vibration Impact Assessment, DOT-T-95-16, April 1995

Figure 11-1

FTA's Noise Impact Criteria for Transit Projects

Table 11-2
FTA's Land Use Category and Metrics for Transit Noise Impact Criteria

Land Use Category	Noise Metric (dBA)	Description of Land Use Category
1	Outdoor $L_{eq(h)}$*	Tracts of land where quiet is an essential element in the intended purpose. This category includes lands set aside for serenity and quiet, and such land uses as outdoor amphitheaters and concert pavilions, as well as National Historic Landmarks with significant outdoor use.
2	Outdoor L_{dn}	Residences and buildings where people normally sleep. This category includes homes, hospitals, and hotels, where a nighttime sensitivity to noise is assumed to be of utmost importance.
3	Outdoor $L_{eq(h)}$*	Institutional land uses with primarily daytime and evening use. This category includes schools, libraries, and churches, where it is important to avoid interference with such activities as speech, meditation, and concentration on reading material. Buildings with interior spaces where quiet is important—such as medical offices, conference rooms, recording studios, and concert halls—fall into this category. Places for meditation or study associated with cemeteries, monuments, museums. Certain historical sites, parks, and recreational facilities are also included.

Note: * L_{eq} for the noisiest hour of transit-related activity during hours of noise sensitivity.
Source: *Transit Noise and Vibration Impact Assessment*, FTA, April 1995.

on existing ambient noise levels. Thus, where existing noise levels are 40 dBA, for land use categories 1 and 2 the respective L_{eq} and L_{dn} noise exposure from the project would create impacts if they were above approximately 50 dBA and would create severe impacts if they were above approximately 55 dBA. For category 3, a project noise exposure level above approximately 55 dBA would be considered an impact and above approximately 60 dBA would be considered severe impacts. The difference between "severe impact" and "impact" is that the former denotes a change in noise level that a significant percentage of people would find annoying while the latter is indicative of a change in noise level noticeable to most people but not necessarily sufficient to result in strong adverse reactions from the community.

GENERAL NOISE ASSESSMENT

INTRODUCTION

The FTA general noise assessment methodology, contained in the FTA guidance manual, was used to determine the potential for significant project noise impacts from a) increased train service at sensitive locations on Long Island and Queens, b) relocation of MNR and NYAR operations to alternate locations in the Bronx and Queens, and c) *possible* creation of new train storage yards in Nassau and/or Suffolk County, as described below.

INCREASED TRAIN SERVICE

The LIRR system consists of 10 branches and hundreds of miles of track. For purposes of the general noise assessment of increased train service, the system was divided into 17 segments. These segments were developed based on locations with comparable and contiguous train pass-bys. The segments and the stations are presented in Table 11-3. Segments with no change (or negative change) in the number of trains between existing and future 2020 conditions were not

Table 11-3
LIRR Branch Segment Representation

LIRR Station of Analysis	Represents Branch Segment Between	Segment Letter (see Fig. 11-2)
Flatbush Avenue	Flatbush Avenue and Jamaica	A
Jamaica	Sunnyside and Jamaica	B
Great Neck	Main Line and Port Washington	C
Valley Stream	Jamaica and Valley Stream	D
Floral Park	Jamaica and Floral Park	E
Hempstead	Floral Park and Hempstead	F
Far Rockaway	Valley Stream and Far Rockaway	G
Long Beach	Valley Stream and Long Beach	H
West Hempstead	Valley Stream and West Hempstead	I
Mineola	Floral Park and Mineola	J
Oyster Bay	Mineola and Oyster Bay	K
Hicksville	Mineola and Hicksville	L
Huntington	Hicksville and Huntington	M
Port Jefferson	Huntington and Port Jefferson	N
Babylon	Valley Stream, Bethpage, and Babylon	O
Ronkonkoma	Bethpage and Ronkonkoma	P
Patchogue	Babylon and Montauk	Q

included in the analysis, since no adverse noise impacts would occur at these locations. These included the segments between the main line and Hunterspoint Avenue, between Long Island City and Jamaica, and between Ronkonkoma and Greenport.

Methodology and Data Input

The general noise assessment methodology consists of determining the project noise exposure at 50 feet from the centerline of track and comparing the calculated levels (i.e., with the Preferred Alternative) with allowable levels based on existing noise levels and land use categories. Since the general noise assessment is used as a screening methodology to determine which locations would require a detailed investigation, it was assumed that somewhere along each branch or section of branch of the existing rail line, all land use categories may be present within 50 feet of the track centerline. Therefore, both the L_{dn} as well as the L_{eq} noise metrics were used in the analysis.

The average number of cars per train on each branch segment for existing conditions for both the peak hour and 24-hour analyses were based on current operational characteristics. The average number of cars per train on each branch segment for future 2020 peak hour conditions was predicted based on the future 2020 service plan, and estimated ridership. Since the off-peak service plan is not demand-driven, it was assumed that existing and 2020 train consists for off-peak hours are the same. In all cases, diesel trainsets were assumed to consist of one operating locomotive (dual-mode train sets are equipped with two locomotives only one of which operates at a given time).

Since ballasted, welded rail is used along most branch segments, this type of rail was assumed for the noise assessment. The thresholds of impact for each land use category were determined based on calculated existing noise levels using Figure 11-1.

Results

During the peak hour for FTA Category 1 land uses, as shown in Table 11-4, there are eight segments or locations where *general noise assessment indicated the* potential *for* impacts from the Preferred Alternative. These segments are Jamaica, Great Neck, Floral Park, Mineola, Oyster Bay, Hicksville, Huntington, and Ronkonkoma. For FTA Category 3 land uses, as shown in the Table 11-4, there are no segments with the potential for impacts from the Preferred Alternative.

Table 11-4

General Noise Assessment Results by Location, Peak Hour (8 to 9 AM), 50 feet from Track Centerline

Segment Letter	Segment	Existing Peak Hour Noise Level L_{eq} (dBA)	Land Use Category 1 Threshold of Impact L_{eq} (dBA)	Land Use Category 3 Threshold of Impact L_{eq} (dBA)	Peak Hour Project Noise Exposure Levels L_{eq} (dBA)	Potential Impacts of the Preferred Alternative (by Land Use Category)	Onset of Impact from Centerline (feet)
A	Flatbush Avenue	67	62	67	61	No Impact	—
B	Jamaica	71	65	70	68	Impact (1)	100
C	Great Neck	60	58	63	59	Impact (1)	65
D	Valley Stream	71	65	70	65	No Impact	—
E	Floral Park	71	65	70	68	Impact (1)	100
F	Hempstead	57	56	61	51	No Impact	—
G	Far Rockaway	52	54	59	47	No Impact	—
H	Long Beach	55	55	60	48	No Impact	—
I	West Hempstead	52	54	59	46	No Impact	—
J	Mineola	70	65	70	68	Impact (1)	100
K	Oyster Bay	64	60	65	61	Impact (1)	65
L	Hicksville	70	65	70	67	Impact (1)	80
M	Huntington	68	63	68	64	Impact (1)	65
N	Port Jefferson	67	62	67	59	No Impact	—
O	Babylon	68	63	68	62	No Impact	—
P	Ronkonkoma	64	60	65	62	Impact (1)	80
Q	Patchogue	65	61	66	59	No Impact	—

Notes:
Noise levels shown are rounded to the nearest decibel.
Threshold of Impact indicates impact would occur at greater than or equal to (≥) the value presented.

Over a 24-hour period for FTA Category 2 land uses, as shown in Table 11-5, the Preferred Alternative could potentially create noise impacts at six segments or locations—Valley Stream, Jamaica, Floral Park, Mineola, Hicksville, and Port Jefferson (see Figure 11-2). With the exception of Valley Stream, these locations represent a continuous portion of the LIRR system, from Sunnyside to the Port Jefferson station. With respect to Valley Stream, these potential impacts are predicted to occur because several lines converge at or just before this section of the system, and in the future, additional diesel trains are forecast to be present on the branch. The latter condition is not a direct result of the Preferred Alternative, but rather a consequence of the new dual-mode diesel locomotives introduced as part of future background conditions common to all alternatives, which will enable diesel trains from the Montauk or Port Jefferson Branches to run the length of the system into Manhattan. In the existing condition, most diesel trains do not go west of Babylon on the Montauk Branch.

Table 11-5
General Noise Assessment Results by Location, L_{dn} 24 Hour Day-Night, 50 feet from Track Centerline

Segment Letter	Segment	Existing Day-Night Noise Level L_{dn} (dBA)	Land Use Category 2 Threshold of Impact L_{dn} (dBA)	Project Noise Exposure Level L_{dn} (dBA)	Potential Impact of the Preferred Alternative (Land Use Category 2)	Onset of Impact from Centerline (feet)
A	Flatbush Avenue	72	65	60	No Impact	—
B	Jamaica	77	65	74	Impact	400
C	Great Neck	68	63	62	No Impact	—
D	Valley Stream	76	65	68	Impact	100
E	Floral Park	76	65	68	Impact	100
F	Hempstead	67	63	60	No Impact	—
G	Far Rockaway	62	59	52	No Impact	—
H	Long Beach	67	62	58	No Impact	—
I	West Hempstead	63	60	58	No Impact	—
J	Mineola	75	65	67	Impact	80
K	Oyster Bay	65	61	56	No Impact	—
L	Hicksville	75	65	67	Impact	80
M	Huntington	73	65	64	No Impact	—
N	Port Jefferson	67	62	65	Impact	100
O	Babylon	75	65	54	No Impact	—
P	Ronkonkoma	71	65	56	No Impact	—
Q	Patchogue	66	62	57	No Impact	—

Notes:
Noise levels shown are rounded to the nearest decibel.
Threshold of Impact indicates impact would occur at greater than or equal to (≥) the value presented.

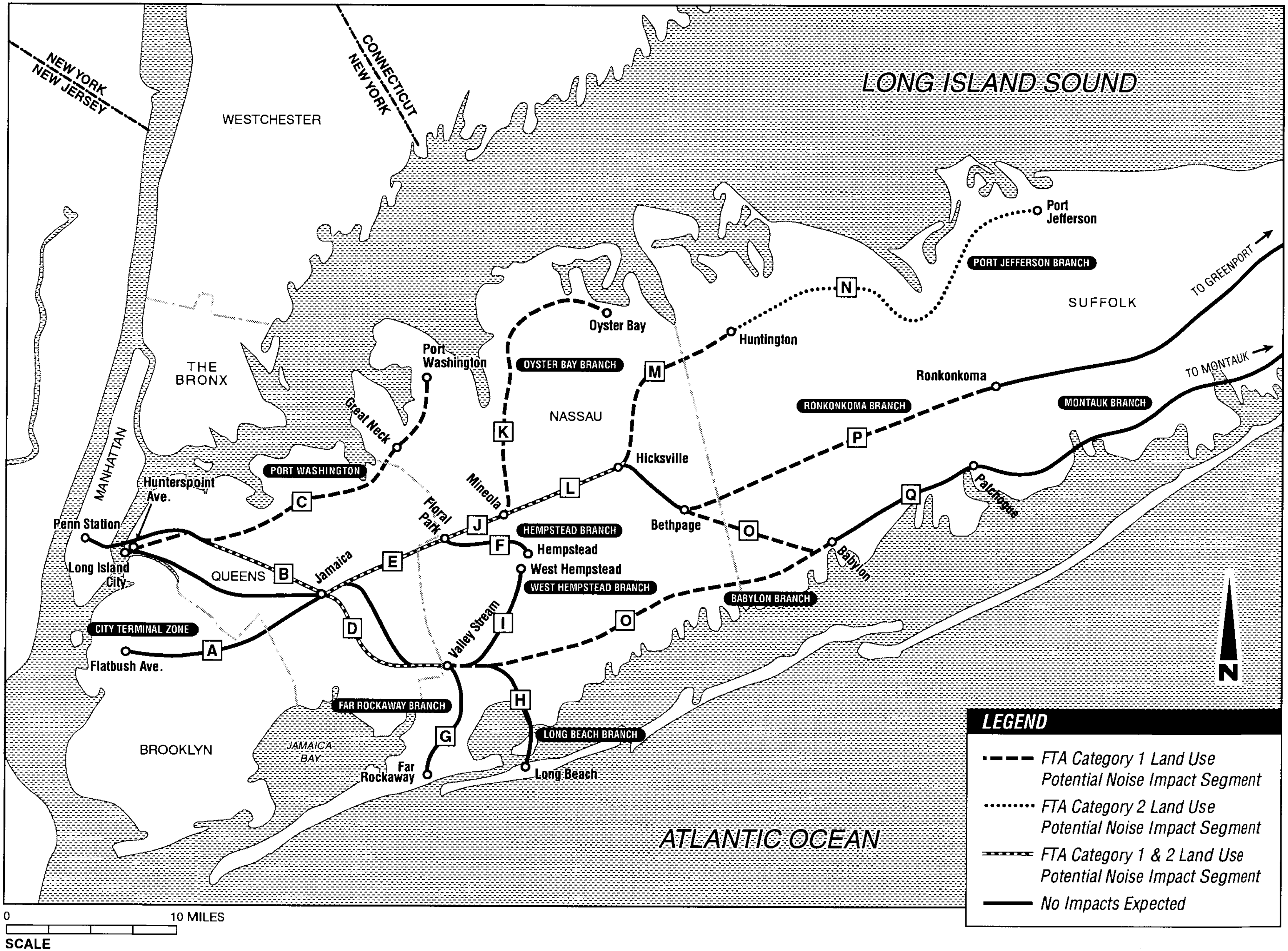
Detailed noise analysis was conducted for all rail segments where the general noise assessment indicated the potential for impacts. That analysis is provided later in this chapter.

REPLACEMENT YARDS

As discussed in Chapter 2, "Project Alternatives," the Preferred Alternative would involve construction at three rail yards in New York City—either Blissville or Maspeth Yard and Fresh Pond Yard in Queens and Highbridge Yard in the Bronx. This section assesses the potential noise impacts associated with relocating the displaced MNR and NYAR existing operations from Grand Central Terminal's (GCT) Madison Avenue facility and Yard A, respectively.

Blissville Yard—a former rail yard located on the Montauk Branch—would serve as the main replacement for the NYAR's lost storage at Yard A. Four unelectrified tracks with a storage capacity of approximately 60 freight cars would be constructed. In addition, track connections to the Montauk Branch would be restored. The land uses surrounding the yard are entirely

3•00



MTA / LIRR

East Side Access

Figure 11-2

General Noise Assessment Results

industrial, and the nearest residential use is more than 400 feet away with several intervening structures shielding use from the yard. In the future, it is expected that one train would use Blissville between 5 and 9 PM.

As an alternative to Blissville, storage for NYAR would be provided at Maspeth Yard, which is an active yard along the Montauk Branch 1¼ miles from Blissville Yard. *(However, as noted in Chapter 2, NYAR is no longer considering Maspeth Yard for this purpose.)* While the area surrounding the yard is predominantly industrial, there are several residential uses just past the southern end of the yard. The new storage tracks would be constructed in the part of the yard (northwest of Maspeth Avenue) that is entirely surrounded by industrial uses. Currently, three trains per day operate out of this yard and in the future, it is not expected that this level of activity would be exceeded. In fact, based on current expectations, only two trains per day may utilize Maspeth Yard. Therefore, the Preferred Alternative would not increase noise exposure at this location.

Fresh Pond Yard is located at the junction of the LIRR Montauk Branch and the Conrail Connector to the LIRR Bay Ridge Branch, and is the center of NYAR's freight operations. The Preferred Alternative would provide for a new maintenance facility to replace NYAR's current building at Yard A. The new maintenance building would be approximately in the middle of the yard. Although land uses in the area are predominantly residential, the yard is bordered, for the most part, by a buffer of industrial uses (see Chapter 3, "Land Use, Zoning, and Public Policy," for a more detailed discussion of land uses in the area). The maintenance building would be more than 700 feet away from any residential use. The addition of this facility in an active rail yard would not result in any perceptible noise impacts at sensitive receptors.

Highbridge is an existing, partially used MNR yard situated between the Harlem River and the Major Deegan Expressway. The Preferred Alternative would construct storage and service tracks for six electric train sets at this location. In addition, a car appearance facility and an employee parking area would also be provided. While not part of the Preferred Alternative, MNR's future plans for the yard include five storage and service tracks *for diesel-electric trains* and an enclosed Train Washer Facility.

In terms of sensitive land uses, the expressway and river form barriers between the yard and surrounding residential uses. The nearest residential use is approximately 400 feet from the center of the yard. Potential impacts were assessed for the midday storage of electric train sets for MNR's commuter operations.

The use of Highbridge Yard for daytime storage and servicing by the diesel-electric trains would not increase noise levels near the yard site. Currently, diesel-electric trains after the morning peak must go to Harmon Yard, 34 miles north of GCT, for midday servicing. In current operations, the northbound dual-mode locomotives travel north from GCT in electric mode, and switch from electric- to diesel-mode at 125th Street, which is 4.2 miles from GCT. They proceed from there in diesel mode, until reaching Harmon. Trains return from Harmon in the opposite manner before the PM peak period. In the future, MNR plans to reduce this round-trip by storing and servicing some of these trains at Highbridge. Since the Highbridge facility would be equipped with third-rail electric power and is only 6 miles from GCT, the dual-mode trains would operate in the electric mode from GCT to Highbridge and back to GCT. Therefore, between Highbridge and GCT, the number of train passbys would be the same with this new facility for diesel-electric trains as when trains continue to Harmon. Between Highbridge and Harmon, the number of diesel-mode *passbys would decrease. Consequently, no additional study was necessary for the diesel-electric portion of Highbridge Yard.*

Methodology and Data Input

A general noise assessment analysis was conducted for Highbridge and Blissville Yard sites using the procedures contained in the FTA guidance manual. At Highbridge, the analysis assessed the potential impacts of 11 electric train movements twice during the midday. At Blissville, the analysis was based on NYAR's operating requirements described above.

At each yard site, for purposes of the general noise assessment analysis, a receptor was selected at the nearest residence. Therefore, the land use at the sites is FTA Land Use Category 2 and impacts are assessed using the L_{dn} metric. For purposes of this assessment, existing noise levels were estimated using the FTA methodology based on population density (i.e., Table 5-7, "Estimating Existing Noise Exposure for General Assessment," contained in the FTA guidance document, *Transit Noise and Vibration Impact Assessment*).

Results

As summarized in Table 11-6, based on the results of the general noise assessment, the Preferred Alternative would not result in any impacts in the areas surrounding the replacement yard sites.

Table 11-6

General Noise Assessment of Replacement Yards

Noise Receptor Site	FTA Land Use Category*	Noise Descriptor	Existing Ambient Noise Level**	Allowable Project Noise Exposure Level		Predicted Project Noise Exposure Level	Result	Ambient Noise Level with Project
				Impact	Severe Impact			
Highbridge	2	L_{dn}	65.0	61.0	66.0	55.0	No Impact	65.4
Blissville	2	L_{dn}	65.0	61.0	66.0	47.0	No Impact	65.1

Notes:
* For definition of land use categories, see Table 11-2.
** Estimated value.

LONG ISLAND STORAGE YARDS

Each *illustrative Long Island* storage yard location *analyzed in this FEIS (see Chapter 2 for a full discussion)* was screened to determine whether any noise-sensitive receptors are located within the distance of project noise influence, in this case within 1,000 feet of the center of the proposed yard if there are intervening buildings (buildings in the source paths) and within 2,000 feet of the center of proposed yard if there are no obstructions in the source paths. For areas not screened out, further analysis was conducted.

As shown in Table 11-7, the analysis indicated that at one yard (Yaphank West), no potential for impact would occur; at the other *six* sites, further analysis was performed. For each of these sites a general noise assessment was performed following FTA criteria.

Table 11-7
Long Island Storage Yard Sites with Sensitive Receptors Within Screening Distances

FTA Land Use Category	Site						
	Cerro Wire	Babylon	Yaphank East	Yaphank West	Ronkon-koma	Pilgrim Hospital	Riverhead
2	Yes	Yes	Yes	No	Yes	Yes	Yes
3	Yes	No	No	No	No	Yes	Yes

Note: For definition of land use categories, see Table 11-2.

Methodology and Data Input

Following the FTA general noise assessment methodology, the following steps were taken at each of the analysis rail yards:

- Using Geographical Information Systems (GIS), aerial photographs, and field studies, the noise-sensitive receptors that were the closest sensitive land uses to the center of the yard sites were selected;
- Noise measurements were performed at each receptor site to establish existing conditions;
- Noise levels due to yard operations were calculated at each receptor site using the calculation procedures presented in the FTA guidance document; and
- Project-generated noise levels and project impacts at each receptor site were determined using the FTA impact criteria shown in Figure 11-1.

<u>Noise Receptor Locations</u>. The following is a brief description of the receptor sites for each of the yards examined:

- Site 1, Cerro Wire site: At Colony Lane between Linda Lane and Walnut Drive in Locust Grove. It is located in a residential area with 2-story houses. The nearest residences are located approximately 600 feet from the existing LIRR tracks and 900 feet from the center of proposed yard, if the yard is developed in a configuration across the Cerro Wire site and adjacent Syosset Landfill. Rail and local traffic dominate existing ambient noise levels.
- Site 2, Babylon site: At Union Boulevard between Hawley Avenue and Higbie Lane in Babylon. This site is in a low-rise residential area with 2-story houses. The nearest residences are located approximately 220 feet from the existing LIRR tracks and 150 feet from the center of proposed yard. At this location, traffic from Union Boulevard is a significant contributing factor to ambient noise levels.
- Site 3, Yaphank East site: At the end of Park Street in Yaphank, in a low-rise residential area with 2-story houses. The nearest residences are located approximately 90 feet from the existing LIRR tracks and 800 feet from the center of proposed yard. At this location train horn noise is a significant contributing factor to total ambient noise levels.
- Site 4, Ronkonkoma site: At the end of Latham Place in Ronkonkoma. It is adjacent to the existing Ronkonkoma Yard, in a residential area with 1- and 2-story houses. A 15-foot-high noise barrier is located along the property line of residential houses adjacent to the tracks. The nearest residences are located approximately 90 feet from the existing LIRR tracks and

650 feet from the center of proposed yard. Noise from rail uses dominates the existing ambient noise levels.

- Site 5, Pilgrim Hospital site: On Community College Road at Pilgrim Psychiatric Hospital in Edgewood. It is in a low-rise hospital area with 3-story residences. The nearest buildings are located approximately 1,200 feet from the center of proposed yard. Traffic from Community College Road dominates existing ambient noise levels.
- Site 6, Riverhead site: At Hubbard Avenue immediately adjacent to the tracks between Sandalwood Lane and Daly Drive in Riverhead. This site in a low-rise residential area with 1-story houses. The nearest residences are located approximately 80 feet from the existing LIRR tracks and 280 feet from the center of proposed yard. Train noise from the tracks dominates existing ambient noise levels.

The land use at all of the receptor sites is FTA Land Use Category 2. Therefore, impacts were assessed using the L_{dn} noise descriptor.

Existing Noise Levels. At each of the *six* receptor sites, noise levels were measured to determine existing $L_{eq(1)}$ noise levels, using the methodology described later in this chapter.

At each measurement site, full 1-hour measurements were made during a typical weekday hour when maximum rail activity occurs (i.e., between noon Monday and noon Friday). In accordance with FTA guidance, L_{dn} noise levels were estimated based on the hourly L_{eq} for the loudest hour of day.

As shown in Table 11-8, at Sites 1, 4, 5, and 6 existing L_{dn} noise levels ranged from 49.3 dBA to 57.4 dBA. Noise levels of this magnitude are considered "quiet" under FTA characterizations. At Sites *2 and 3*, existing L_{dn} noise levels were 72.5 and 70.9 dBA, respectively. Noise levels of this magnitude are considered "very noisy" under FTA characterizations. These high levels of noise are due to heavy traffic from Union Boulevard at Site 7 and the warning horn operations from trains passing the at-grade crossing at Site 3 and. At these two residential locations, measured noise was greater than 72.9 dBA L_{eq}—approaching the EPA-identified threshold noise level of 75 dBA $L_{eq(24\text{-hour})}$ to protect public health and welfare.

Table 11-8
Existing Noise Levels at Long Island Storage Yard Sites

Site	Location	Measured Noise Level ($L_{eq(1)}$)	Calculated Noise Level (L_{dn})
1	Cerro Wire	58.9	56.9
2	Babylon	74.5	72.5
3*	Yaphank East	72.9	70.9
3	Yaphank East	52.4	50.4
4	Ronkonkoma	51.3	49.3
5	Pilgrim Hospital	58.3	56.3
6	Riverhead	52.9	50.9

Note: * With warning horn.

<u>Calculation Procedure and Input Data</u>. A general noise assessment analysis was conducted for each of yards using the FTA calculation procedures previously described above (see "Replacement Yards"). Calculated noise levels were adjusted to account for any attenuation provided by natural shielding or barriers. Daily train movements in the analysis ranged from a low of 6 at Pilgrim Hospital, Riverhead, and Ronkonkoma sites to a maximum of *32* at the *Cerro Wire* site.

Results

Table 11-9 shows the existing ambient noise levels, calculated project-generated noise exposure level, and cumulative noise levels with the Preferred Alternative in place. (Details are provided in the noise technical appendix.) Based on the results of the general noise assessment, only a yard at Riverhead would result in a noise impact and the Preferred Alternative's project noise exposure would only exceed the FTA criteria by 0.2 dB. A 10-foot-high noise barrier would eliminate the potential impact at this location.

Table 11-9
General Noise Assessment of Long Island Yard Sites

Site	Location	Land Use Category	Noise Descriptor	Existing Noise Level	Allowable Project Noise Exposure Level		Predicted Project Noise Exposure Level	Result	Build Noise Level
					Impact	Severe Impact			
1	Cerro Wire	2	L_{dn}	56.9	56.2	61.9	48.3	No Impact	57.5
2	Babylon	2	L_{dn}	72.5	65.0	71.3	60.0	No Impact	72.7
*3**	Yaphank E	2	L_{dn}	70.9	65.0	70.1	46.1	No Impact	71.0
3	Yaphank E	2	L_{dn}	50.4	53.5	59.7	46.1	No Impact	51.8
4	Ronkonkoma	2	L_{dn}	54.4	55.0	60.9	40.1	No Impact	54.6
5	Pilgrim	2	L_{dn}	56.3	55.9	61.7	39.8	No Impact	56.4
6	Riverhead	2	L_{dn}	50.9	53.7	59.8	53.8	Impact	55.6

Note: * Includes noise from train warning horns.

DETAILED NOISE ANALYSIS

INTRODUCTION

At the rail segments where the general noise assessment indicated the potential for impacts, a detailed noise analysis was performed in compliance with the procedures contained in the FTA guidance manual. The purpose of a detailed analysis is to make a prediction of impact and an assessment of the effectiveness of mitigation with greater precision than can be achieved with the general assessment methodology.

Based on the results of the general noise assessment, a detailed noise analysis was carried out for the following rail segments—Woodside to Jamaica, Jamaica to Floral Park, and Jamaica to Valley Stream in Queens, Floral Park to Mineola; Mineola to Hicksville, and Valley Stream to Babylon in Nassau County; and Farmingdale to Ronkonkoma and Hicksville to Port Jefferson in Suffolk County.

NOISE PREDICTION METHODOLOGY

In general, the methodology utilized for the detailed noise analysis contained the following steps: on each of the analysis rail segments, noise-sensitive receptors sites which were near and adjacent to the railroad right-of-way were selected using Geographical Information Systems (GIS), aerial photographs, and field studies; noise measurement was performed at each receptor site to establish existing conditions; noise levels due to rail operations were calculated at each receptor site, using the calculation procedures contained in the FTA guidance document, for the project alternatives; noise levels due to non-rail noise sources at each receptor site were estimated by subtracting calculated existing rail noise from measured noise levels; the total future noise levels for each project alternative at each receptor site were calculated by adding rail noise to non-rail noise levels; project generated noise levels and project impacts at each receptor site were determined using the FTA impact criteria shown in Figure 11-1; and finally, at receptor sites where impacts or severe impacts were predicted to occur the feasibility of possible mitigation measures was examined.

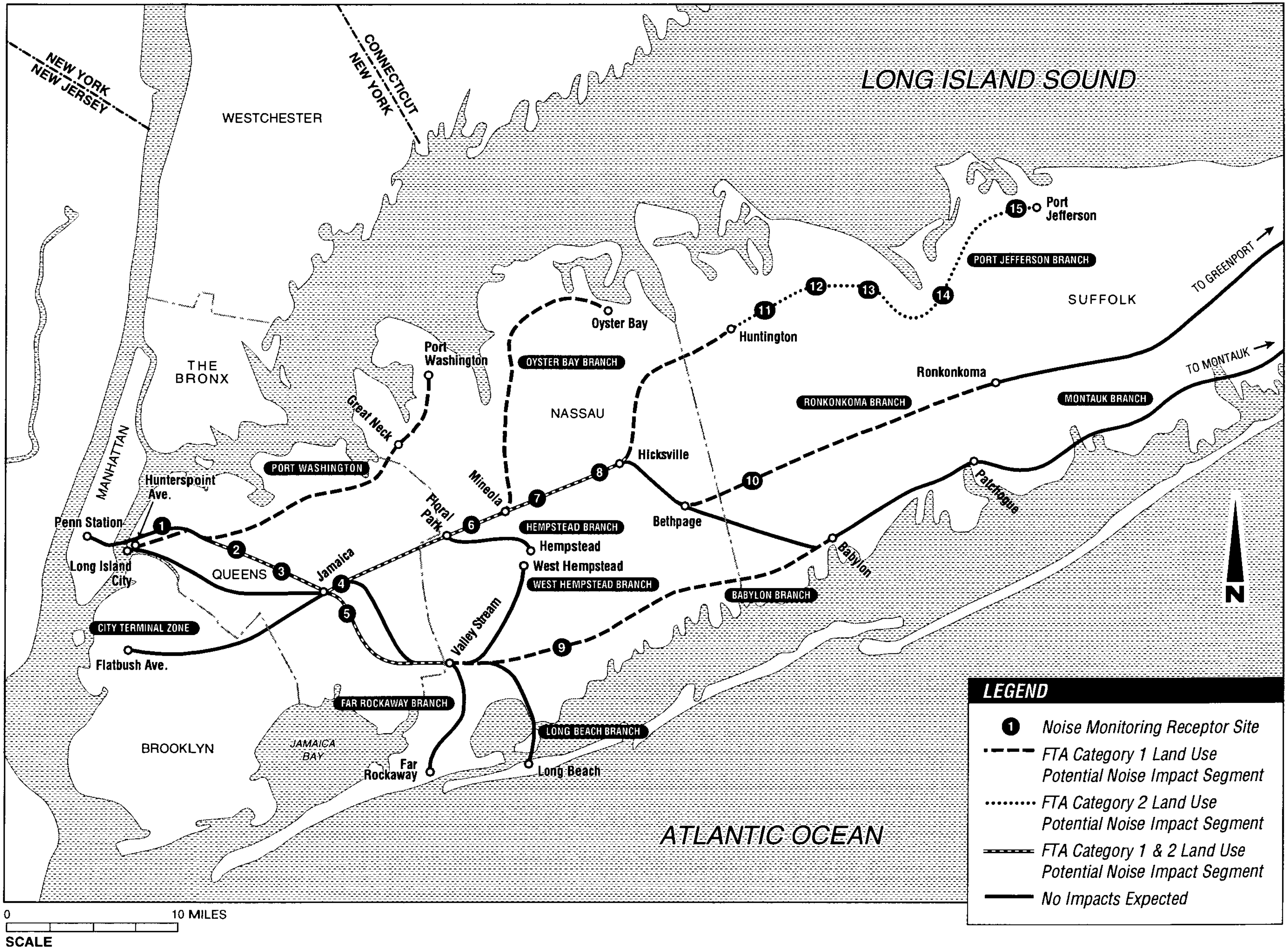
SELECTION OF NOISE RECEPTOR SITES

As shown in Figure 11-3 and Table 11-10, the 15 sites selected are each adjacent to noise-sensitive land uses. Noise measurements were typically made at locations that were on public streets rather than on private property at residences, and adjusted based upon distance from the track to reflect the noise levels at the closest appropriate receptor site to the railroad right-of-way. They were selected based initially on an examination of GIS data for the rail segments which were previously identified as having the potential for project impacts. No category 1 sites were identified adjacent to the Port Washington Branch, Oyster Bay Branch, or between Hicksville and Huntington stations. Field studies were then performed to confirm that each site has a sensitive land use, that rail noise is the dominant noise source, and that each site is generally the closest sensitive receptor location to the rail tracks. Based on the above criteria, each receptor site should yield maximum project impacts (i.e., other potential receptor sites in the general location of the selected receptor sites, would be expected to have smaller project impacts than the selected receptor sites). In addition, the 15 sites were selected to provide geographic coverage of the areas that may potentially be impacted by the proposed project (i.e., they were spread over the various segments of the rail line potentially impacted by the proposed project).

The following is a brief description of each of the receptor sites:

- Site 1 is located at Barnett Avenue in Sunnyside, Queens. It is located adjacent to the Woodside to Jamaica segment, in a historical residential area with 2-story private houses, as well as some 7-story apartment buildings. The rail tracks at this location are at-grade. The nearest residences are located approximately 90 feet from the tracks. The receptor was shielded by some garage structures from the tracks. Traffic from Barnett Avenue contributes to the total ambient noise levels.

- Site 2 is located at the end of 63rd Avenue near the rail track in Rego Park, Queens. It is located adjacent to the Woodside to Jamaica segment, in a low-rise residential area with 2-story houses. The rail tracks at this location are at-grade. The nearest residences are located approximately 90 feet from the tracks.



MTA / LIRR
East Side Access

Figure 11-3
Noise Monitoring Receptor Sites

Table 11-10
Noise Receptor Sites and Locations

Site	Location	Segment	FTA Land Use Category
1	Barnett Ave. between 46th and 48th Streets	Woodside to Jamaica	2
2	63rd Ave. between Alderton and Austin Streets	Woodside to Jamaica	2
3	Burns St. between Tennis Road and 69th Avenue	Woodside to Jamaica	1 & 2
4	175th St. between Archer and Douglas Avenues	Jamaica to Floral Park	2
5	Smith St. between 119th & 129th Avenues	Jamaica to Valley Stream	2
6	Main St. between Plainfield Avenue and Granger Street	Floral Park to Mineola	2
7	Post Ave. between Orchard and Madison Streets	Mineola to Hicksville	2
8	Kinkel St. between Railroad Avenue and Broadway	Mineola to Hicksville	2
9	Commercial Street	Valley Stream to Babylon	1
10	Between Little East Neck Road and Wellwood Avenue	Farmingdale to Ronkonkoma	1
11	Railroad between Cuba Road and Breen Avenue	Huntington to Port Jefferson	2
12	Bark Pl. between Old Bridge Road and Gilder Street	Huntington to Port Jefferson	2
13	End of Knob Hill Drive near Hilltop Drive	Huntington to Port Jefferson	2
14	North Country between Lynam St. and Woodlawn Ave.	Huntington to Port Jefferson	2
15	End of Baylis Avenue near North Country Road	Huntington to Port Jefferson	2

Note: For definition of land use categories, see Table 11-2.

- Site 3 is located on Burns Street in Forest Hills, Queens. It is adjacent to the Woodside to Jamaica segment, in a high-rise residential area with 7-story apartment buildings. Besides residential uses, the Forest Hill Stadium, a FTA category 1 land use, is also adjacent to the tracks at this location. The rail tracks at this location are elevated approximately 10 feet above the street. The nearest residences are located approximately 95 feet from the tracks. Traffic from Burns Street contributes to the total ambient noise levels.
- Site 4 is located at the end of 175th Street in Jamaica, Queens. It is adjacent to the Jamaica to Floral Park segment, in a low-rise residential area with 2-story houses. The rail tracks at this location are at two levels: at-grade and elevated approximately 15 feet. The nearest residences are located approximately 60 feet from the tracks.
- Site 5 is located at Smith Street in Jamaica, Queens. It is adjacent to the Jamaica to Valley Stream segment, in a low-rise residential area with 2-story houses. The rail tracks at this location are elevated approximately 15 feet above grade. The nearest residences are located approximately 60 feet from the tracks.
- Site 6 is located at Main Street in the Village of Floral Park, in Nassau County. It is adjacent to the Floral Park to Mineola segment, in a low-rise residential area with 2-story houses. The rail tracks at this location are elevated approximately 10 feet above grade. The nearest residences adjacent the track are approximately 55 feet from the tracks.
- Site 7 is located in the Village of Carle Place, in Nassau County. It is adjacent to the Mineola to Hicksville segment, in a high-rise residential area with 10-story apartment buildings. The rail tracks at this location are at-grade. The nearest residences are located approximately 60 feet from the tracks. The receptor was approximately 30 feet from the rail track, in the rear parking area of a high-rise apartment building.

- Site 8 is located at Kinkel Street and Railroad Avenue in the Village of New Cassel, in Nassau County. It is adjacent to the Floral Park to Mineola segment, in a low-rise residential area with 2-story private houses. The rail tracks at this location are at-grade. The nearest residences are located approximately 70 feet from the tracks. At this location train horn noise is a significant contributing factor to total ambient noise levels. In addition, traffic from Urban Avenue contributes to the total ambient noise levels.
- Site 9 is located at the border of Freeport and Merrick, in Nassau County. It is adjacent to the Valley Stream to Babylon segment, in a portion of Roosevelt Park, a Nassau County park, near 28th Street. The rail tracks at this location are at-grade.
- Site 10 is located in the Town of Babylon, in Nassau County. It is adjacent to the Farmingdale to Ronkonkoma segment, in a portion of Colonial Springs Golf Course, which represented other adjacent and nearby park areas. The rail tracks at this location are at-grade. Traffic from Long Island Avenue contributes to the total ambient noise levels.
- Site 11 is located on Railroad Street, at a distance of 30 feet to the tracks, in the Village of Greenlawn, in Suffolk County. It is adjacent to the Hicksville to Port Jefferson segment, in a low-rise residential area with 2-story private houses. The rail tracks at this location are at-grade. The nearest residences are approximately 90 feet from the tracks. At this location train horn noise is a significant factor in terms of total ambient noise levels. In addition, traffic from Cuba Road contributes to the total ambient noise levels.
- Site 12 is located on Bark Lane in the Village of East Northport, in Suffolk County. It is adjacent to the Hicksville to Port Jefferson segment, in a low-rise residential area with 2-story private houses. The rail tracks at this location are at-grade. The nearest residences are approximately 60 feet from the tracks. The noise receptor, approximately 115 feet from the tracks, was shielded from the tracks by one row of houses.
- Site 13 is located on Knob Hill Drive in the Town of Smithtown, in Suffolk County. It is adjacent to the Hicksville to Port Jefferson segment, in a low-rise residential area with 2-story private houses. The rail tracks at this location are at-grade. The nearest residences are approximately 100 feet from the tracks.
- Site 14 is located just off North Country Road in the Village of St. James, in Suffolk County. It is adjacent to the Hicksville to Port Jefferson segment, at a location adjacent to a health-care center and 2-story apartment buildings. The rail tracks at this location are at-grade. The receptor was approximately 70 feet from the tracks, and the nearest residences are approximately 80 feet from the tracks.
- Site 15 is located at the end of Baylis Avenue in the Village of Port Jefferson Station, in Suffolk County. It is adjacent to the Hicksville to Port Jefferson segment, in a low-rise residential area with 2-story private houses. The rail tracks at this location are at-grade. The nearest residences are approximately 35 feet from the tracks.

NOISE MONITORING

At each of the 15 receptor sites noise levels were measured to determine existing L_{dn} and/or $L_{eq(1)}$ noise levels. Measurements were made during September, October, and early November 1999. For residential land uses, full 24-hour measurements were made during a typical weekday, between noon Monday and noon Friday. For non-residential land uses, peak hour measurements were made during the weekday hour when maximum rail activity occurs.

With the exception of sites 9 and 10, 24-hour noise monitoring was conducted. Measurements at these location were made on the A-scale (dBA) for a sampling period of 1 hour, throughout a 24-hour measurement period. At sites 9 and 10, 60-minute noise monitoring was conducted.

For both the 24-hour and 1-hour measurements, the noise analyzer was mounted at a height of approximately 5 feet above the ground. Both analyzers were calibrated before and after readings. Data were digitally recorded by the noise analyzer and displayed at the end of the sampling period in units of dBA. Measured quantities included L_{eq}, L_1, L_{10}, L_{50}, L_{90}, and L_{max}. A windscreen was used during all sound measurements, except for calibration. All measurement procedures conformed with the requirements of ANSI Standard S1.13-1971 (R1976).

RAIL NOISE PREDICTION METHODOLOGY

The FTA guidance manual procedure and formulas for calculating rail noise were utilized to determine noise from train operations. Using the FTA methodology, $L_{eq(1)}$ and L_{dn}, noise levels for free-field acoustic conditions (no reflections above ground) from fixed-rail sources were determined based on a variety of factors, including the number of rail cars, train speed, distance to receptor, the surrounding terrain, and in the case of diesel trains, the number of locomotives. It should be noted that the analysis conservatively assumes a source reference value of 108 dB for locomotive warning horn noise for the existing conditions and No Action and Build Alternatives. LIRR has recently started a program to retrofit locomotives with a warning horn that will result in a significantly less-intrusive horn sound that will comply with the minimum 96 dB standard required by the Federal Railroad Administration.

Table 11-11 shows passbys* and speed data used for detailed noise assessment calculations.

Table 11-11

Input Train Data for Detailed Noise Analysis

Segment	Site No.	Speed (mph)	Existing: 7 AM to 10 PM	Existing: 10 PM to 7 AM	Existing: Peak Hour	No Action Alternative (2020): 7 AM to 10 PM	No Action Alternative (2020): 10 PM to 7 AM	No Action Alternative (2020): Peak Hour	Preferred Alternative (2020): 7 AM to 10 PM	Preferred Alternative (2020): 10 PM to 7 AM	Preferred Alternative (2020): Peak Hour
Woodside to Jamaica[E/D]	1-3	80	360/27	81/1	41/6	311/75	80/13	39/13	418/75	103/13	61/13
Jamaica to Floral Park[E/D]	4	80	170/50	65/14	22/8	151/96	74/26	17/14	189/96	54/26	28/14
Jamaica to Valley Stream[E/D]	5	70	222/6	78/4	29/2	223/0	78/0	27/0	284/0	89/0	42/0
Floral Park to Mineola[E/D]	6	80	122/55	51/15	15/8	110/96	51/26	14/14	132/96	38/26	22/14
Mineola to Hicksville[E/D]	7-8	80	122/24	53/6	15/7	110/62	50/20	14/10	132/62	38/20	22/10
Valley Stream to Babylon[E]	9	80	NA	NA	14	NA	NA	14	NA	NA	17
Farmingdale to Ronkonkoma[E]	10	80	NA	NA	5	NA	NA	5	NA	NA	8
Huntington to Port Jefferson[D]	11-15	65	26	12	3	41	18	6	41	18	6

Note: E-Electric, D-Diesel, E/D-Electric/Diesel.

NON-RAIL NOISE

While rail noise was the dominant noise source at each of the receptor sites, other sources (e.g., vehicular traffic, aircraft, children playing, neighborhood noise, etc.) contributed to total ambient noise levels. This component of the total ambient noise levels was determined by

* Train passbys at a given location consist of both trains with passengers and those not in service but headed to a yard or terminal station.

subtracting calculated existing rail noise from measured noise level. For future conditions, noise from these sources were assumed to be unchanged from existing conditions.

EXISTING CONDITIONS

As shown in Table 11-12, the measured noise levels at residential locations ranged between 63.7 dBA L_{dn} and 86.1 dBA L_{dn}. These existing noise levels are considered "very noisy" under FTA characterizations. This high level of noise is due to the density of rail operations in the study area. At several residential locations measured L_{dn} noise levels were greater than 75 dBA. Measured $L_{eq(1)}$ noise levels at park land sites ranged between 69.0 dBA and 77.0 dBA. (Additional detailed monitoring data are provided in the noise technical appendix.)

Table 11-12

Existing Noise Levels

LIRR Receiver	Noise Descriptor	Measured Total Noise Level	Calculated Rail Noise Level	Calculated Non-Rail Noise Level
1	L_{dn}	69.6	67.7	65.2
2	L_{dn}	71.0	69.3	66.2
3	L_{dn}	74.7	73.6	68.6
3	L_{eq}	77.6	74.0	75.2
4	L_{dn}	76.7	75.9	69.0
5	L_{dn}	75.8	74.4	70.2
6	L_{dn}	77.2	76.9	65.0
7	L_{dn}	80.8	80.6	68.3
8	L_{dn}	75.6	74.9	67.1
9	L_{eq}	69.0	69.0	44.5
10	L_{eq}	77.3	73.5	75.0
11	L_{dn}	86.1	84.8	80.0
12	L_{dn}	63.7	61.7	59.3
13	L_{dn}	70.5	69.0	65.3
14	L_{dn}	68.2	67.5	60.0
15	L_{dn}	79.0	77.9	72.4
Note: * Includes noise from train warning horns.				

At all 15 receptors sites, noise from trains is the dominant noise source. Warning horn noise contributed to total noise levels at 10 of the 15 sites. At Site 8, warning horn noise was the dominant noise source.

PROBABLE IMPACTS OF THE PROJECT ALTERNATIVES

The following discussion analyzes possible noise impacts that could result from operation of the project alternatives.

NO ACTION ALTERNATIVE

Future noise levels for the No Action Alternative, were calculated using the methodology previously described. Table 11-13 shows the calculated No Action Alternative noise levels and existing noise levels. (Details are provided in the noise technical appendix.) As shown in Table 11-13, the maximum increase in Ldn values would be 3.1 dBA when comparing No

Table 11-13
Impact Evaluation of Noise from the No Action Alternative

Noise Receptor Site	Land Use Category	Noise Descriptor	Existing Noise Level*	No Action Noise Level
1	2	L_{dn}	68.0	69.7
2	2	L_{dn}	71.3	73.0
3	2	L_{dn}	72.2	74.1
3	1	L_{eq}	77.6	78.6
4	2	L_{dn}	77.2	78.9
5	2	L_{dn}	76.3	77.1
6	2	L_{dn}	77.2	78.9
7	2	L_{dn}	76.3	78.3
8	2	L_{dn}	75.6	74.1
9	1	L_{eq}	69.0	69.3
10	1	L_{eq}	69.3	69.3
11	2	L_{dn}	79.2	80.8
12	2	L_{dn}	67.9	70.4
13	2	L_{dn}	67.3	70.0
14	2	L_{dn}	67.3	70.4
15	2	L_{dn}	77.6	80.5

Notes:
* Adjusted to values at nearest residence.
For definition of land use categories, see Table 11-2.

Action noise levels with existing noise levels, and the maximum increase in Leq(1) values would be 1.0 dBA when comparing No Action noise levels with existing noise levels. These changes are due to changes in service predicted to occur without the proposed project (e.g., changes in the number of trains, electric and diesel consists, etc.). These changes would result in impacts at most receptor sites, and severe impacts at two receptor sites, when FTA impact criteria were applied to this alternative. As previously discussed, a severe impact denotes an increase in noise level that is perceived by most people as annoying while an impact is noticeable but not sufficient to result in adverse community reaction. At Site 8, the No Action Alternative noise level would be less than the existing noise level because by the year 2020 LIRR would eliminate eight locations on this segment of track with at-grade street crossings by grade separation or street closing, thereby eliminating train warning horn noise and reducing noise levels.

The noise results presented above, while calculated at specific receptor sites, reflect effects of the No Action Alternative at comparable locations along the specified rail segment. Similar increases in noise level may occur one or two blocks further away from the track (depending on the shielding provided by buildings, and vehicular noise levels from traffic on the adjacent street). The additional trains with the No Action Alternative (compared to existing conditions) would increase the number of trains passbys at all 15 of the receptor sites and consequently increase the number (but not the magnitude) of intrusive passby events.

TSM ALTERNATIVE

The TSM Alternative would increase LIRR train length, and would increase service to the LIRR Hunterspoint Avenue and Long Island City stations.

In general, increasing the train length would result in noise levels that would be slightly (but not appreciably) higher that those for the No Action Alternative. The maximum change in L_{dn} values would be approximately 3.2 dBA when comparing TSM Alternative noise levels with existing noise levels, and the maximum change in $L_{eq(1)}$ values would be 1.1 dBA when comparing TSM Alternative noise levels with existing noise levels. Based on FTA impact criteria, these changes would result in impacts at most receptor sites, and severe impacts at a few receptor sites. The additional trains with the TSM Alternative (compared to existing conditions) would increase the number of trains passbys at all 15 of the receptor sites and consequently increase the number (but not perceptibly change the magnitude) of intrusive passby events.

In general, the increase in service between the LIRR Hunterspoint Avenue and Long Island City stations would result in an increase in noise levels at any sensitive receptor sites adjacent to this portion of track. There are few sensitive receptors immediately adjacent to this portion of track (i.e., the predominant land use is industrial). However, because existing noise levels in this area are high, it is likely that the increase in the number of trains with the TSM Alternative would result in impacts, and possibly severe impacts, at any sensitive receptor sites adjacent to the track on this segment of the rail line. In addition, the additional trains with the TSM Alternative (compared with existing conditions) would increase the number of train passbys at locations adjacent to this segment of the rail line and consequently increase the number of intrusive passby events.

PREFERRED ALTERNATIVE

Increased Rail Operations in Queens, Nassau, and Suffolk Counties

Future noise levels for the Preferred Alternative were calculated using the methodology previously described at locations in Queens and Long Island due to increased rail operations. Table 11-14 shows the calculated project noise exposure (i.e., project-generated noise) cumulative build noise levels, and existing noise levels. (Details are provided in the noise technical appendix.) The maximum change in L_{dn} values would be 3.1 dBA when comparing Preferred Alternative noise levels with existing noise levels, and the maximum change in $L_{eq(1)}$ values would be 1.7 dBA when comparing Preferred Alternative noise levels with existing noise levels. In general, noise levels with the Preferred Alternative would be slightly higher than noise levels with the No Action Alternative.

At the nearest residences on Barnett Avenue adjacent to Site 1, the total ambient L_{dn} noise level with the Preferred Alternative would increase by 2.1 dBA compared to existing levels, which is not perceptible. However, the project noise exposure L_{dn} level would be approximately 66.0 dBA, which would be above the FTA impact criteria value of 62.9 dBA. Therefore, at Site 1, noise due to the Preferred Alternative would have an impact based on FTA noise impact criteria.

At the nearest residences on 63rd Avenue adjacent to Site 2, the L_{dn} noise level with the Preferred Alternative would increase approximately 2.2 dBA compared to existing levels. The project-noise exposure L_{dn} level would produce L_{dn} noise levels of approximately 69.5 dBA, which would be above the FTA impact criteria value of 65.0 dBA. Therefore, at Site 2 noise with the Preferred Alternative would have an impact based on FTA noise impact criteria.

Table 11-14
Impact Evaluation of Noise from the Preferred Alternative

Noise Site	Segment[a]	FTA Land Use Category[b]	Noise Descriptor	Existing Ambient Noise Level[c]	Allowable Project Noise Exposure Level[d]		Predicted Project Noise Exposure Level[d]	Result	Ambient Noise Level with Project
					Impact	Severe Impact			
1	Woodside to Jamaica	2	L_{dn}	68.0	62.9	68.1	66.0	Impact	70.1
2	Woodside to Jamaica	2	L_{dn}	71.3	65.0	70.4	69.5	Impact	73.5
3	Woodside to Jamaica	2	L_{dn}	72.2	65.0	71.1	70.9	Impact	74.7
3	Woodside to Jamaica	1	L_{eq}	77.6	65.0	75.3	74.2	Impact	79.3
4	Jamaica to Floral Park	2	L_{dn}	77.2	65.0	75.0	71.1	Impact	78.2
5	Jamaica to Valley Stream	2	L_{dn}	76.3	65.0	74.2	70.0	Impact	77.2
6	Floral Park to Mineola	2	L_{dn}	77.2	65.0	75.0	71.6	Impact	78.3
7	Mineola to Hicksville	2	L_{dn}	76.3	65.0	74.2	65.8	Impact	76.7
8	Mineola to Hicksville	2	L_{dn}	75.6	65.0	73.7	60.8	No Impact	72.8[e]
9	Valley Stream to Babylon	1	L_{eq}	69.0	63.6	68.8	63.5	No Impact	70.1
10	Farmingdale to Ronkonkoma	1	L_{eq}	69.3	63.8	69.0	57.1	No Impact	69.5
11	Huntington to Port Jefferson	2	L_{dn}	79.2	65.0	75.0	75.9	Severe Impact	80.8
12	Huntington to Port Jefferson	2	L_{dn}	67.9	63.8	68.9	66.8	Impact	70.4
13	Huntington to Port Jefferson	2	L_{dn}	67.3	62.4	67.7	66.7	Impact	70.0
14	Huntington to Port Jefferson	2	L_{dn}	67.3	62.5	67.7	67.5	Impact	70.4
15	Huntington to Port Jefferson	2	L_{dn}	77.6	65.0	75.0	77.4	Severe Impact	80.5

Notes:
a Adjusted to values at nearest receptor.
b For definition of land use categories, see Table 11-2.
c See Figure 11-3 and Table 11-11 for locations.
d Definitions of noise exposure levels, etc., are found in Figure 11-1.
e As noted in the text, the ambient noise levels at Site 8 will decrease in the future because of LIRR's grade crossing elimination program.

At the nearest residences on Burns Street adjacent to Site 3, the L_{dn} noise level with the Preferred Alternative would increase approximately 2.5 dBA compared to existing levels. The project-noise exposure L_{dn} level would produce L_{dn} noise levels of approximately 70.9 dBA, which would be above the FTA impact criteria value of 65.0 dBA. At Site 3, noise with the Preferred Alternative would have an impact based on FTA noise impact criteria. In addition, the peak hour L_{eq} noise level (Category 1 land use) with the Preferred Alternative would increase approximately 1.7 dBA compared to existing levels. The project-noise exposure L_{eq} level would produce L_{eq} noise levels of approximately 74.2 dBA, which would be above the FTA impact criteria value of 65.0 dBA. Therefore, at Site 3 noise with the Preferred Alternative would have an impact based on FTA noise impact criteria for Category 1 and Category 2 land uses.

At the nearest residences on 175th Street adjacent to Site 4, the L_{dn} noise level with the Preferred Alternative would increase 1.0 dBA compared to existing levels. The project-noise exposure L_{dn} level would be approximately 71.1 dBA, which would be above the FTA impact criteria value of 65.0 dBA. Therefore, at Site 4, noise with the Preferred Alternative would have an impact based on FTA noise impact criteria.

At the nearest residences on Smith Street adjacent to Site 5, the L_{dn} noise level with the Preferred Alternative would increase 0.9 dBA compared to existing levels. The project-noise exposure L_{dn} level would be approximately 70.0 dBA, which would be above the FTA impact criteria value of 65.0 dBA. Therefore, at Site 5, noise with the Preferred Alternative would have an impact based on FTA noise impact criteria.

At the nearest residences on Main Street adjacent to Site 6, the L_{dn} noise level with the Preferred Alternative would increase 1.1 dBA compared to existing levels. The project-noise exposure L_{dn} level would be approximately 71.6 dBA, which would be above the FTA impact criteria value of 65 dBA. Therefore, at Site 6, noise with the Preferred Alternative would have an impact based on FTA noise impact criteria.

At the nearest residences on Post Avenue adjacent to Site 7, existing noise levels are relatively high, and the L_{dn} noise level with the Preferred Alternative would increase 0.4 dBA compared to existing levels. The project-noise exposure L_{dn} level with the Preferred Alternative would be approximately 65.8 dBA, which would be above the FTA impact criteria value of 65.0 dBA. Therefore, at Site 7, noise due to the Preferred Alternative would have an impact based on FTA noise impact criteria.

At the nearest residences on Kinkel Street adjacent to Site 8, where existing ambient noise levels are affected by noise from train warning horns as trains approach the Urban Avenue and Railroad Avenue at-grade crossing, the L_{dn} noise level with the Preferred Alternative would decrease by 2.8 dBA compared to existing levels. This decrease in noise levels comes from the elimination of at-grade crossings and the need to use the horn along this track segment. The project noise exposure L_{dn} level would be approximately 60.8 dBA, which would be below the FTA impact criterion of 65.0 dBA. Therefore, at Site 8 the Preferred Alternative would not have an impact based on FTA noise impact criteria.

At Roosevelt Park adjacent to Site 9, the L_{eq} noise level with the Preferred Alternative would increase 1.1 dBA compared to existing levels. The project noise exposure L_{eq} level would be approximately 63.5 dBA, which would be below the FTA impact criteria value of 63.6 dBA. Therefore, at Site 9, noise with the Preferred Alternative would not have an impact based on FTA noise impact criteria.

At Colonial Springs Golf Course near 28th Street adjacent to Site 10, a Category 1 land use site, the L_{eq} noise level with the Preferred Alternative would increase 0.2 dBA compared to existing levels. The project noise exposure L_{eq} noise level would be approximately 57.1 dBA, which would be below the FTA impact criteria value of 63.8 dBA. Therefore, at Site 10, noise with the Preferred Alternative would have no impact based on FTA noise impact criteria.

At the nearest residences on Railroad Street adjacent to Site 11, where existing ambient noise levels are relatively high and are affected by noise from train warning horns as the trains approach the Cuba Avenue and Railroad Street at grade crossing, the L_{dn} noise level with the Preferred Alternative would increase 1.6 dBA compared to existing levels. The project noise exposure L_{dn} level would be approximately 75.9 dBA, which would be above the FTA severe impact criteria value of 75.0 dBA. At Site 11, noise with the Preferred Alternative would have a severe impact based on FTA noise impact criteria. In addition, even without the train warning horn, the L_{dn} noise level would result in severe noise impacts per FTA criteria.

At the nearest residences on Bark Lane adjacent to Site 12, where existing ambient noise levels are relatively low, the L_{dn} noise level with the Preferred Alternative would increase 2.5 dBA compared to existing levels. The project noise exposure L_{dn} level would be approximately 66.8 dBA, which would be above the FTA impact criteria value of 63.8 dBA. Therefore, at Site 12, noise with the Preferred Alternative would have an impact based on FTA noise impact criteria.

At the nearest residences on *Knob Hill Drive* adjacent to Site 13, the L_{dn} noise level with the Preferred Alternative would increase 2.7 dBA compared to existing levels. The project noise exposure L_{dn} level would be approximately 66.7 dBA, which would be above the FTA impact criteria value of 62.4 dBA. Therefore, at Site 13, noise with the Preferred Alternative would have an impact based on FTA noise impact criteria.

At the nearest residences on *North Country Road* adjacent to Site 14, the L_{dn} noise level with the Preferred Alternative would increase 3.1 dBA compared to existing levels. The project noise exposure L_{dn} level would be approximately 67.5 dBA, which would be above the FTA severe impact criteria value of 62.5 dBA. Therefore, at Site 14, noise with the Preferred Alternative would have an impact based on FTA noise impact criteria.

At the nearest residences on Baylis Avenue adjacent to Site 15, the L_{dn} noise level with the Preferred Alternative would increase 2.9 dBA compared to existing levels. The project noise exposure L_{dn} level would be approximately 77.4 dBA, which would be above the FTA severe impact criteria value of 75.0 dBA. Therefore, at Site 15, noise with the Preferred Alternative would have a severe impact based on FTA noise impact criteria.

The noise results presented above, while calculated at specific receptor sites, reflect effects of the Preferred Alternative at comparable locations along the specified rail segment. At locations where impacts or severe impacts are predicted to occur, these impacts would also occur at comparable locations along the specified rail segment, and may also occur one or two blocks further away from the track (depending on the shielding provided by buildings, and vehicular noise levels from traffic on the adjacent street).

To summarize, based on FTA criteria, noise impacts would occur at most residential properties adjacent to the railroad between Woodside and Hicksville stations; Jamaica and Valley Stream stations; and Huntington and Port Jefferson stations. There are more than 400 residences located adjacent to the 47 miles of track where noise "impacts" are predicted to occur. In certain locations between Huntington and Port Jefferson, noise levels would exceed FTA criteria for "severe impacts" (see Table 11-15). The wayside noise impacts along this segment are a direct result of operating more dual-mode trains, which would occur under the No Action and TSM Alternatives as well. By *the end of* 2000, LIRR is planning to operate all of the dual-mode trains it currently owns to provide direct service between the Port Jefferson Branch and Penn Station. As shown in Table 11-11, the number of trains on this branch will increase from the current 38 per day to 59 per day under all of the project alternatives. There are approximately 52 residences that are located adjacent to the approximately 2.7 miles of track where "severe" impacts are predicted to occur.

Other Project-Related Noise

Stationary source mechanical equipment (i.e., ventilation facilities, power substations, etc.) would be designed so that noise produced by operation of this equipment would not result in noise impacts. The Preferred Alternative would require the addition of new ventilation facilities beneath either 54th Street (Option 1) or 55th Street (Option 2), as well as the expansion of existing above-grade facilities in other locations in Manhattan, Roosevelt Island, and Queens. In addition, the Preferred Alternative would require a new ventilation building at 47 East 44th

Table 11-15
Summary of Locations and Approximate Lengths of Track (feet) With Impacts and Severe Impacts

Segment	Length of Track with	
	Impact	Severe Impact
Woodside to Jamaica	37,000	
Jamaica to Floral Park	29,000	
Jamaica to Valley Stream	39,000	
Floral Park to Mineola	17,000	
Mineola to Hicksville	25,000	
Huntington to Port Jefferson	103,000	14,000
Totals	**250,000**	**14,000**

Street. Under Option 1, this new building would be used for emergency ventilation only. Under Option 2, this new building would house emergency ventilation equipment and also house gas-fired chiller equipment on its roof to provide heating, ventilation, and air conditioning for the new mezzanine area in the lower level of GCT. The equipment for all of the proposed facilities is being designed to meet all applicable noise standards and regulations, and to avoid producing noise levels that cause impacts. Equipment in New York City would meet the provisions of Local Law No. 64, which provides noise criteria based upon zoning designations, and Section 24-237 of the New York City Noise Code, which limits noise produced by circulation devices at residences (i.e., it states that no person shall operate or permit to be operated a circulation device which creates a sound level in excess of 45 dBA inside a dwelling unit measured at a point 3 feet from the open portion of the nearest window). Operation of mechanical equipment would not produce impacts per FTA criteria; however, testing of some of the proposed mechanical equipment may produce short-term noise levels which are intrusive and annoying.

Airborne noise from train operations below grade (i.e., *in tunnels*) would not be expected to produce noise impacts. The primary concerns from train operations below grade are typically noise emanating through openings to the street through ventilation shafts and subway station entrances. Because of equipment specifications and design, for the Preferred Alternative, noise from ventilation equipment and shafts would not produce noise levels that cause project impacts. In addition, with the Preferred Alternative, there would be no *below-ground stations along the route with direct line-of-sight access to street-level,* and therefore, no locations where noise from below grade rail vehicle operations would produce significantly increased noise levels above grade. Consequently, noise from these sources would not result in project impacts.

Noise levels due to additional vehicular traffic generated by the Preferred Alternative would not increase perceptibly either in the GCT area, or in the area adjacent to the various LIRR stations where the additional service would be provided. In the GCT area, the Preferred Alternative would generate approximately 300 new taxi trips in the peak hours, and lesser numbers of trips during off-peak hours. These additional trips would not result in a significant increase in traffic volumes on the surrounding streets and, per FTA criteria, would not cause a noise impact. Similarly, the additional trips generated by the Preferred Alternative at LIRR stations—where additional service would be provided as part of this project—would not result in significant increases in traffic volumes on the surrounding streets and, per FTA criteria, would not cause any noise impacts.

MITIGATION MEASURES

Mitigation measures were explored to eliminate or reduce impacts and severe impacts predicted to occur with the Preferred Alternative. The measures examined generally fall into three categories: treatments that reduce noise levels at the source; measures that reduce noise levels along the source-to-receiver propagation path; and treatments that reduce noise levels at the receiver.

Source treatments include: vehicle noise specifications whereby new and reconditioned trains, cars, and other equipment must meet stringent noise requirements; rail/wheel treatments, such as wheel truing, rail grinding, etc.; and operational restrictions such as reducing speeds and reducing operations. LIRR already has a program that includes stringent vehicle noise specifications and rail/wheel treatments. Therefore, no additional benefits could be taken for implementing these measures. Operational restrictions, such as those cited above, while they would reduce noise levels, would not be acceptable in terms of satisfying service requirements of LIRR riders.

Propagation path mitigation measures include sound barriers, noise buffers, and alternative alignments. While the installation of sound barriers along the railroad right-of-way would be effective in reducing outdoor noise levels, it would not be practical due to the extensive wall length that would be required to mitigate the identified noise impacts. At the portions of the Port Jefferson Branch where noise levels are expected to exceed 80 dBA, the construction of sound barrier walls would cost approximately $2.3 million per mile and would reduce noise levels to 70-75 dBA. The LIRR operates more than 700 trains per day on its 10 branches, which cover more than 365 miles of right-of-way. The size of the existing system prohibits the LIRR from considering mitigation measures for impacts related to changes in the operating plan. It is presently LIRR policy to consider noise mitigation only for railroad extension projects and new yard locations.

Sound barriers do not reduce noise levels for upper floors of taller buildings and also present problems related to visual quality, graffiti, shadows, public safety concerns, and the potential to divide communities. LIRR is not proposing to provide sound barriers as mitigation for *the East Side Access* project. *(Noise barriers would be used to mitigate noise from a new rail storage yard to be developed by LIRR if significant adverse impacts are predicted for such a yard.)*

Receiver treatments include: providing sound insulation for buildings; and alternative ventilation. Sound insulation typically includes providing new windows, tight fitting doors, and caulking and insulating the building. Alternative ventilation includes providing either air conditioning or some type of air handling system which allows occupants to keep their windows shut, even in warm weather, thereby reducing interior noise levels. This type of mitigation would carry very high costs due to the large number of private residences and other buildings that would require this type of treatment. Consequently, LIRR is not proposing to provide receiver treatment as mitigation for this project.

An additional type of mitigation that falls within the source treatment category which should be mentioned, is a set of measures which would reduce train warning horn noise. Train warning horns typically produce maximum passby noise levels, L_{max}, of between 90 to 105 dBA at 50 feet, and are intrusive. LIRR has been examining a variety of measures to reduce train warning horn noise. One group of measures considered would utilize directional warning devices placed on the street (rather than on the moving train), and tend to limit the area affected by warning horn noise. However, these devices present operational problems, and would reduce, but not eliminate project impacts at locations where train noise is present. Currently, LIRR is in the process of putting new train warning horns in the locomotives which will sound shorter blasts (controlled by the engineer instead of being an automatic duration), and will be positioned on the front of the locomotive, instead of the side, thereby providing a more restrained directional sound. However, this measure will also only reduce, but not eliminate project impacts at locations where train noise is present. Absent the elimination of the at-grade crossing and/or the construction of noise barriers, there is no effective mitigation to eliminate impacts at locations where train horn noise is a significant noise source.

In conclusion, there are no cost-effective measures that would not present other problems, to mitigate impacts and/or severe impacts that are predicted to occur with the Preferred Alternative. Consequently, LIRR is not proposing to provide noise mitigation as part of the project, and predicted impacts and/or severe impacts would be unmitigated.

C. VIBRATION

INTRODUCTION AND METHODOLOGY

Fixed railway operations have the potential to produce high vibration levels, since railway vehicles contact a rigid steel rail with steel wheels. The effects of ground-borne vibration include discernable movement of building floors, rattling of windows, shaking of items on shelves or hanging on walls, and rumbling sounds. Train wheels rolling on the steel rails create vibration energy that is transmitted into the track support system. The amount of vibrational energy is strongly dependant on factors such as how smooth the wheels and rails are, and the vehicle suspension system. The vibration of the track structure "excites" the adjacent ground, creating vibration waves that propagate through the various soil and rock strata to the foundations of nearby buildings. As the vibration propagates from the foundation through the remaining building structure, certain resonant, or natural, frequencies of various components of the building may be excited.

The vibration of floors and walls may cause perceptible vibration, rattling of items such as windows or dishes on shelves, or a rumble noise. The rumble is the noise radiated from the motion of the room surfaces. This is called ground-borne noise.

The project's potential effects on vibration resulting from the operation of the new service to GCT are analyzed in this section, after a brief introduction to vibration fundamentals and impact criteria.

VIBRATION FUNDAMENTALS

Vibrations consist of rapidly fluctuating motions in which there is no "net" movement. When an object vibrates, any point on the object is displaced from its initial "static" position equally in both directions so that the average of all its motion is zero. Any object can vibrate differently in three mutually independent directions; vertical, horizontal, and lateral. It is common to describe vibration levels in terms of velocity, which represents the instantaneous speed at a point on the object that is displaced. In a sense, the human body responds to an average vibration amplitude, which is usually expressed in terms of the root mean square (rms) amplitude.

All vibration levels in this document are referenced to 1 x 10^{-6} inches per second. "VdB" (referenced to 1 x 10^{-6} inches per second) is used for vibration decibels to reduce the potential for confusion with noise decibels.

Effect of Propagation Path

Vibrations are transmitted from the source to the ground, and propagate through the ground to the receiver. Soil conditions have a strong influence on the levels of ground-borne vibration. Stiff soils, such as some clay and rock, can transmit vibrations over substantial distances. Sandy soils, wetlands, and groundwater tend to absorb movement and thus reduce vibration transmission. Because subsurface conditions vary widely, measurement of actual vibration conditions, or transfer mobility, at the site can be the most practical way to address the variability of propagation conditions.

Human Response to Vibration Levels

Although the perceptibility threshold for ground-borne vibration is about 65 VdB, the typical threshold of human annoyance is 72 VdB. As a comparison, buses and trucks rarely create vibration that exceeds 72 VdB unless there are significant bumps in the road, and these vehicles are operating at moderate speeds. Vibration levels for typical human and structural responses and sources are shown in Table 11-16. Background vibration is usually well below the threshold of human perception, and is of concern only when the vibration affects very sensitive manufacturing or research equipment. Electron microscopes, high-resolution lithography equipment, recording studios, and laser and optical benches are typical of equipment that is highly sensitive to vibration.

Table 11-16

Typical Levels of Ground-Borne Vibration

Human/Structural Response	Velocity Level (VdB)	Typical Sources (@ 50 feet)
Threshold, minor cosmetic damage fragile buildings	100	Blasting from construction projects
		Bulldozers and other heavy tracked construction equipment
Difficulty with vibration-sensitive tasks, such as reading a video screen	90	
		Commuter rail, upper range
Residential annoyance, infrequent events	80	Rapid Transit Rail, upper range
		Commuter Rail, typical range
Residential annoyance, frequent events		Bus or Truck over bump
	70	Rapid Transit Rail, typical range
Limit for vibration-sensitive equipment. Approximate threshold for human perception of vibration		Bus or truck, typical
	60	
		Typical background vibration
	50	

Source: U.S. Dept of Transportation, FTA, *Transit Noise and Vibration Impact Assessment*, April 1995.

VIBRATION STANDARDS AND CRITERIA

With the construction of new rail rapid transit systems in the past 20 years, considerable experience has been gained about how communities would react to various levels of building vibration. This experience, combined with the available national and international standards, represents a good foundation for predicting annoyance from ground-borne noise and vibration in residential areas.

The FTA-developed criteria for environmental impact from ground-borne vibration and noise are based on the maximum levels for a single events. The impact criteria are defined in the FTA guidance manual and are shown in Table 11-17. The criteria for acceptable ground-borne vibration are expressed in terms of rms velocity levels in decibels and the criteria for acceptable ground-borne noise are expressed in terms of A-weighted sound level. The limits are specified for the three land use categories defined below:

- **Vibration Category 1: High Sensitivity**—Buildings where low ambient vibration is essential for the operations within the building, which may be well below levels associated with human annoyance. Typical land uses are vibration-sensitive research and manufacturing, hospitals, and university research operations.
- **Vibration Category 2: Residential**—This category covers all residential land uses and any buildings where people sleep, such as hotels and hospitals. No differentiation is made between different types of residential areas. This is primarily because ground-borne vibration and noise are experienced indoors and building occupants have practically no means to reduce their exposure. Even in a noisy urban area, the bedrooms often will be quiet in buildings that have effective noise insulation and tightly closed windows. Hence, an occupant of a bedroom in a noisy urban area is likely to be just as sensitive to ground-borne noise and vibration as someone in a quiet suburban area.
- **Vibration Category 3: Institutional**—This category includes schools, churches, other institutions, and quiet offices that do not have vibration-sensitive equipment, but still have the potential for activity interference.

There are some buildings, such as concert halls, TV and recording studios, and theaters, that can be very sensitive to vibration and ground-borne noise, but do not fit into any of these three categories. Special vibration level thresholds are defined for these land uses. For simplicity, this assessment considers only the three vibration categories listed above. For this analysis, the criteria for frequent events was used for impact assessment and mitigation analysis.

IMPACT ASSESSMENT METHODOLOGY

FTA has provided guidance about the assessment and analysis of vibration impacts caused by new rail systems. FTA provides two approaches to vibration assessment: (1) General Vibration Assessment; and (2) Detailed Vibration Analysis. The General Assessment uses generalized data to develop a curve of vibration levels as a function of distance from the track, and is useful to screen alternatives when detailed data is not available to assess impacts. FTA recommends the Detailed Vibration Analysis during final design or at the outset of the project if there are particularly sensitive land uses in close proximity to the track.

Table 11-17
Ground-Borne Vibration and Noise Impact Criteria

Vibration Category	Ground-Borne Vibration Impact Levels (VdB re 1 micro inch/sec) Frequent Events[1]	Infrequent Events[2]	(dBA re 20 micro Pascals) Frequent Events[1]	Infrequent Events[2]
1	65 VdB[3]	65 VdB[3]	—[4]	—[4]
2	72 VdB	80 VdB	35 dBA	43 dBA
3	75 VdB	83 VdB	40 dBA	48 dBA

Notes:
1 "Frequent Events" are defined as those with more than 70 vibration events per day. Most rapid transit projects fall into this category.
2 "Infrequent Events" are defined as those with fewer than 70 vibration events per day. This category includes most commuter rail systems.
3 This criterion limit is based on levels that are acceptable for most moderately sensitive equipment such as optical microscopes. Vibration sensitive manufacturing or research will require detailed evaluation to define the acceptable vibration levels. Ensuring lower vibration levels in a building often requires special design of the HVAC systems and stiffened floors.
4 Vibration-sensitive equipment is not sensitive to ground-borne noise.

Source: *Transit Noise and Vibration Impact Assessment*, FTA, April 1995, pages 8-2 through 8-3.

The detailed approach incorporates an on-site impact testing method to determine the "transfer mobility." Transfer mobility is a measure of the efficiency of vibration transmission through the ground and offers a way to predict train and construction-induced vibration levels in buildings with reasonable accuracy before a project is constructed.

The detailed method consists of the following steps:

1. Characterize the existing vibration environment.
2. Determine the train's force density, which is the actual force applied to the ground by the train. Force density is frequency dependent and is also dependent on the train's speed.
3. Determine vibration transmission properties of the soil. The transfer mobility can vary dramatically depending on the underground conditions/geology. Consequently, the only practical and accurate method available to determine transfer mobility is on-site vibration propagation testing using a seismic impact hammer.
4. Determine building coupling losses and amplification factors. The extent to which surface vibrations are attenuated in a building depends on a variety of factors, such as the foundation type, whether or not the building is founded on rock, and the type of construction.
5. Calculate train-induced vibration spectra in buildings based on steps 1 through 4.

EXISTING VIBRATION ENVIRONMENT

Vibration monitoring locations were chosen above the new tunnel alignments to provide geographic coverage in the study area. A 24-hour monitoring period was used to capture both the high vibration levels that occur in the study area during the day and the lower ambient levels occurring at night. The existing vibration environment is an important factor in the assessment of a new source of vibration. If existing vibration levels are high enough, it could be that the new source of vibration would not be noticeable. Vibration from the new trains could be masked or indistinguishable from existing train, truck, and car traffic. The monitoring locations are shown in Figure 11-4 and the range of measured maximum vibration levels is shown in Table 11-18.

Table 11-18

Ambient Vibration Levels

Site No.	Address	Vibration Level (VdB)
1	466 Lexington Avenue	56-72[1]
2	270 Park Avenue	55-57[1]
3	301 Park Avenue	53-77[2]
4	350 Park Avenue	31-56[1]
5	370 Park Avenue	30-59[1]
6	390 Park Avenue—Lever House	30-59[1]
7	425 Park Avenue	44-70[1]
8	500 Park Avenue	36-47[1]
9	521 Park Avenue	36-66[2]
10	786 Lexington Avenue	37-78[3]
11	166 East 63rd Street	32-51[1]
12	201 East 62nd Street	33-49[1]
13	250 East 63rd Street	33-49[1]
14	Newcomers High School	28-55[2,4]

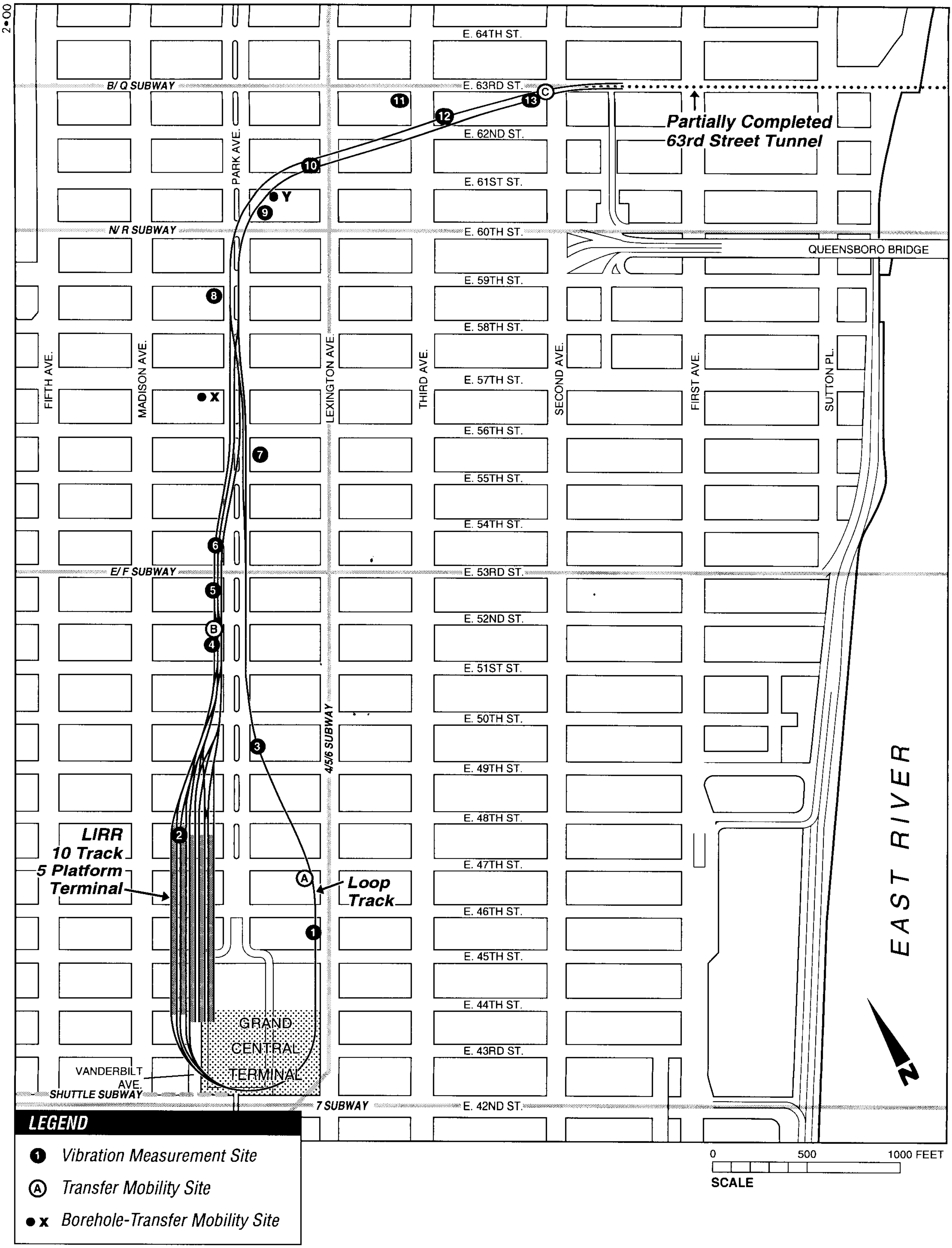
Notes:
1 Monitoring performed during May 1999.
2 Monitoring performed during July 1999.
3 Monitoring performed during September 1999.
4 Newcomers High School (not shown in Figure 11-4) is located in Queens near Northern Boulevard.

Currently, only four sites experience maximum vibration levels on the order of 72 VdB, and most sites experience much lower vibration levels. The lowest vibration levels are on the order of 30 VdB. Graphs of the 24-hour vibration data for each measurement site are presented in the Technical Report. The peaks in vibration level are due to nearby trains, surface vehicular traffic, and mechanical equipment in the building.

TRAIN FORCE DENSITY AND TRANSFER MOBILITY

The Detailed Vibration Analysis procedure requires train force density to predict vibration levels at a particular location. Force density is the actual force applied to the ground by the train. This force cannot be measured directly, but it can be inferred by measuring train-induced vibration and transfer mobility. The point source transfer mobility is determined by using an instrumented drop weight and a series of vibration sensors at various distances from the impact. The line source transfer mobility is the sum of point source mobilities evaluated along a line representing the train.

Train force density tests were performed in March 1999 at a test site near Floral Park, NY, using a six-car M3 train provided by LIRR. M7 trains, which do not yet operate on the LIRR system, would also be operated in the new service to GCT along with current M3 trains. Of trains



MTA / LIRR
East Side Access

Figure 11-4

Ambient Vibration Monitoring Sites in Manhattan

available for the test, the M3 train was the most similar to the M7 train in its operational characteristics.

Vibration data were recorded from the impact hammer using accelerometers located 25, 50, 75, 100, 200, and 300 feet from the tracks. Train-induced vibration at 15, 30, 45, and 55 mph were recorded with the same accelerometer array.

As shown in Table 11-19, vibration propagation (transfer mobility) measurements were conducted at five sites within the Manhattan and Queens study areas.

Table 11-19
On-Site Vibration Propagation Test Locations

Site No.	Address	Horizontal Distance from Impact to Accelerometers (feet)
1	47th Street and Lexington Avenue	0, 18, 44, 64, 130
2	52nd Street and Park Avenue	0, 25, 50, 75, 100
3	57th Street and Park Avenue	0, 25, 52, 88, 115
4	61st Street and Park Avenue	0, 25, 50, 80, 110, 160
5	63rd Street and Second Avenue	No measurable signal
6	Queens—41st Avenue and Vernon Boulevard	0, 25, 50, 75, 100, 200

The measured data from these sites could be used to represent their respective geographic areas; however, to be conservative, the results from Site 3 were used to represent the Manhattan Study Area for depths up to 114 feet, since it yielded the most efficient vibration propagation. The geology in the Manhattan Study Area is relatively consistent and is composed of rock with a thin (approximately 20-foot-thick) layer of soil on top. For depths greater than 114 feet, the results from Site 4 were used. Details on the force density and transfer mobility tests can be found in the vibration appendix.

PREDICTED TRAIN-INDUCED VIBRATION LEVELS

The force density data (as a function of train speed), vibration propagation, a track-bed correction, and building coupling and amplification corrections are used to estimate train-induced vibration levels at sensitive buildings along the corridor. The results can be expressed in terms of vibration velocity as a function of frequency. Frequency is an important parameter, since both human annoyance and specific mitigation techniques are frequency dependent.

TRACK SUPPORT CORRECTION

The track support configuration for the at-grade force density tests was tie on ballast. The basic track fixation method proposed for the project is direct fixation on the concrete tunnel invert, which is stiffer than tie on ballast. Consequently, a correction* is required to account for the difference in vibration isolation between these two supports. The correction factor is a function of rail support modulus; thus, due to the differences in track fixation, vibration levels were increased approximately 4 to 7 VdB, depending on the frequency.

* Based in part on Bay Area Rapid Transit vibration measurements provided by Wilson, Ihrig & Associates.

BUILDING COUPLING LOSS CORRECTIONS

Ground-borne vibration in buildings is typically attenuated by a certain amount, depending on how well coupled the building is to the ground. Many buildings in the Manhattan Study Area are founded on rock, FTA recommends a coupling loss of 0 dB. For buildings founded in soil, the FTA manual cites coupling losses ranging from 5 to 13 dB for buildings of increasing size. Since small buildings in the Manhattan area (4 stories or less) are generally founded on soil, a coupling loss of approximately 7 dB was used for 1- to 2-story buildings and 10 dB for 3- to 4-story buildings.*

A summary of the coupling loss corrections used in the analysis is shown in Table 11-20.

Table 11-20
Building Coupling Loss Categories

No. Stories	Coupling Loss (dB)
1-2	-7
2-4	-10
>5	0

BUILDING AMPLIFICATION

Building structures typically have resonant frequencies in the 10 to 30 Hz range. That is, when excited by a vibration source, certain parts of a building (such as at the mid-span of a floor) may actually amplify vibration at the resonant frequency. A 6 dB amplification factor (from 10-30 Hz) was added to account for possible building amplification. During final design, such building-specific factors will be analyzed and refined.

PROBABLE IMPACTS OF THE PROJECT ALTERNATIVES

NO ACTION ALTERNATIVE

Under the No Build Alternative, there would be no vibration or ground-borne impacts, since no new rail service would occur.

TSM ALTERNATIVE

The components of the TSM Alternative would not result in any increases in peak vibration levels throughout the study area since no new rail lines would be constructed.

PREFERRED ALTERNATIVE

Manhattan

The ground-borne noise and vibration effects of the Preferred Alternative were determined using the previously described methodology for both engineering options for buildings along the alignment in Manhattan. For the base case, without any special vibration mitigation, it was

* These coupling loss values vary with frequency. Please see the vibration appendix for more detail.

assumed that the track fixation method would be direct fixation (with a static stiffness of 300,000 pounds/inch and fastener spacing of 24 inches). *The* project's effect on ground-borne noise and vibration levels in the study area is *discussed below, followed by* a discussion of *the* mitigation measures *to be implemented.*

Option 1. The results of the analysis for this option (LIRR station in the lower level of GCT) are presented in Figure 11-5. As shown in the figure, Option 1 of the Preferred Alternative would have potential impacts on ground-borne noise levels at a number of buildings along the project alignment. Vibration levels would be below the FTA criteria and no impacts would occur.

Option 1 would also result in predicted ground-borne noise levels that could potentially exceed the FTA's criteria of 35 dBA for residential buildings and 40 dBA for non-residential structures. The analysis indicates that 236 non-residential* and 241 residential structures could potentially have significant impacts under this option. However, predicted levels may be lower than existing levels in areas where there is currently train activity, such as along Park and Lexington Avenues. In such locations, existing ground-borne noise from MNR and NYCT operations may meet or exceed the predicted levels for the project, and there would be no impact in these locations. Ongoing measurements indicate a wide variation in ground-borne noise and vibration levels in buildings. In fact, some data have shown much lower vibration levels in large buildings than predicted by the model, indicating that a 0 dB coupling loss may not be appropriate. However, to be conservative, the 0 dB recommended by the FTA manual has been used in this analysis. The extent to which existing noise levels differ from predicted ground-borne levels will be refined during final design.

As noted in Chapter 2 ("Project Alternatives"), Option 2 has been selected as the preferred engineering option for East Side Access.

Option 2. Due to the greater track depth of this option, project-induced vibration levels would not exceed the FTA criteria at any location along the alignment and ground-borne noise levels would exceed FTA criteria at only 10 residential and 4 non-residential locations. *As noted above, calculations were made conservatively, assuming a coupling loss of 0 dB. However, in some locations, existing ground-borne noise may be higher than levels predicted for the project, so that no project-related impact would occur. The extent to which existing noise levels differ from predicted ground-borne levels will be refined during final design.*

Roosevelt Island

Service for the Preferred Alternative would use the lower level of the 63rd Street Tunnel, which passes under Roosevelt Island. Based on distances to existing buildings, project-induced vibration or ground-borne noise levels would not exceed FTA criteria at any location under Roosevelt Island. However, should residential structures planned for construction approximately 150 feet from the 63rd Street Tunnel be built, the Preferred Alternative may cause ground-borne noise impacts of 35-40 dBA.

* The specific land use will be determined during final design.

Queens

In Queens, service for the Preferred Alternative would use the lower level of the 63rd Street Tunnel and its continuation along 41st Avenue. Throughout the entire traverse from the East River until reaching Yard A, the LIRR tracks would be below existing NYCT subway lines. Similar to Manhattan, no location would exceed the FTA's criteria for vibration impact. While the analysis of the proposed LIRR service indicates that 45 residential and 37 non-residential buildings would exceed the ground-borne noise criteria (see Figure 11-6), these levels may not exceed current levels due to train operations in the upper tunnel. The extent to which existing noise levels may exceed predicted project ground-borne noise will be determined during final design.

VIBRATION MITIGATION MEASURES

Design features would be incorporated into the project to mitigate its potential ground-borne noise impacts along the project route in Manhattan and Queens. Resilient rail fastenings and ties would be used in project tunnels in Manhattan to avoid potential ground-borne noise impacts. In Queens, potential ground-borne noise impacts would be mitigated through the use of floating slabs, resiliently supported ties and fasteners, or ballast mats as needed at certain locations.

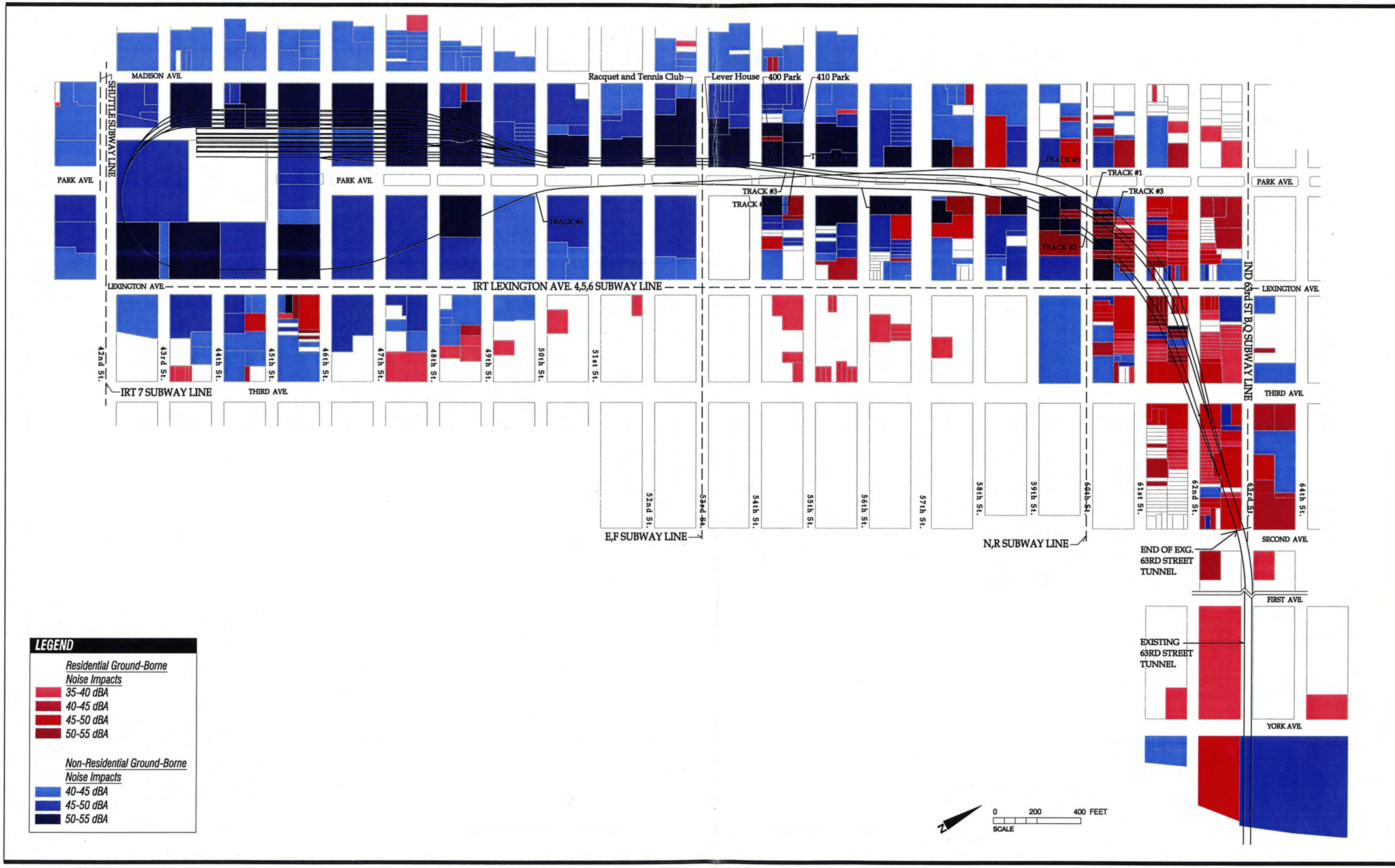
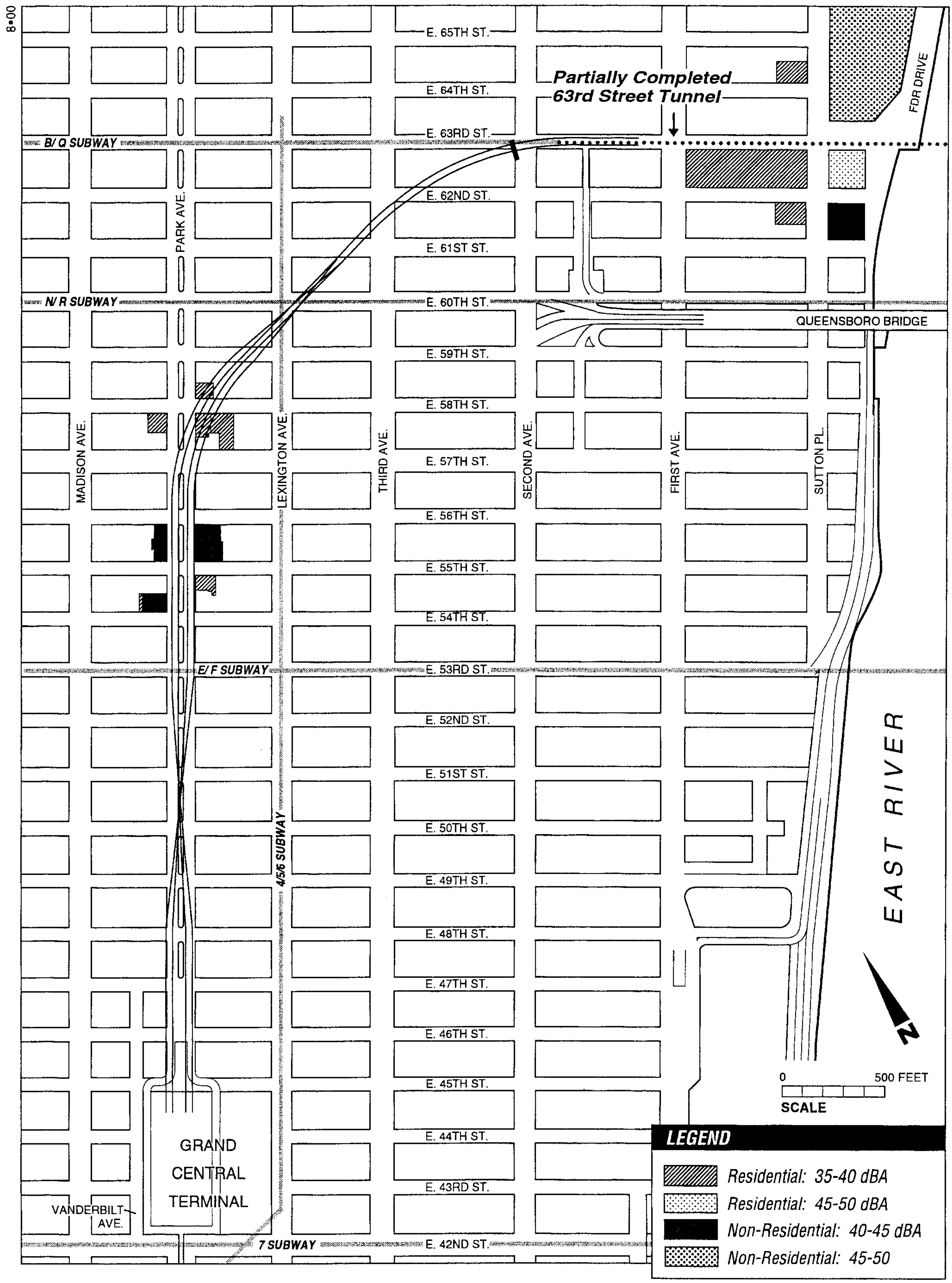


Figure 11-5

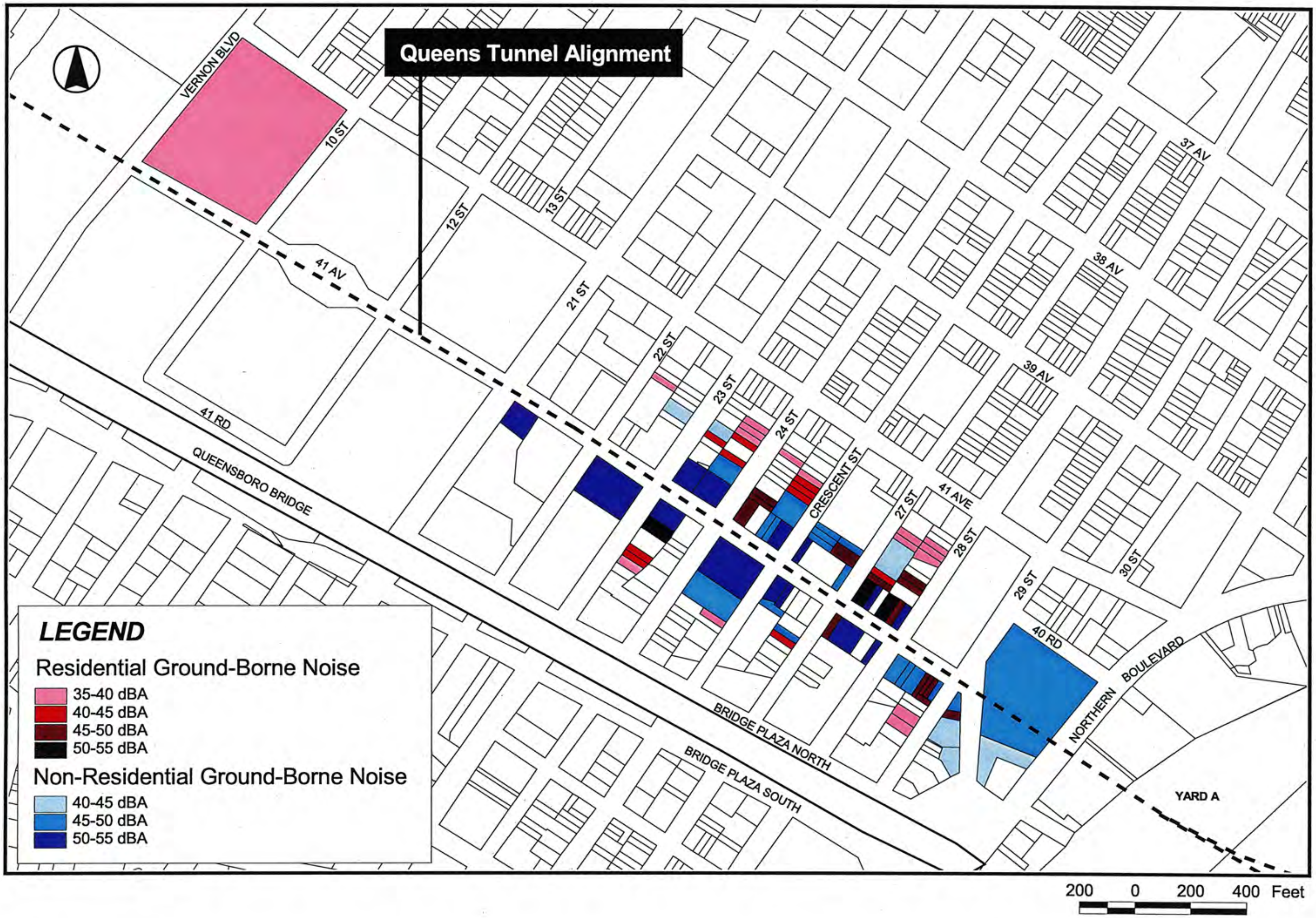
Potential Train-Induced Ground-Borne Noise Impacts, Manhattan Alignment - Option 1



MTA / LIRR
East Side Access

Figure 11-6

Manhattan Alignment Option 2
Potential Train-Induced Ground-Borne Noise Impacts



MTA / LIRR

East Side Access

Figure 11-7

Queens Alignment: Potential Train Induced Ground-Borne Noise Impacts