Chapter 12: Noise and Vibration

A. INTRODUCTION

This chapter of the FEIS assesses the potential for noise and vibration impacts from construction and operation of the proposed Second Avenue Subway. The chapter is divided into two main sections:

- Section B, which examines the potential for airborne noise impacts; and
- Section C, which examines the potential for vibration and ground-borne noise impacts.

Each of these sections includes a description of impact standards and criteria, a description of existing conditions, a description of future conditions common to all alternatives, an assessment of construction impacts, an assessment of permanent impacts once the subway is operational, and a description of potential mitigation measures. Although the analyses and corresponding mitigation measures for these two assessments contain similar language, the analyses actually assess two different types of potential impacts.

Airborne noise is what most people think of when they hear the word "noise." It is noise that travels through the air—such as the sound of traffic on a nearby roadway, or children playing in a playground. *Ground-borne noise* is the rumbling sound caused by *vibration* (or oscillatory motion). With ground-borne noise, buildings and other structures act like speakers for low-amplitude noise. As an example, ground-borne noise is the low rumbling sound that occurs within a building as a subway passes beneath.

Because of both the nature of the construction required to excavate subway tunnels and stations through more than 8.5 miles of Manhattan and Manhattan's overall density, there would be significant localized airborne noise impacts during the construction period. As described below, NYCT would undertake numerous mitigation measures to minimize the extent of these impacts. Nevertheless, it will not be possible to completely mitigate all impacts—chiefly because of the proximity of existing residential and other buildings to the construction activities. However, once the new subway is operational, the system would operate more quietly than the existing subway lines in Manhattan, and any potential airborne and ground-borne impacts would be mitigated using technologies currently employed by NYCT throughout its system.

Please note that Appendix J of this FEIS provides supporting information for the various analyses, including descriptive information on how noise and vibrations are perceived, and details on the assessment methodologies and conclusions.

B. AIRBORNE NOISE

The analysis of airborne noise for the Second Avenue Subway was performed using the procedures set forth in the FTA guidance manual, *Transit Noise and Vibration Impact Assessment*, April 1995. This FTA guidance document sets forth methodologies for analyzing airborne noise during construction and operation. It also provides the criteria for assessing impacts as well as suggested mitigation measures.

STANDARDS AND CRITERIA FOR AIRBORNE NOISE

Airborne noise levels associated with the construction and operation of the proposed Second Avenue Subway are subject to the noise criteria defined by the FTA. In addition, noise levels from some construction equipment are regulated by the Noise Control Act of 1972, 49 USC § 4901 et. seq.

The FTA guidance manual does not present standardized criteria for assessing airborne noise impacts from construction. However, it does contain criteria for levels that, if exceeded, may result in adverse community reaction; these stated criteria are used as the reference impact criteria for the project. These criteria are a function of the land use of the affected areas near a transit project, and day and night 1- and 8-hour L_{eq} noise levels and L_{dn} noise levels. L_{eq} is the constant equivalent sound level of a fluctuating noise source, usually for one hour, while L_{dn} is a description for the cumulative 24-hour day-night noise level that accounts for greater nighttime sensitivity for noise. (For more information on these descriptors, see Appendix J.)

Table 12-1 shows the FTA's construction assessment impact values for both the general noise assessment and the detailed noise assessment conducted in accordance with FTA methodologies. For purposes of impact assessment, an airborne noise impact would occur if noise levels during construction exceed the FTA recommended values in Table 12-1.

For airborne operational noise, the FTA guidance manual defines noise criteria based on the specific type of land use that would be affected, with explicit operational noise impact criteria for three land use categories. These impact criteria are based on either peak 1-hour L_{eq} or 24-hour L_{dn} values. Table 12-2 describes the land use categories defined in the FTA report, and provides noise metrics used for determining operational noise impacts. As described in Table 12-2, Categories 1 and 3—which include land uses that are noise-sensitive, but where people do not sleep—require examination using the 1-hour L_{eq} descriptor for the noisiest peak hour. Category 2, which includes residences, hospitals, and other locations where nighttime sensitivity to noise is very important, requires examination using the 24-hour L_{dn} descriptor.

The FTA impact criteria for airborne operational noise (see Figure 12-1) are keyed to the noise level generated by the project (called "project noise exposure") in locations of varying ambient noise levels. Two types of impacts—"severe impact" and "impact"—are defined for each land use category, depending on existing ambient noise levels. The difference between "severe impact" and "impact" is that a severe impact occurs when a change in noise level occurs that a significant percentage of people would find annoying, while an impact occurs when a change in noise level occurs that is noticeable to most people but not necessarily sufficient to result in strong adverse reactions from the community. For purposes of impact assessment, an airborne noise impact during operations would occur if noise levels during operation fall in the "impact" or "severe impact" areas of the curve represented in Figure 12-1. For example, for Land Use Category 2 and an existing noise exposure of 60 dBA, a project noise exposure of 65 dBA would result in "severe impact" while a project noise exposure of 60 dBA would constitute an "impact." Similarly, for the same land use category and existing noise exposure, a project noise exposure of 55 dBA would not constitute an impact.

Table 12-1
FTA Impact Criteria for Construction

General Assessment			
Land Use	**Descriptor**	**Day**	**Night**
Residential	$L_{eq(1)}$	90	80
Commercial	$L_{eq(1)}$	100	100
Industrial	$L_{eq(1)}$	100	100
Detailed Assessment			
Land Use	**Descriptor**	**Day**	**Night**
Residential	$L_{eq(8)}$	80	70
Commercial	$L_{eq(8)}$	85	85
Industrial	$L_{eq(8)}$	90	90
Detailed Assessment			
Land Use	**Descriptor**	**30-day Average**	
Residential	L_{dn}	75[1]	
Commercial	$L_{eq(24)}$	80	
Industrial	$L_{eq(24)}$	85	

Note: [1] In urban areas with very high ambient noise levels (L_{dn} greater than 65 dB), L_{dn} from construction operations should not exceed the existing ambient + 10 dB.

Table 12-2
FTA's Land Use Category and Metrics for Operational Transit Noise Impact Criteria

Land Use Category	Noise Metric (dBA)	Description of Land Use Category
1	Outdoor $L_{eq(h)}$[1]	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}[2]	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 $L_{eq(h)}$[1]	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.

Notes: [1] L_{eq} for the noisiest hour of transit-related activity during hours of noise sensitivity.
[2] L_{dn} for the 24-hour cumulative noise level.
Source: *Transit Noise and Vibration Impact Assessment*, FTA, April 1995.

AIRBORNE NOISE PREDICTION METHODOLOGY

Following the procedures set forth in FTA's guidance manual, existing noise levels were first determined by field measurement. Then, project-generated noise levels from subway operations were calculated. Finally, those levels were evaluated using the impact criteria discussed above to determine the project's potential for significant adverse impacts.

SELECTION OF NOISE RECEPTORS

To determine the existing ambient noise levels in the area that could be affected by the Second Avenue Subway's operation, specific analysis locations (referred to as "receptors" because they represent locations where someone might hear, or "receive," noise from the project) were chosen throughout the study area. A total of 17 receptor locations (shown in Figures 12-2 and 12-3 and on Table 12-3) below were chosen along the project alignment; these sites, which are distributed across the various neighborhood study areas, were selected for assessment because they encompass the range of existing conditions that occur along the entire alignment. Together, the sites include both locations that would be particularly sensitive to noise increases (e.g., residences, hospitals, parks), as well as locations that would be likely to experience the greatest increases in noise from the project's operation. These receptor locations were chosen to evaluate the project's airborne noise impacts during operations. (As described below, construction impacts analyses were not conducted for these specific locations but rather for representative locations in the various neighborhood zones where different types of construction activities would occur.)

Table 12-3
Noise Receptor Sites and Locations

Site	Location	Zone	FTA Land Use Category[1]	Type of Measurement	Year of Measurement[2]
1	Second Ave between 128th & 127th Sts	East Harlem	3	24-Hour	2002
2	125th St between Park & Lexington Aves	East Harlem	2	20-Minutes	2002
3	Second Ave between 117th & 116th Sts	East Harlem	2	24-Hour	2002
4	Second Ave between 109th & 107th Sts	East Harlem	2	20-Minutes	1997
5	Second Ave between 99th & 97th Sts	East Harlem	2	20-Minutes	1997
6	Second Ave between 96th & 95th Sts	Upper East Side	2	24-Hour	2002
7	Second Ave between 79th & 78th Sts	Upper East Side	3	24-Hour	1997
8	66th St between Second & Third Aves	Upper East Side	2	20-Minutes	2002
9	Second Ave between 65th & 64th Sts	Upper East Side	2	20-Minutes	1997
10	Second Ave between 55th & 54th Sts	East Midtown	2	20-Minutes	1997
11	Second Ave between 34th & 33rd Sts	East Midtown	2	24-Hour	2002
12	Second Ave between 29th & 28th Sts	Gramercy Park/ Union Square	2	20-Minutes	1997
13	Second Ave between 2nd & 1st Sts	E. Village/ Lower E. Side/Chinatown	2	24-Hour	2002
14	Chrystie St between Delancey & Rivington Sts	E. Village/Lower E. Side/Chinatown	2	20-Minutes	2002
15	Forsyth St between Delancey & Rivington Sts	E. Village/ Lower E. Side/Chinatown	2	20-Minutes	2002
16	Water St between Beekman & Fulton Sts	Lower Manhattan	2	24-Hour	1997
17	Water St between Pine & Wall Sts	Lower Manhattan	2	20-Minutes	1997

Notes:

1 For definition of land use categories, see Table 12-2.

2 Measurements were made in 1997 as part of the original MESA MIS/DEIS and in 2002 to supplement those locations.

MODELING TO PREDICT AIRBORNE NOISE IMPACTS DUE TO CONSTRUCTION ACTIVITIES

Airborne noise from construction activities was estimated following the methodologies set forth in the April 1995 FTA guidance manual. Both the general noise assessment and detailed noise assessment procedures were followed. In accordance with the manual, both procedures use an equation that accounts for the noise emissions of the construction equipment, the amount of time the equipment is in use, and the distance between the equipment and the receptor (see Appendix J) to calculate noise levels due to operation of a single piece of construction equipment. The combination of noise from several pieces of equipment operating during the same time period is obtained from addition of the L_{eq} values for each piece of equipment.

For the general airborne noise assessment, it was assumed that the two noisiest pieces of equipment operate continuously at the same time. For the detailed airborne noise assessment, 8-hour L_{eq} values and 30-day average L_{dn} values were calculated assuming all appropriate usage factors for the specified time periods.

MODELING TO PREDICT IMPACTS DUE TO SUBWAY OPERATIONS

Airborne noise from subway operations was also analyzed using the methodologies set forth in the FTA guidance manual and described in Appendix J. The analysis considered three major noise sources associated with subway operations: noise from fixed-rail operations (e.g., noise from subway train operations emanating from stations, air ventilation openings, and subway gratings), noise from mechanical equipment operations (e.g., substations, HVAC equipment, etc.), and noise from subway train yards.

For noise from fixed-rail operations, due to the short distances between sources and sensitive noise receptors, the detailed noise analysis methodology (rather than the screening analysis procedures or general noise assessment methodology contained in the FTA guidance manual) was used to determine project-generated noise levels and to examine potential impacts.

EXISTING CONDITIONS: AIRBORNE NOISE

The results of measurements taken at the 17 receptor locations are provided below in Table 12-4, with additional details provided in Appendix J. As shown in the table and appendix, the measured noise levels are relatively high and reflect the study area's high level of vehicular activity as well as the corridor's overall density.

FUTURE CONDITIONS COMMON TO ALL ALTERNATIVES: AIRBORNE NOISE

In the future, traffic volumes throughout the study area are expected to increase by approximately 0.5 percent per year, which will cause small increases in ambient noise levels. In addition to general background growth, some discrete projects (e.g., the proposed redevelopment of the Con Edison parcels in the East 30s) would also add traffic to the study area and were accounted for in the assessment. Table 12-4 shows maximum predicted $L_{eq(1)}$ and L_{dn} noise levels in the year 2025[1] without the proposed Second Avenue Subway (i.e., noise levels for the

[1] As described previously in this FEIS, the analysis year has been changed from 2020 to 2025 to be consistent with the Section 5309 FTA New Starts Annual Update for 2005.

Table 12-4
Existing and No Build Noise Levels[1]

Site	Existing Noise Level		Future No Build 2025 Noise Level	
	Maximum $L_{eq(1)}$	L_{dn}	Maximum $L_{eq(1)}$	L_{dn}
1	73.3	75.7	73.8	76.2
2	73.6	75.6	74.1	76.1
3	77.8	80.3	78.3	80.8
4	75.5	77.5	76.1	78.1
5	75.6	75.0	76.2	75.6
6	73.6	77.3	74.1	77.8
7	84.1	82.4	84.7	83.0
8	66.4	67.8	66.9	68.3
9	76.6	78.4	77.2	79.0
10	78.6	77.7	79.2	78.3
11	78.5	81.4	79.0	81.9
12	76.8	78.1	77.4	78.7
13	73.5	76.8	74.0	77.3
14	72.1	73.9	72.6	74.4
15	66.8	66.9	67.3	67.4
16	72.6	74.3	73.2	74.9
17	74.7	76.0	75.3	76.6

Note: [1] The measurements in the No Build portion of this table have been adjusted to account for the change in the analysis year from 2020 to 2025.

No Build conditions). The maximum change in No Build L_{dn} and $L_{eq(1)}$ noise levels when compared with existing noise levels would be 0.5 dBA. These changes would be insignificant and imperceptible.

CONSTRUCTION IMPACTS OF THE PROJECT ALTERNATIVES: AIRBORNE NOISE

Both existing and future noise levels in the study area are relatively high at almost all locations in the study area during almost all hours of the day. They reflect the fact that traffic volumes throughout the study area are high, with relatively high truck and bus volumes. Nevertheless, even with these relatively high airborne noise levels, construction activities associated with the proposed Second Avenue Subway would be expected, at times, to cause noticeable and significant increases in noise levels, as construction activities are unavoidably noisy. These increases would occur in all four construction phases when construction activities are taking place. The noise impacts during construction would occur in the vicinity where construction work is occurring. The times and locations where these increased noise conditions would occur would vary depending on the location of construction, the equipment and construction methods employed, and the distance between the noise source and the receptor. However, the types and extent of the impacts would be comparable in all construction phases.

Because the project alignment and therefore construction activities would unavoidably occur within close proximity to sensitive land uses (e.g., residential uses), the project's construction has the potential to result in perceptible changes in noise levels that may result in annoyance to nearby residents. Construction must occur close to active land uses in order to create new subway stations within the already developed neighborhoods on the East Side of Manhattan. Since most construction activities could take place between 15 and 24 hours a day, 6 days per week, significant airborne noise impacts may occur not only during the day, but also during nighttime and weekend periods. However, several of the noisiest activities—such as pile installation and vertical blasting—would not occur late at night.

Both a general assessment and a detailed assessment were performed to examine the potential for noise impacts during construction. The analyses examined noise levels produced by the three main techniques used for tunnel and station construction: mechanized tunnel boring (which would occur for 24 hours each day), mining (which would typically not occur late at night except for underground areas being drilled horizontally, where drilling may occur for 24 hours each day), and cut and cover (which would typically not occur between 10 PM and 7AM except for activities related to utility relocation). Because of its special nature, utility relocation for the project would typically occur at night; this is consistent with the hours maintained for other utility relocation projects in New York City. Utility relocation generally takes place at night because fewer people use utilities during nighttime hours and because fewer traffic disruptions would occur from the necessary lane closures. However, it is possible that certain utility relocation efforts could take place during the daytime. While relocating utilities would entail opening the streetbed, construction would be on a smaller scale than the cut and cover construction activities required for stations and shafts described in Chapter 3, "Description of Construction Methods and Activities."

Noise from construction equipment is regulated by EPA noise emission standards. These federal requirements mandate that certain classifications of construction equipment and motor vehicles meet specified noise emission standards. MTA and NYCT would ensure that this regulation would be carefully followed. Appendix J provides information on typical noise levels for construction equipment.

In general, because the project area has relatively high airborne noise levels due to existing traffic volumes, the increase in noise levels caused by delivery trucks and workers traveling to and from the construction sites would not be perceptible. However, small increases in noise levels would be expected near a few defined delivery truck routes and streets in the immediate vicinity of localized construction areas. Except for the areas immediately adjacent to the sites, all truck trips would be restricted to truck routes.

Table 12-5 shows the maximum 1-hour L_{eq} values obtained following the general airborne noise assessment procedures, and the maximum 8-hour average L_{eq} and 30-day L_{dn} values obtained following the detailed assessment procedures. This table shows noise that would be generated by the project at each construction area. The maximum predicted values are shown for receptors ranging in distance from 20 to 60 feet from the center of construction. Project values that exceed FTA criteria values are considered significant adverse impacts.

Because of the proximity of construction activities to sensitive uses (including residences), noise levels at receptor locations would exceed one or more of the FTA construction impact criteria at most locations even with implementation of mitigation measures. (Unlike the impact criteria used for operational impacts, construction period impacts are not categorized as "severe" or not.) These significant airborne noise impacts would occur for distances up to approximately 750 feet from where construction operations are taking place. Airborne noise travels both vertically and horizontally; whenever a line-of-sight is available between the noise source and a receptor location within approximately 750 feet, the impacts could occur.

Table 12-5
Maximum Noise Levels During Construction Without Mitigation

Approximate Location	1-Hour L_{eq} FTA Criteria Value	1-Hour L_{eq} Maximum Project Value	8-Hour Average L_{eq} FTA Criteria Value	8-Hour Average L_{eq} Maximum Project Value	30-Day Average L_{dn} FTA Criteria Value	30-Day Average L_{dn} Maximum Project Value
Phase 2						
125th St, Madison-Lexington Ave	90/80	101-92	80/70	101-92	86	94-85
125th St, Second-Third Aves	90/80	101-92	80/70	101-92	86	94-85
119th-115th St on Second Ave	90/80	101-92	80/70	101-92	90	94-85
108th-105th St on Second Ave	90/80	101-92	80/70	101-92	88	94-85
Phase 1						
98th-94th St on Second Ave	90/80	101-92	80/70	101-92	87	94-85
87th-83rd St on Second Ave	90/80	101-92	80/70	101-92	87	94-85
73rd-69th St on Second Ave	90/80	101-92	80/70	101-92	88	94-85
66th St, Second-Third Ave	90/80	101-92	80/70	101-92	78	94-85
63rd St, Second-First Ave	90/80	101-92	80/70	101-92	78	94-85
Phase 3						
57th-52nd St on Second Ave	90/80	101-92	80/70	101-92	88	94-85
45th-41st St on Second Ave	90/80	101-92	80/70	101-92	88	94-85
36th-32nd St on Second Ave	90/80	101-92	80/70	101-92	91	94-85
26th-23rd St on Second Ave	90/80	101-92	80/70	101-92	88	94-85
15th-12th St on Second Ave	90/80	101-92	80/70	101-92	88	94-85
4th St-Houston St on Second Ave	90/80	101-92	80/70	101-92	87	94-85
Phase 4						
Delancey-Hester St on Chrystie St	90/80	101-92	80/70	101-92	84	94-85
Delancey-Grand St on Forsyth St	90/80	101-92	80/70	101-92	77	94-85
Pell-Madison St on Chatham Sq	90/80	101-92	80/70	101-92	77	94-85
Peck Slip-Fulton St on Water St	90/80	101-92	80/70	101-92	84	94-85
Wall St-Coenties Slip on Water St	90/80	101-92	80/70	101-92	86	94-85

Notes:
1 xx/yy are day/night one-hour or average-eight-hour values.
2 xx-yy are range of levels for distances from 20 to 60 feet from center of construction operations.
3 Maximum project values show noise levels that would be created without mitigation. Because similar construction equipment would be used at most construction sites, the range of impacts is expected to be comparable.
4 The values are based on use of the particular equipment and activities that are expected to occur at the various station and shaft site construction areas, including, where applicable, backhoes, cherry pickers, front-end loaders, air compressors, truck loading, cranes, explosives, storage hoppers, muck bins, and asphalt pouring machines.

The values shown in Table 12-5 do not include noise from pile-driving operations, because these operations would take place only for a relatively short time period (about 3 months) at any location. Noise produced by pile driving would vary depending on the soil conditions and the specific construction equipment and techniques utilized. For example, typical noise levels for an impact pile driver are 109 dBA at 20 feet and 101 dBA at 50 feet. Vibratory or sonic pile drivers are about 5 dBA quieter. In an effort to mitigate noise impacts, NYCT has committed to avoiding use of impact pile driving methods where possible, using bored or augured piles instead; however, it will still be necessary to use impact piles to drive the steel sheeting needed to construct the various retaining walls. Where piles must be driven, vibratory, sonic, or other types of pile drivers that produce lower noise levels than impact pile drivers would be used where possible. In all cases, however, pile-driving operations would produce intrusive and annoying noise levels that would exceed the FTA's construction impact criteria. Pile-driving operations would not occur at night, although it is possible that certain activities needed to support pile-driving (such as drilling) could occur during nighttime hours under certain circumstances.

With regard to noise from tunneling operations conducted using the various types of Tunnel Boring Machines (TBMs), airborne noise from this source is generally not expected to be discernible, since most of the noise would be contained underground and would be masked by the high existing ambient noise levels. However, absent the implementation of special measures, noise from TBMs would be discernible and possibly annoying at the times when these operations are taking place at access/extraction points and other locations where airborne noise can emanate out of openings in the ground.

Mining operations would use drilling and controlled blasting, and except for some limited locations where vertical blasting may occur (chiefly at shaft sites and some stations), most of the noise would be contained underground and is not expected to be discernible. At locations where vertical blasting would occur, noise from the blasting would be discernible for a very short period of time (i.e., for the several-second duration of the blast). In general, due to the short duration of these events, average hourly noise levels would not be significantly affected by the blast noise. However, the rapid and dynamic change in noise levels that result from these events would be intrusive at nearby residences and businesses.

Vertical blasting operations would be temporary, and are only expected to occur for a limited period of time at any construction location. All blasting would conform to regulations of the New York City Fire Department (FDNY) and any other applicable regulations, and would use timed multiple charges of limited blast intensity, which would reduce potential impacts. Except in extraordinary circumstances, vertical blasting would not occur late at night. An example of an "extraordinary circumstance" might occur near hospitals, where blasting would need to be scheduled so as not to interfere with surgical procedures. Another example is where work would occur at or near an existing subway station, where daytime disruptions to service would create adverse impacts on a far greater number of passengers.

Noise would also be generated from ground improvement and trucking activities, slurry wall construction, spoils removal at stations and from the tunnels, and other activities. To reduce noise associated with such construction, performance standards (provided below in the section called "Types of Noise Mitigation Procedures") would be established by NYCT and included with contract documents that must be met by all contractors during construction. A variety of measures would be employed to meet these standards, which could include using buckets and vertical conveyors to move spoils to the street level, lining hoppers and trucks with rubber to minimize the effect of spoils being deposited into hoppers and trucks; and using drive-through street-level truck enclosures for truck loading. Overall, the implementation of such measures would reduce the number of adverse airborne noise impacts, but will not eliminate all of them. Even with these measures, construction operations would create significant adverse airborne noise impacts at a number of locations—in particular, at a large number of residences.

While the SDEIS considered using truck elevators to move trucks between below-ground activities and street-level as a means of reducing noise associated with conveyors and chutes, it has since been determined that use of such hoists would be impractical. Because the hoists move very slowly, trucks waiting to use the hoists would have to queue on the adjacent streets, creating noise, before entering the elevators. Each truck would take approximately 15 minutes to load, greatly lengthening the project's construction schedule. In addition, the truck hoists would themselves create noise, although not at the levels reported for spoils removal operations.

While most above-ground construction operations would occur 15 hours per day, TBM tunneling and spoils removal would occur for 24 hours per day, creating noise at all sites where spoils or activities related to the TBMs would be located. These sites include the various TBM launch sites, the shaft site/spoils removal area at Playground 96, the shaft site/spoils removal area on 66th Street at Second Avenue; the shaft site/spoils removal areas at St. Vartan Park and Kips Bay Plaza; the shaft site/spoils removal area near Houston Street; the shaft site on Water Street; the potential spoils removal routes on Old Slip or Gouverneur Lane; and the barge site at Pier 6. (Please see Chapter 3, "Description of Construction Methods and Activities," for a more complete description of the activities that would take place at these locations.) Below-ground TBM tunneling would not itself create airborne noise impacts; see below for the ground-borne noise analysis.

Noise would also be significant at all 16 station construction areas—and any other locations where cut-and-cover construction would occur—for varying periods of time. Although NYCT will use below-ground mining techniques as much as possible to help minimize impacts—including airborne noise—at least some cut-and-cover construction will be required at all stations. In some cases, entire stations will need to be built using cut-and-cover techniques because of geological or other conditions.

As described in Chapter 3, each station would be constructed in several distinct phases, and the amount, type, and timing of noise impacts would vary according to the phase. For example, for stations constructed using cut-and-cover technology, pile installation in the center of Second Avenue to support decks would be a very noisy activity, but this activity would only occur for a fairly short period (approximately 3 months). However, once the street is excavated to a depth sufficient to permit activities to occur below-ground, a deck would be installed over the street surface. At such time, noisy activities would be concentrated at the shafts (typically measuring 30 feet by 30 feet) used to remove spoils from the station excavation area, and in the immediate vicinity. Most of the remaining five-block station area would be less affected by noise and other construction disturbances because the activities would essentially occur within an underground enclosure. Under no circumstance would the entire excavation area be open to the air simultaneously.

At each station, most construction activities would not occur late at night (i.e., between 10 PM and 7 AM). However, some spoils removal activities would occur during the overnight period to help minimize traffic and other disturbances that would be worse during daytime hours. At any location where spoils would be removed overnight, NYCT would require construction contractors to provide mitigation such as an enclosure (described in more detail below) to meet the construction noise limits specified by NYCT and provided below. These limits and other mitigation measures will all be contained in the project's Construction Environmental Protection Program, or "CEPP" (also described below).

Although a variety of mitigation measures will be implemented to reduce noise levels during construction, the impact on residents who live in the affected areas would still be significant and adverse. These impacts would occur for a considerable period of time—several years for a typical station and up to 8 years at the shaft site/station/spoils removal areas in the 96th Street and 34th Street vicinities.

OVERVIEW OF NOISE MITIGATION PROCEDURES AND MEASURES

NYCT is committed to developing and implementing an extensive mitigation program to reduce and alleviate construction noise impacts. This program, described within this chapter, will be contained within the project's CEPP, which is being modeled on those developed for other large urban construction projects, such as the MTA's East Side Access Project in Manhattan and the Central Artery/Tunnel Project (also known as the "Big Dig") in Boston. As explained in other chapters of this FEIS, the CEPP will be the document in which all project commitments and requirements related to construction will be incorporated. NYCT will incorporate relevant portions of the CEPP in all construction contracts, and contractors will be obligated to follow these provisions.

TYPES OF NOISE MITIGATION MEASURES

Overall, the types of noise mitigation that would be implemented along the project area would vary depending on the type and extent of construction, its proximity to sensitive uses (such as residences), and line-of-sight between construction and receptors. Consequently, noise mitigation measures cannot be applied on a "one size fits all" basis, but must instead be tailored to the specific situation at each location.

Prior to any construction, NYCT will require its contractors to establish and secure its approval for site-specific Noise Control Plans which will describe the particular noise reduction measures required to meet the specified noise level limitations designed to minimize nuisance noise conditions. These plans will include all of the noise control commitments made in this FEIS or elsewhere, if appropriate. Among the elements of these plans will be: a description of anticipated construction activities; noise level calculations to predict lot-line construction noise during applicable daytime, evening, and nighttime periods (see below for a description of this process); an inventory of construction equipment and associated noise levels; sketches of the construction sites; and summary tables listing anticipated noise levels.

Establishment of Lot Line Limits (Performance Standards) and Monitoring Requirements

One of the most important aspects of the Noise Control Plans will include NYCT's commitment to achieve a certain level of noise reduction based on the establishment of performance standards, also known as "lot line limits." (Lot line limits are defined as the maximum level of noise that could be experienced either by the nearest residential building or at 200 feet from the construction site, whichever is closer.) With this approach, contractors will have the freedom to choose from a number of different methods of reducing noise levels provided they do not exceed the specified performance standard level defined in Table 12-6. The values provided in this table are based on the general observation that while an increase of 5 dB(A) may be noticeable, it should not represent an unacceptable noise hardship condition.

In all areas, NYCT will require that all contractors conduct construction activities in such a manner that *cumulative* noise levels measured 200 feet from construction limits or at the lot line of the nearest affected building, whichever is closer, do not exceed the levels specified in Table 12-6. In no case will the public be exposed to construction noise levels exceeding 90 dB(A) for continuous noise levels, or to levels exceeding 125 dB(A) for impulsive noise.

As shown in the table, prediction of lot line construction noise levels will take account of the types of surrounding land uses and the time of day for all construction activities. They will also take account of existing ambient (or background) noise levels. Prior to any construction, NYCT

Table 12-6
Cumulative Construction Noise Lot-Line Limits at 200 Feet[1]

Noise Monitoring Location Land Use	Average Noise Not to Exceed (L_{eq}) [2]	Maximum Noise Level Criteria (L_{max}) [3]
DAYTIME (7 AM TO 6 PM)		
Noise Sensitive Locations	75 or Background + 5 [4]	85 [4] (or 90 for impact equipment)
Commercial Areas	80 or Background + 5 [4]	None [5]
Industrial Areas	85 or Background + 5 [4]	None [5]
EVENING (6 PM TO 10 PM)		
Noise-Sensitive Locations	Background + 5	85
Commercial Areas	Background + 5 [4]	None [5]
Industrial Areas	None [5]	None [5]
NIGHT-TIME (10 PM TO 7 AM)		
Noise-Sensitive Locations	Background + 5	80
Commercial Areas	None [5]	None [5]
Industrial Areas	None [5]	None [5]

Notes: This table is new for the FEIS.

1 All measurements will be taken at the affected lot line. In situations where the work site is within 50 feet of a lot-line, the measurement will be taken at the lot line, and then adjusted in accordance with the values provided in Table 12-8 (below). Lot line noise limits will apply to all points along the receptor's lot line.

2 L_{eq} noise readings are averaged over 20-minute intervals and compared against the higher of the two criteria. L_{eq} Level (dB(A), slow) re 2x10-5 Pa

3 L_{max} noise readings occur instantaneously. L_{max} Level (dB(A), slow) re 2x10-5 Pa

4 Noise from impact equipment is exempt from the L_{eq} requirement, however is subject to a lot-line Lmax limit of 95 dBA.

5 In no case will the public be exposed to construction noise levels exceeding 90 dB(A) on "slow" response or to impulsive noise levels exceeding 125 dB(A) maximum transient level fast response as measured on a general purpose sound level meter.

will require its contractors to conduct ambient noise measurements[1] at noise-sensitive locations to identify existing conditions prior to construction. At noise-sensitive locations, the contractor will be required to collect background noise measurements for at least 24 hours over two non-consecutive days from Monday through Saturday and on one Sunday at locations identified in the Noise Monitoring Plan prior to the start of construction.

It should be noted that at some locations, existing ambient noise levels are already above those specified in FTA impact criteria for construction. Consequently, reducing construction noise to within FTA impact criteria levels would not be possible because the construction noise would be masked by the ambient noise levels. The potential measures to mitigate airborne noise impacts currently under consideration are discussed later in this chapter in the section entitled, "Noise Mitigation," as is the process that NYCT will use to inform the public about the further development of such measures as engineering progresses.

Prior to any construction, NYCT will also require contractors to secure its approval for a noise monitoring and reporting protocol that will be used throughout the construction process. Among the measures to be included in this protocol are: identifying the receptor locations where noise

1 Measurements will be taken on the "A" scale of a general purpose integrating sound level meter conforming to ANSI Standard S1.4 for Type 1 or Type 2 sound level meters at slow response.

monitoring would be performed; specifying the type(s) of noise measurement devices to be used; describing the noise monitoring methods and procedures, including data reporting methods, that would be used; delineating response procedures and actions to be taken for any lot-line or equipment noise levels that exceed specified lot line noise limits; and identifying appropriate complaint response and resolution procedures.

Once construction begins, 24-hour noise monitoring stations will also be established at noise sensitive locations; these stations will provide NYCT with the ability to monitor its contractors to ensure that the performance standards established by NYCT and detailed above are met. Upon notification of a noise complaint, noise measurements will be promptly taken at the complainant's location during activities representative of the offending operation. The complaint response measurement will be immediately submitted to NYCT or its designate. In the event that the measured level exceeds allowable limits or results in nuisance conditions, the Contractor will be instructed to implement noise reduction controls immediately.

Noise Standards for Construction Equipment

To achieve the performance standards identified in Table 12-6, one aspect of the Noise Control Plan will include providing NYCT with an inventory of all equipment to be used on each construction site along with its associated noise levels, and then ensuring that use of the construction equipment does not exceed the cumulative values provided in Table 12-6. One potential means of accomplishing this is by outfitting construction machinery with efficient noise-suppression devices.

For each piece of equipment listed to be used on the construction site, contractors will have to complete an "Application for Certificate of Equipment Noise Compliance" for approval by NYCT or its designate. Testing procedures will conform to specifications found in the approved Noise Control Plan (described above). All construction equipment will be tested every 6 months while in use, and will also be subject to periodic compliance testing whenever evidence of non-compliance is apparent. If any equipment is without a currently valid noise certification on file, or if the equipment fails its random noise compliance test (i.e., exceeds the 50 foot emission limits in Table 12-7 or the adjusted value provided in Table 12-8 for emission limits of less than 50 feet), the contractor will have to implement adequate mitigation measures to comply with the equipment noise limits**.**

Additional Mitigation Measures

Once construction begins, each contractor will be required to implement a range of mitigation measures in order to meet the performance standards identified above. As shown in Table 12-9 and as described in more detail below in the section entitled "Noise Mitigation," these measures may include acoustical sound barriers and/or enclosures to help mitigate noise at locations where their use would not create more severe traffic, visual, or other impacts. Other potential means of mitigating noise impacts at the construction sites include the use of vertical conveyors, which operate more quietly than other means of transporting spoils; lining trucks and/or hoppers with rubber; and using flagmen or manually adjustable alarms on trucks to reduce noise from backup alarms. At blasting sites, use of noise screens, blasting mats, and sequential or multi-delay blasting machines would also reduce noise. Ultimately, at the time of construction, NYCT's contractors will be able to select from these or other noise abatement measures to ensure that construction noise does not exceed the performance standards. Prior to implementing any of these measures, NYCT will also discuss the advantages and disadvantages involved with

Table 12-7
Construction Equipment 50-Foot Noise Emission Limits

Equipment Category	L_{max} Level (dB(A), slow re $2x10^{-5}$ Pa)	Impact or Continuous
Arc Welder	73	Continuous
Auger Drill Rig	85	Continuous
Backhoe	80	Continuous
Bar Bender	80	Continuous
Boring Jack Power Unit	80	Continuous
Chain Saw	85	Continuous
Compressor	70	Continuous
Compressor (other)	80	Continuous
Concrete Mixer	85	Continuous
Concrete Pump	82	Continuous
Concrete Saw	90	Continuous
Concrete Vibrator	80	Continuous
Crane	85	Continuous
Dozer	85	Continuous
Excavator	85	Continuous
Front End Loader	80	Continuous
Generator	82	Continuous
Generator (25 KVA or less)	70	Continuous
Grader	85	Continuous
Grinder Saw	85	Continuous
Horizontal Boring Hydro Jack	80	Continuous
Hydra Break Ram	90	Impact
Impact Pile Driver	95	Impact
In situ Soil Sampling Rig	84	Continuous
Jackhammer	85	Impact
Mounted Impact Hammer (hoe ram)	90	Impact
Paver	85	Continuous
Pneumatic Tools	85	Continuous
Pumps	77	Continuous
Rock Drill	85	Continuous
Scraper	85	Continuous
Slurry Trenching Machine	82	Continuous
Soil Mix Drill Rig	80	Continuous
Street Sweeper	80	Continuous
Tractor	84	Continuous
Truck (dump, delivery)	84	Continuous
Vacuum Excavator Truck (vac-truck)	85	Continuous
Vibratory Compactor	80	Continuous
Vibratory Pile Driver	95	Continuous
All other equipment with engines larger than 5 HP	85	Continuous
Truck (dump, delivery)	84	Continuous

Note: This table is new for the FEIS.

Table 12-8
Adjustments for Equipment Noise Measurements at Less Than 50 Feet

Measurement Distance (in feet)	Values to Be Subtracted from Measured Noise Levels for Construction Equipment Identified in Table 12-7 to Estimate Noise Levels at 50 Feet (dBA)
19-21	8
22-23	7
24-26	6
27-29	5
30-33	4
34-37	3
38-42	2
43-47	1
48-50	0
Note: This table is new for the FEIS.	

Table 12-9
Overview of Airborne Construction Noise Impacts and Mitigation[1]

From[2]	To[2]	Activity	Typical Construction Activity	Possible Airborne Noise Impact	Mitigation Options[3]
Phase 2 Construction Activities					
525 ft west of Fifth on 125 St	450 ft west of Fifth on 125 St	Shaft site	Underground boring	N	None required.
			Pile installation	Y	Use of jersey barriers with a 6-8 foot barrier on top to mitigate noise at street level. Use of alternative piling techniques, such as bored or augered piling, rather than impact piling. Work would typically not occur between 10 pm and 7 am.
			Excavation of street to depth sufficient to permit decking to be installed and retrieve TBM	Y	Use of jersey barriers with a 6-8 foot barrier on top to mitigate noise at street level. Fit jackhammers and other equipment with silencers. Work would typically not occur between 10 pm and 7 am.
			Transfer of materials through shaft opening	Y	Clad crane with acoustic paneling. Fit crane with silencer.
			Trucking of TBM components	Y	Use of flagmen or manually adjust-able alarms to mitigate noise from truck back-up alarms at night.
450 feet west of Fifth Ave on 125 St	Park Ave at 125th Street	Bored tunnel	Underground boring	N	None required.

Table 12-9 (cont'd)
Overview of Airborne Construction Noise Impacts and Mitigation[1]

From[2]	To[2]	Activity	Typical Construction Activity	Possible Airborne Noise Impact	Mitigation Options[3]
Park Ave at 125th Street	Third Ave at 125th Street	Cut and cover station (125th Street)	Underground boring	N	None required.
			Utility relocation	Y	Fit jackhammers, air compressors, generators, light plant and cranes with silencers. Use of noise tents around workers using jackhammers.
			Construction of retaining walls (e.g., slurry wall)	Y	Use of jersey barriers with a 6-8 foot barrier on top to mitigate noise at street level. Work would typically not occur between 10 pm and 7 am.
			Pile installation	Y	Use of jersey barriers with a 6-8 foot barrier on top to mitigate noise at street level. Use of alternative piling techniques, such as bored or augered piling, rather than impact piling. Work would typically not occur between 10 pm and 7 am.
			Excavation of street to depth sufficient to permit decking to be installed and construct station	Y	Use of jersey barriers with a 6-8 foot barrier on top to mitigate noise at street level. Fit jackhammers and other equipment with silencers. Work would typically not occur between 10 pm and 7 am.
			Transfer of materials through deck opening	Y	Clad crane with timber paneling, enclosing the crane. Fit crane with silencer. Possibly locate ventilation fans, dewatering pumps, air compressors and generators in tunnel.
			Spoils removal	Y	Lining hoppers with rubber to reduce impact noise from rock; enclose truck area below hopper or enclose both hopper and truck.
			Trucking	Y	Use of flagmen or manually adjustable alarms to mitigate noise from truck back-up alarms at night.
Third Ave at 125 St	Third Ave at 125 St	Cut and cover (shaft site for TBM launch and spoils removal at curve)	Utility relocation	Y	Fit jackhammers, air compressors, generators, light plant and cranes with silencers. Use of noise tents around workers using jackhammers.
			Construction of retaining walls (e.g., slurry wall)	Y	Use of jersey barriers with a 6-8 foot barrier on top to mitigate noise at street level. Work would typically not occur between 10 pm and 7 am.
			Excavation of street to depth sufficient to permit decking to be installed and to launch TBM	Y	Use of jersey barriers with a 6-8 foot barrier on top to mitigate noise at street level. Fit jackhammers and other equipment with silencers. Work would typically not occur between 10 pm and 7 am.

Table 12-9 (cont'd)
Overview of Airborne Construction Noise Impacts and Mitigation[1]

From[2]	To[2]	Activity	Typical Construction Activity	Possible Airborne Noise Impact	Mitigation Options[3]
Third Ave at 125 St (cont'd)	Third Ave at 125 St (cont'd)	Cut and cover (shaft site for TBM launch and spoils removal at curve) (cont'd)	Spoils removal	Y	Lining hoppers with rubber to reduce impact noise from rock; enclose truck area below hopper or enclose both hopper and truck.
			Trucking	Y	Use of flagmen or manually adjust-able alarms to mitigate noise from truck back-up alarms at night.
129 St	122 St	Cut and cover tunnel (storage tracks)[2]	Utility relocation	Y	Fit jackhammers, air compressors, generators, light plant and cranes with silencers. Use of noise tents around workers using jackhammers.
			Construction of retaining walls (e.g., slurry wall)	Y	Use of jersey barriers with a 6-8 foot barrier on top to mitigate noise at street level. Work would typically not occur between 10 pm and 7 am.
			Pile installation	Y	Use of jersey barriers with a 6-8 foot barrier on top to mitigate noise at street level. Use of alternative piling techniques, such as bored or augered piling, rather than impact piling. Work would typically not occur between 10 pm and 7 am.
			Excavation of street to depth sufficient to permit decking to be installed and construct storage tracks	Y	Use of jersey barriers with a 6-8 foot barrier on top to mitigate noise at street level. Fit jackhammers and other equipment with silencers. Work would typically not occur between 10 pm and 7 am.
			Spoils removal	Y	Lining hoppers with rubber to reduce impact noise from rock; enclose truck area below hopper or enclose both hopper and truck.
			Trucking	Y	Use of flagmen or manually adjust-able alarms to mitigate noise from truck back-up alarms at night.
Third at 125 St	122 St	Soft ground bored tunnel	Underground mining	N	None required.
			Ground improvement	Y	Use of site barriers to mitigate noise at street level.
122 St	120 St	Cut and cover (tunnel and TBM retrieval)	Utility relocation	Y	Fit jackhammers, air compressors, generators, light plant and cranes with silencers. Use of noise tents around workers using jackhammers.
			Construction of retaining walls (e.g., slurry wall)	Y	Use of jersey barriers with a 6-8 foot barrier on top to mitigate noise at street level. Work would typically not occur between 10 pm and 7am.
			Pile installation	Y	Use of jersey barriers with a 6-8 foot barrier on top to mitigate noise at street level. Use of alternative piling techniques, such as bored or augered piling, rather than impact piling. Work would typically not occur between 10 pm and 7 am.

Table 12-9 (cont'd)
Overview of Airborne Construction Noise Impacts and Mitigation[1]

From[2]	To[2]	Activity	Typical Construction Activity	Possible Airborne Noise Impact	Mitigation Options[3]
122 St (cont'd)	120 St (cont'd)	Cut and cover (tunnel and TBM retrieval) (cont'd)	Excavation of street to depth sufficient to permit decking to be installed, to construct tunnels and to retrieve TBM	Y	Use of jersey barriers with a 6-8 foot barrier on top to mitigate noise at street level. Fit jackhammers and other equipment with silencers. Work would typically not occur between 10 pm and 7 am.
			Transfer of materials through deck opening	Y	Clad crane with timber paneling, enclosing the crane. Fit crane with silencer. Possibly locate ventilation fans, dewatering pumps, air compressors and generators in tunnel.
			Trucking	Y	Use of flagmen or manually adjustable alarms to mitigate noise from truck back-up alarms at night.
120 St	119 St	Existing tunnel	None	N	None required.
119 St	115 St	Cut and cover station (116th Street)	Utility relocation	Y	Fit jackhammers, air compressors, generators, light plant and cranes with silencers. Use of noise tents around workers using jackhammers.
			Construction of retaining walls (e.g., slurry wall)	Y	Use of jersey barriers with a 6-8 foot barrier on top to mitigate noise at street level. Work would typically not occur between 10 pm and 7 am.
			Pile installation	Y	Use of jersey barriers with a 6-8 foot barrier on top to mitigate noise at street level. Use of alternative piling techniques, such as bored or augered piling, rather than impact piling. Work would typically not occur between 10 pm and 7 am.
			Excavation of street to depth sufficient to permit decking to be installed and to construct station	Y	Use of jersey barriers with a 6-8 foot barrier on top to mitigate noise at street level. Fit jackhammers and other equipment with silencers. Work would typically not occur between 10 pm and 7 am.
			Transfer of materials through deck opening	Y	Clad crane with timber paneling, enclosing the crane. Fit crane with silencer. Possibly locate ventilation fans, dewatering pumps, air compressors and generators in tunnel.
			Spoils removal	Y	Lining hoppers with rubber to reduce impact noise from rock; enclose truck area below hopper or enclose both hopper and truck.
			Trucking	Y	Use of flagmen or manually adjustable alarms to mitigate noise from truck back-up alarms at night.
115 St	110 St	Existing tunnel	None	N	None required.
110 St	108 St	Cut and cover tunnel	Utility relocation	Y	Fit jackhammers, air compressors, generators, light plant and cranes with silencers. Use of noise tents around workers using jackhammers.

Table 12-9 (cont'd)
Overview of Airborne Construction Noise Impacts and Mitigation[1]

From[2]	To[2]	Activity	Typical Construction Activity	Possible Airborne Noise Impact	Mitigation Options[3]
110 St (cont'd)	108 St (cont'd)	Cut and cover tunnel (cont'd)	Construction of retaining walls (e.g., slurry wall)	Y	Use of jersey barriers with a 6-8 foot barrier on top to mitigate noise at street level. Work would typically not occur between 10 pm and 7 am.
			Pile installation	Y	Use of jersey barriers with a 6-8 foot barrier on top to mitigate noise at street level. Use of alternative piling techniques, such as bored or augered piling, rather than impact piling. Work would typically not occur between 10 pm and 7 am.
			Excavation of street to depth sufficient to permit decking to be installed and to construct tracks	Y	Use of jersey barriers with a 6-8 foot barrier on top to mitigate noise at street level. Fit jackhammers and other equipment with silencers. Work would typically not occur between 10 pm and 7 am.
108 St	105 St	Cut and cover station (106th Street)	Utility relocation	Y	Fit jackhammers, air compressors, generators, light plant and cranes with silencers. Use of noise tents around workers using jackhammers.
			Demolition of existing station wall	Y	Work would not occur between 10 pm and 7 am.
			Construction of retaining walls (e.g., slurry wall)	Y	Use of jersey barriers to mitigate noise at street level. Work would typically not occur between 10 pm and 7 am.
			Pile installation	Y	Use of jersey barriers with a 6-8 foot barrier on top to mitigate noise at street level. Use of alternative piling techniques, such as bored or augered piling, rather than impact piling. Work would typically not occur between 10 pm and 7 am.
			Excavation of street to depth sufficient to permit decking to be installed and to construct station	Y	Use of jersey barriers with a 6-8 foot barrier on top to mitigate noise at street level. Fit jackhammers and other equipment with silencers. Work would typically not occur between 10 pm and 7 am.
			Transfer of materials through deck opening	Y	Clad crane with timber paneling, enclosing the crane. Fit crane with silencer. Possibly locate ventilation fans, dewatering pumps, air compressors and generators in tunnel.
			Trucking	Y	Use of flagmen or manually adjustable alarms to mitigate noise from truck back-up alarms at night.
Phase 1 Construction Activities					
105 St	99 St	Existing tunnel	Demolition of some existing walls	Y	Work would not occur between 10 pm and 7 am.
			Construction of new walls	N	None required.

Table 12-9 (cont'd)
Overview of Airborne Construction Noise Impacts and Mitigation[1]

From[2]	To[2]	Activity	Typical Construction Activity	Possible Airborne Noise Impact	Mitigation Options[3]
105 St (cont'd)	99 St (cont'd)	Existing tunnel (cont'd)	Trucking	Y	Use of flagmen or manually adjustable alarms to mitigate noise from truck back-up alarms at night.
99 St	98 St	Cut and cover tunnel	Utility relocation	Y	Fit jackhammers, air compressors, generators, light plant and cranes with silencers. Use of noise tents around workers using jackhammers.
			Construction of retaining walls (e.g., slurry wall)	Y	Use of jersey barriers with a 6-8 foot barrier on top to mitigate noise at street level. Work would typically not occur between 10 pm and 7 am.
			Pile installation	Y	Use of jersey barriers with a 6-8 foot barrier on top to mitigate noise at street level. Use of alternative piling techniques, such as bored or augered piling, rather than impact piling. Work would typically not occur between 10 pm and 7 am.
			Excavation of street to depth sufficient to permit decking to be installed	Y	Use of jersey barriers with a 6-8 foot barrier on top to mitigate noise at street level. Fit jackhammers and other equipment with silencers. Work would typically not occur between 10 pm and 7 am.
98 St	94 St	Cut and cover station (96th Street)	Utility relocation	Y	Fit jackhammers, air compressors, generators, light plant and cranes with silencers. Use noise tents around workers using jackhammers.
			Construction of retaining walls (e.g., slurry wall)	Y	Use of jersey barriers with a 6-8 foot barrier on top to mitigate noise at street level. Work would typically not occur between 10 pm and 7 am.
			Pile installation	Y	Use of jersey barriers with a 6-8 foot barrier on top to mitigate noise at street level. Use of alternative piling techniques, such as bored or augered piling, rather than impact piling. Work would typically not occur between 10 pm and 7 am.
			Excavation of street to depth sufficient to permit decking to be installed and to construct station	Y	Use of jersey barriers with a 6-8 foot barrier on top to mitigate noise at street level. Fit jackhammers and other equipment with silencers. Work would typically not occur between 10 pm and 7 am.
			Transfer of materials through deck opening	Y	Clad crane with timber paneling, enclosing the crane. Fit crane with silencer. Possibly locate ventilation fans, dewatering pumps, air compressors and generators in tunnel.
			Trucking	Y	Use of flagmen or manually adjustable alarms to mitigate noise from truck back-up alarms at night.

Table 12-9 (cont'd)
Overview of Airborne Construction Noise Impacts and Mitigation[1]

From[2]	To[2]	Activity	Typical Construction Activity	Possible Airborne Noise Impact	Mitigation Options[3]
97 St	96 St	Construction support and staging site (Playground 96)	Various staging processes and tunnel support facilities	Y	Place noise barrier around site perimeter. Use of electric rather than diesel pumps, winches, etc. Provide noise baffling at electric substation.
94 St	92 St	Cut and cover shaft site	Utility relocation	Y	Fit jackhammers, air compressors, generators, light plant and cranes with silencers. Use of noise tents around workers using jackhammers.
			Construction of retaining walls (e.g., slurry wall)	Y	Use of jersey barriers with a 6-8 foot barrier on top to mitigate noise at street level. Work would typically not occur between 10 pm and 7 am.
			Pile installation	Y	Use of jersey barriers with a 6-8 foot barrier on top to mitigate noise at street level. Use of alternative piling techniques, such as bored or augered piling, rather than impact piling. Work would typically not occur between 10 pm and 7 am.
			Excavation of street to depth sufficient to permit decking to be installed and to launch/retrieve TBM	Y	Use of jersey barriers with a 6-8 foot barrier on top to mitigate noise at street level. Fit jackhammers and other equipment with silencers. Work would typically not occur between 10 pm and 7 am.
			Spoils removal	Y	Lining hoppers with rubber to reduce impact noise from rock; enclose truck area below hopper or enclose both hopper and truck.
			Trucking	Y	Use of flagmen or manually adjustable alarms to mitigate noise from truck back-up alarms at night.
92 St	87 St	Bored tunnel in rock	Underground boring	N	None required.
87 St	83 St	Bored tunnel in rock	Underground boring	N	None required.
			Underground horizontal blasting to create cavern	N	None required.
			Vertical blasting to create shafts	Y	Use blast mats and multi-delay charges to reduce intensity. Work would typically not occur between 10 pm and 7 am.
			Openings to bring materials in and out and to create station entrances	Y	Clad crane with timber paneling, enclosing the crane. Fit crane with silencer. Possibly locate ventilation fans, dewatering pumps, air compressors and generators in tunnel.
			Spoils removal	Y	Lining hoppers with rubber to reduce impact noise from rock; enclose truck area below hopper or enclose both hopper and truck.

Table 12-9 (cont'd)
Overview of Airborne Construction Noise Impacts and Mitigation[1]

From[2]	To[2]	Activity	Typical Construction Activity	Possible Airborne Noise Impact	Mitigation Options[3]
87 St (cont'd)	83 St (cont'd)	Mined station (86th Street)	Trucking	Y	Use of flagmen or manually adjustable alarms to mitigate noise from truck back-up alarms at night.
		Cut and cover station component (86th Street)	Utility relocation	Y	Fit jackhammers, air compressors, generators, light plant and cranes with silencers. Use of noise tents around workers using jackhammers.
			Construction of retaining walls (e.g., slurry wall)	Y	Use of jersey barriers with a 6-8 foot barrier on top to mitigate noise at street level. Work would typically not occur between 10 pm and 7 am.
			Pile installation	Y	Use of jersey barriers with a 6-8 foot barrier on top to mitigate noise at street level. Use of alternative piling techniques, such as bored or augered piling, rather than impact piling. Work would typically not occur between 10 pm and 7 am.
83 St	73 St	Bored tunnel in rock	Underground boring	N	None required.
73 St	69 St	Bored tunnel in rock	Underground boring	N	None required.
		Mined station (72nd Street)	Underground horizontal blasting to create cavern	N	None required.
			Vertical blasting to create shafts	Y	Use blast mats and multi-delay charges to reduce intensity.. Work would typically not occur between 10 pm and 7 am.
			Openings to bring materials in and out and to create station entrances		Clad crane with timber paneling, enclosing the crane. Fit crane with silencer. Possibly locate ventilation fans, dewatering pumps, air compressors and generators in tunnel.
			Spoils removal	Y	Lining hoppers with rubber to reduce impact noise from rock; enclose truck area below hopper or enclose both hopper and truck.
			Trucking and other activity		Use of flagmen or manually adjustable alarms to mitigate noise from truck back-up alarms at night.
		Cut and cover station component (72nd Street)	Utility relocation	Y	Fit jackhammers, air compressors, generators, light plant and cranes with silencers. Use of noise tents around workers using jackhammers.
			Construction of retaining walls (e.g., slurry wall)	Y	Use of jersey barriers with a 6-8 foot barrier on top to mitigate noise at street level. Work would typically not occur between 10 pm and 7 am.
			Pile installation	Y	Use of jersey barriers with a 6-8 foot barrier on top to mitigate noise at street level. Use of alternative piling techniques, such as bored or augered piling, rather than impact piling. Work would typically not occur between 10 pm and 7 am.

Table 12-9 (cont'd)
Overview of Airborne Construction Noise Impacts and Mitigation[1]

From[2]	To[2]	Activity	Typical Construction Activity	Possible Airborne Noise Impact	Mitigation Options[3]
69 St	62 St	Bored tunnel in rock	Underground boring and drill and blast	N	None required.
65 St	63 St	Mined tunnel (63rd St connector—curve west)	Soil stabilization	Y	Use of site barriers to mitigate noise at street level.
			Underground drill and blast	N	None required.
			Vertical blasting to create shaft site at 66th Street/Second Avenue	Y	Use blast mats and multi-delay charges to reduce intensity. Work would typically not occur between 10 pm and 7 am.
			Spoils removal	Y	Lining hoppers with rubber to reduce impact noise from rock; enclose truck area below hopper or enclose both hopper and truck.
			Trucking	Y	Use of flagmen or manually adjustable alarms to mitigate the noise from the truck back-up alarms at night.
63 St	61 St	Mined tunnel (63rd St connector—curve east)	Underground drill and blast	N	None required.
Phase 3 Construction Activities					
62 St	57 St	Bored tunnel in rock	Underground boring	N	None required.
57 St	52 St	Cut and cover station (55th Street)	Utility relocation	Y	Fit jackhammers, air compressors, generators, light plant and cranes with silencers. Use of noise tents around workers using jackhammers.
			Construction of retaining walls (e.g., slurry wall)	Y	Use of jersey barriers with a 6-8 foot barrier on top to mitigate noise at street level. Use of alternative piling techniques, such as bored or augered piling, rather than impact piling. Work would typically not occur between 10 pm and 7 am.
			Excavation of street to depth sufficient to permit decking to be installed and to construct station	Y	Use of jersey barriers with a 6-8 foot barrier on top to mitigate noise at street level. Fit jackhammers and other equipment with silencers. Work would typically not occur between 10 pm and 7 am.
			Transfer of materials through deck opening	Y	Clad crane with timber paneling, enclosing the crane. Fit crane with silencer. Possibility of locating ventilation fans, dewatering pumps, air compressors and generators in the tunnel.
			Spoils removal	Y	Lining hoppers with rubber to reduce impact noise from rock; enclose truck area below hopper or enclose both hopper and truck.

Table 12-9 (cont'd)
Overview of Airborne Construction Noise Impacts and Mitigation[1]

From[2]	To[2]	Activity	Typical Construction Activity	Possible Airborne Noise Impact	Mitigation Options[3]
57 St (cont'd)	52 St (cont'd)	Cut and cover station (55th Street) (cont'd)	Trucking	Y	Use of flagmen or manually adjustable alarms to mitigate the noise from the truck back-up alarms at night.
52 St	45 St	Bored tunnel in rock	Underground boring	N	None required.
45 St	41 St	Bored tunnel in rock	Underground boring	N	None required.
		Mined station (42nd Street)	Underground horizontal blasting to create cavern	N	None required.
			Vertical blasting to create shafts	Y	Use blast mats and multi-delay charges to reduce intensity. Work would typically not occur between 10 pm and 7 am.
			Openings to bring materials in and out and to create station entrances	Y	Clad crane with timber paneling, enclosing the crane. Fit crane with silencer. Possibly locate ventilation fans, dewatering pumps, air compressors and generators in tunnel.
		Mined station (42nd Street)	Spoils removal	Y	Lining hoppers with rubber to reduce impact noise from rock; enclose truck area below hopper or enclose both hopper and truck.
			Trucking	Y	Use of flagmen or manually adjustable alarms to mitigate noise from truck back-up alarms at night.
		Cut and cover station component (42nd Street)	Utility relocation	Y	Fit jackhammers, air compressors, generators, light plant and cranes with silencers. Use of noise tents around workers using jackhammers.
			Construction of retaining walls (e.g., slurry wall)	Y	Use of jersey barriers with a 6-8 foot barrier on top to mitigate noise at street level. Work would typically not occur between 10 pm and 7 am.
			Pile installation	Y	Use of jersey barriers with a 6-8 foot barrier on top to mitigate noise at street level. Use of alternative piling techniques, such as bored or augered piling, rather than impact piling. Work would typically not occur between 10 pm and 7 am.
41 St	36 St	Bored tunnel in rock	Underground boring	N	None required.
36 St	33 St	Bored tunnel in rock	Underground boring	N	None required.
		Cut and cover station (34th Street)	Utility relocation	Y	Fit jackhammers, air compressors, generators, light plant and cranes with silencers. Use of noise tents around workers using jackhammers.
			Construction of retaining walls (e.g., slurry wall)	Y	Use of jersey barriers with a 6-8 foot barrier on top to mitigate noise at street level. Work would typically not occur between 10 pm and 7 am.

Table 12-9 (cont'd)
Overview of Airborne Construction Noise Impacts and Mitigation[1]

From[2]	To[2]	Activity	Typical Construction Activity	Possible Airborne Noise Impact	Mitigation Options[3]
36 St (cont'd)	33 St (cont'd)	Cut and cover station (34th Street) (cont'd)	Pile installation	Y	Use of jersey barriers with a 6-8 foot barrier on top to mitigate noise at street level. Use of alternative piling techniques, such as bored or augered piling, rather than impact piling. Work would typically not occur between 10 pm and 7 am.
			Excavation of street to depth sufficient to permit decking to be installed and to construct station	Y	Use of jersey barriers with a 6-8 foot barrier on top to mitigate noise at street level. Fit jackhammers and other equipment with silencers. Work would typically not occur between 10 pm and 7 am.
			Transfer of materials through deck opening	Y	Clad crane with timber paneling, enclosing the crane. Fit crane with silencer. Possibly locate ventilation fans, dewatering pumps, air compressors and generators in tunnel.
			Spoils removal	Y	Lining hoppers with rubber to reduce impact noise from rock; enclose truck area below hopper or enclose both hopper and truck.
			Trucking	Y	Use of flagmen or manually adjustable alarms to mitigate noise from truck back-up alarms at night.
36 St	35 St	Staging site (St. Vartan Park)	Construction support and staging site	Y	Place noise barrier around site perimeter. Use of electric or hydraulic rather than diesel pumps, winches, etc. Provide noise baffling at electric substation.
		Shaft site	Spoils removal	Y	Lining hopper with rubber to reduce impact noise from rock; enclose truck area below hopper or enclose both hopper and truck.
			Trucking	Y	Use of flagmen or manually adjustable alarms to mitigate noise from truck back-up alarms at night.
33 St	32 St	Shaft site	Spoils removal	Y	Lining hopper with rubber to reduce impact noise from rock; enclose truck area below hopper or enclose both hopper and truck.
			Trucking	Y	Use of flagmen or manually adjustable alarms to mitigate noise from truck back-up alarms at night.
32 St	26 St	Bored tunnel in rock	Underground boring	N	None required.

Table 12-9 (cont'd)
Overview of Airborne Construction Noise Impacts and Mitigation[1]

From[2]	To[2]	Activity	Typical Construction Activity	Possible Airborne Noise Impact	Mitigation Options[3]
26 St	23 St	Bored tunnel in rock	Underground boring	N	None required.
		Mined station (23rd Street)	Underground horizontal blasting to create cavern	N	None required.
			Vertical blasting to create shafts	Y	Use blast mats and multi-delay charges to reduce intensity. Work would typically not occur between 10 pm and 7 am.
			Openings to bring materials in and out and to create station entrances	Y	Clad crane with timber paneling, enclosing the crane. Fit crane with silencer. Possibly locate ventilation fans, dewatering pumps, air compressors and generators in tunnel.
			Spoils removal	Y	Lining hoppers with rubber to reduce impact noise from rock; enclose truck area below hopper or enclose both hopper and truck.
			Trucking and other activity	Y	Use of flagmen or manually adjustable alarms to mitigate noise from truck back-up alarms at night.
		Cut and cover station component (23rd Street)	Utility relocation	Y	Fit jackhammers, air compressors, generators, light plant and cranes with silencers. Use of noise tents around workers using jackhammers.
			Construction of retaining walls (e.g., slurry wall)	Y	Use of jersey barriers to mitigate noise at street level. Work would typically not occur between 10 pm and 7 am.
			Pile installation	Y	Use of jersey barriers with a 6-8 foot barrier on top to mitigate noise at street level. Use of alternative piling techniques, such as bored or augered piling, rather than impact piling. Work would typically not occur between 10 pm and 7 am.
23 St	15 St	Bored tunnel in rock	Underground boring	N	None required.
15 St	11 St	Bored tunnel in rock	Underground boring	N	None required.
		Mined station (14th Street)	Underground horizontal blasting to create cavern	N	None required.
			Vertical blasting to create shafts	Y	Use blast mats and multi-delay charges to reduce intensity. Work would typically not occur between 10 pm and 7 am.
			Openings to bring materials in and out, and to create station entrances	Y	Clad crane with timber paneling, enclosing the crane. Fit crane with silencer. Possibly locate ventilation fans, dewatering pumps, air compressors and generators in tunnel.
			Spoils removal	Y	Lining hoppers with rubber to reduce impact noise from rock; enclose truck area below hopper or enclose both hopper and truck.

Table 12-9 (cont'd)
Overview of Airborne Construction Noise Impacts and Mitigation[1]

From[2]	To[2]	Activity	Typical Construction Activity	Possible Airborne Noise Impact	Mitigation Options[3]
15 St (cont'd)	11 St (cont'd)	Mined station (14th Street) (cont'd)	Trucking and other activity	Y	Use of flagmen or manually adjustable alarms to mitigate noise from truck back-up alarms at night.
		Cut and cover station component (14th Street)	Utility relocation	Y	Fit jackhammers, air compressors, generators, light plant and cranes with silencers. Use of noise tents around workers using jackhammers.
			Construction of retaining walls (e.g., slurry wall)	Y	Use of jersey barriers with a 6-8 foot barrier on top to mitigate noise at street level. Work would typically not occur between 10 pm and 7 am.
			Pile installation	Y	Use of jersey barriers with a 6-8 foot barrier on top to mitigate noise at street level. Use of alternative piling techniques, such as bored or augered piling, rather than impact piling. Work would typically not occur between 10 pm and 7 am.
11 St	4 St	Bored tunnel in rock	Underground boring	N	None required.
4 St	Houston	Cut and cover station (Houston Street)	Utility relocation	Y	Fit jackhammers, air compressors, generators, light plant and cranes with silencers. Use of noise tents around workers using jackhammers.
			Construction of retaining walls (e.g., slurry wall)	Y	Use of jersey barriers with a 6-8 foot barrier on top to mitigate noise at street level. Work would typically not occur between 10 pm and 7 am.
			Pile installation	Y	Use of jersey barriers with a 6-8 foot barrier on top to mitigate noise at street level. Use of alternative piling techniques, such as bored or augered piling, rather than impact piling. Work would typically not occur between 10 pm and 7 am.
			Excavation of street to depth sufficient to permit decking to be installed and to construct station	Y	Use of jersey barriers with a 6-8 foot barrier on top to mitigate noise at street level. Fit jackhammers and other equipment with silencers. Work would typically not occur between 10 pm and 7 am.
			Transfer of materials through deck opening	Y	Clad crane with timber paneling, enclosing the crane. Fit crane with silencer. Possibly locate ventilation fans, dewatering pumps, air compressors and generators in tunnel.
			Trucking	Y	Use of flagmen or manually adjustable alarms to mitigate noise from truck back-up alarms at night.

Table 12-9 (cont'd)
Overview of Airborne Construction Noise Impacts and Mitigation[1]

From[2]	To[2]	Activity	Typical Construction Activity	Possible Airborne Noise Impact	Mitigation Options[3]
4 St (cont'd)	Houston (cont'd)	Possible Shaft site	Spoils removal	Y	Lining hoppers with rubber to reduce impact noise from rock; enclose truck area below hopper or enclose both hopper and truck.
			Trucking	Y	Use of flagmen or manually adjustable alarms to mitigate noise from truck back-up alarms at night.
Phase 4 Construction Activities					
Houston	Delancey	Bored tunnel in soil	Cut and cover construction to remove piles	Y	Use of barriers to mitigate noise in nearby park. Fit jackhammers and other equipment with silencers. Work would typically not occur between 10 pm and 7 am.
			Underground boring	N	None required.
Delancey	Hester	Bored tunnel in soil	Underground boring	N	None required.
		Cut and cover station (Grand Street)	Utility relocation	Y	Fit jackhammers, air compressors, generators, light plant and cranes with silencers. Use of noise tents around workers using jackhammers.
			Construction of retaining walls (e.g., slurry wall)	Y	Use of jersey barriers with a 6-8 foot barrier on top to mitigate noise at street level. Use of barrier to limit noise in park. Work would typically not occur between 10 pm and 7 am.
			Pile installation	Y	Use of jersey barriers with a 6-8 foot barrier on top to mitigate noise at street level. Use of alternative piling techniques, such as bored or augered piling, rather than impact piling. Work would typically not occur between 10 pm and 7 am.
			Excavation of street to depth sufficient to permit decking to be installed and to construct station	Y	Use of jersey barriers with a 6-8 foot barrier on top to mitigate noise at street level. Fit jackhammers and other equipment with silencers. Work would typically not occur between 10 pm and 7 am.
			Transfer of materials through deck opening	Y	Clad crane with timber paneling, enclosing the crane. Fit crane with silencer. Possibly locating ventilation fans, dewatering pumps, air compressors and generators in tunnel.
			Trucking	Y	Use of flagmen or manually adjustable alarms to mitigate noise from truck back-up alarms at night.
Hester	Pell	Bored tunnel in soil	Underground boring	N	None required.
			Ground improvement	Y	Use of jersey barriers with a 6-8 foot barrier on top to mitigate noise at street level.

Table 12-9 (cont'd)
Overview of Airborne Construction Noise Impacts and Mitigation[1]

From[2]	To[2]	Activity	Typical Construction Activity	Possible Airborne Noise Impact	Mitigation Options[3]
Hester (cont'd)	Pell (cont'd)	Bored tunnel in soil (cont'd)	Cut and cover construction to remove piles and TBM	Y	Use of jersey barriers with a 6-8 foot barrier on top to mitigate noise at street level. Fit jackhammers and other equipment with silencers. Work would typically not occur between 10 pm and 7 am.
Pell	Madison	Bored tunnel in soil	Underground boring	N	None required.
		Cut and cover station (Chatham Square)	Utility relocation	Y	Fit jackhammers, air compressors, generators, light plant and cranes with silencers. Use of noise tents around workers using jackhammers.
			Construction of retaining walls (e.g., slurry wall)	Y	Use of jersey barriers with a 6-8 foot barrier on top to mitigate noise at street level. Work would typically not occur between 10 pm and 7 am.
			Pile installation	Y	Use of jersey barriers with a 6-8 foot barrier on top to mitigate noise at street level. Use of alternative piling techniques, such as bored or augered piling, rather than impact piling. Work would typically not occur between 10 pm and 7 am.
			Excavation of street to depth sufficient to permit decking to be installed and to construct station	Y	Use of jersey barriers with a 6-8 foot barrier on top to mitigate noise at street level. Fit jackhammers and other equipment with silencers. Work would typically not occur between 10 pm and 7 am.
			Transfer of materials through deck opening	Y	Clad crane with timber paneling, enclosing the crane. Fit crane with silencer. Possibly locate ventilation fans, dewatering pumps, air compressors and generators in tunnel.
			Trucking	Y	Use of flagmen or manually adjustable alarms to mitigate noise from truck back-up alarms at night.
Madison	Dover	Bored tunnel in soil	Underground boring	N	None required.
			Underpinning beneath certain Brooklyn Bridge approach ramps	N	Use of jersey barriers with a 6-8 foot barrier on top to mitigate noise at street level. Fit jackhammers and other equipment with silencers. Work would typically not occur between 10 pm and 7 am.
			Soil stabilization	Y	Use of site barriers to mitigate noise at street level.
Dover	John	Bored tunnel in soil	Underground boring	N	None required.
			Soil stabilization	Y	Use of site barriers to mitigate noise at street level.
		Cut and cover station (Seaport Station)	Utility relocation	Y	Fit jackhammers, air compressors, generators, light plant and cranes with silencers. Use of noise tents around workers using jackhammers.

Table 12-9 (cont'd)
Overview of Airborne Construction Noise Impacts and Mitigation[1]

From[2]	To[2]	Activity	Typical Construction Activity	Possible Airborne Noise Impact	Mitigation Options[3]
Dover (cont'd)	John (cont'd)	Cut and cover station (Seaport Station) (cont'd)	Construction of retaining walls (e.g., slurry wall)	Y	Use of jersey barriers with a 6-8 foot barrier on top to mitigate noise at street level. Work would typically not occur between 10 pm and 7 am.
			Pile installation	Y	Use of jersey barriers with a 6-8 foot barrier on top to mitigate noise at street level. Use of alternative piling techniques, such as bored or augered piling, rather than impact piling. Work would typically not occur between 10 pm and 7 am.
			Excavation of street to depth sufficient to permit decking to be installed and to construct station	Y	Use of jersey barriers with a 6-8 foot barrier on top to mitigate noise at street level. Fit jack-hammers and other equipment with silencers. Work would typically not occur between 10 pm and 7 am.
			Transfer of materials through deck opening	Y	Clad crane with timber paneling, enclosing the crane. Fit crane with silencer. Possibly locate ventilation fans, dewatering pumps, air compressors and generators in tunnel.
			Trucking	Y	Use of flagmen or manually adjustable alarms to mitigate noise from truck back-up alarms at night.
John	Wall	Bored tunnel in rock	Underground boring	N	None required.
Wall	Coenties Slip	Bored tunnel in rock	Underground boring	N	None required.
		Mined station (Hanover Square)	Underground horizontal blasting to create cavern	N	None required.
			Vertical blasting to create shafts	Y	Use blast mats and multi-delay charges to reduce intensity. Work would typically not occur between 10 pm and 7 am.
			Openings to bring materials in and out and to create station entrances	Y	Clad crane with timber paneling, enclosing the crane. Fit crane with silencer. Possibly locate ventilation fans, dewatering pumps, air compressors and generators in tunnel.
			Spoils removal for stations, tunnels, and tail tracks	Y	Lining hopper with rubber to reduce impact noise from rock; enclose truck area below hopper or enclose both hopper and truck.
			Trucking and other activity	Y	Use of flagmen or manually adjustable alarms to mitigate noise from truck back-up alarms at night.
		Cut and cover station component (Hanover Square)	Utility relocation	Y	Fit jackhammers, air compressors, generators, light plant and cranes with silencers. Use of noise tents around workers using jackhammers.
			Construction of retaining walls (e.g., slurry wall)	Y	Use of jersey barriers with a 6-8 foot barrier on top to mitigate noise at street level. Work would typically not occur between 10 pm and 7 am.

Table 12-9 (cont'd) Overview of Airborne Construction Noise Impacts and Mitigation[1]

From[2]	To[2]	Activity	Typical Construction Activity	Possible Airborne Noise Impact	Mitigation Options[3]
Wall (cont'd)	Coenties Slip (cont'd)	Cut and cover station component (Hanover Square) (cont'd)	Pile installation	Y	Use of jersey barriers with a 6-8 foot barrier on top to mitigate noise at street level. Use of alternative piling techniques, such as bored or augered piling, rather than impact piling. Work would typically not occur between 10 pm and 7 am.
Coenties Slip	Broad	Bored tunnel in rock	Underground boring	N	None required.
Pier 6 on East River		Barge operation for spoils removal	Possible bulkhead repairs and installation of piles	Y	Use of jersey barriers with a 6-8 foot barrier on top to mitigate noise at street level. Work would typically not occur between 10 pm and 7 am.
			Placement of barge cranes	Y	Clad crane with timber paneling, enclosing the crane. Fit crane with silencer.
			Operation of barges	Y	Use engines with quiet technologies.
Broad	South	Bored tunnel in rock (storage tracks)[4]	Underground boring or mining	N	None required.
Whitehall		Cut and cover construc-tion for ancillary facility[4]	Utility relocation	Y	Fit jackhammers, air compressors, generators, light plant and cranes with silencers. Use of noise tents around workers using jackhammers.
			Construction of retaining walls (e.g., slurry wall)	Y	Use of jersey barriers with a 6-8 foot barrier on top to mitigate noise at street level. Work would typically not occur between 10 pm and 7 am.
			Pile driving	Y	Use of jersey barriers with a 6-8 foot barrier on top to mitigate noise at street level. Use of alternative piling techniques, such as bored or augered piling, rather than impact piling. Work would typically not occur between 10 pm and 7 am.
			Excavation of street	Y	Use of jersey barriers with a 6-8 foot barrier on top to mitigate noise at street level. Fit jack-hammers and other equipment with silencers. Work would typically not occur between 10 pm and 7 am.
			Transfer of materials through deck opening	Y	Clad crane with timber paneling, enclosing the crane. Fit crane with silencer. Possibly locate ventilation fans, dewatering pumps, air compressors and generators in tunnel.
			Trucking	Y	Use of flagmen or manually adjustable alarms to mitigate noise from truck back-up alarms at night.

Notes:

1 This table has been substantially revised for the FEIS.

2 Unless otherwise stated, construction would occur on the extended Second Avenue corridor at the indicated cross-street.

3 As noted on page 12-11 of this FEIS, the contractor will be required to implement a range of mitigation measures in order to meet specified performance standards. The contractors will select from the measures identified in this table, or other measures, as necessary, to meet such standards where appropriate. NYCT will limit nighttime work to the hours specified, except in unusual circumstances.

4 Construction would occur in this area only if train storage tracks are built.

implementing these measures with the surrounding communities. (See the discussion of "Airborne Noise Mitigation" for examples of these advantages and disadvantages.) These discussions have already begun with the affected Community Boards.

PERMANENT IMPACTS OF THE PROJECT ALTERNATIVES: AIRBORNE NOISE

An analysis was conducted to evaluate the potential effects from noise due to fixed-rail operations and operation of mechanical equipment (e.g., supply and exhaust fans, climate conditioning equipment, and vents), and noise from subway train yards.

NOISE FROM SUBWAY OPERATIONS IN MANHATTAN

Once operational, the Second Avenue Subway's trains themselves do not have the potential to create airborne noise impacts outside of the tunnel and stations because they will generally be deep below ground. However, the various ancillary facilities such as fans, cooling towers, chillers, and pumps required to operate the Second Avenue Subway project have the potential to generate airborne noise. These ancillary facilities would be located at every station and in certain other areas along the entire alignment, and many of these facilities would have to be located above-ground. (For more information on ancillary facilities, please see Chapter 2, "Project Alternatives.") An assessment of the potential for airborne noise impacts was therefore conducted.

Table 12-10 shows existing and future noise levels with the proposed project at receptor sites along the corridor. For each receptor site, the table provides land use categories, the noise descriptors used for impact evaluation, existing noise levels, FTA impact criteria values (which include both trains and stationary sources of noise, such as ventilation equipment), project-generated noise levels, and predicted noise levels in 2025 with the proposed Second Avenue Subway. NYCT has committed to meet FTA standards for operational airborne noise criteria as defined in the FTA guidance manual, which, as discussed above, depend in part on ambient noise levels. Accordingly, based on existing ambient noise levels along the project corridor, all above-ground mechanical equipment (as well as any below-ground equipment requiring above-ground vents or similar structures) would typically be designed so that the noise level produced when the equipment is in use would not exceed 60 dBA as measured from the façade of the nearest residential property. For reference, 60 dBA is the noise level that would occur with light car traffic at a distance of 50 feet. Consequently, NYCT will commit either to using equipment with low noise levels or to placing such equipment in acoustically shielded enclosures or locations. Acoustic louvers or various types of silencers are among the measures that would be used to attenuate sound at vent buildings and similar structures.

In general, fan noise would be controlled using a combination of in-duct splitter attenuators (which can achieve between 20 to 30 dBA reductions in noise), sound absorptive plenums (large rooms enclosed by acoustic materials which can achieve between 10 and 15 dBA reductions), and potentially acoustic louvers. Along the alignment, approximately 50 percent of the fans would be located below-ground. Noise from cooling towers, which are located on buildings' roofs, would be controlled by building noise barriers around one or both sides of the towers.

As shown in Table 12-10, all of the predicted 2025 noise levels once the subway is operational would be well below the impact criteria, and these sources would not be expected to perceptibly increase ambient noise levels. The maximum change in Build L_{dn} and $L_{eq(1)}$ noise levels, when compared with No Build noise levels, would be less than 1 dBA. These changes would be insignificant and imperceptible.

Table 12-10
Noise Impact Evaluation Due to Operation of Proposed Project at Receptor Sites Along Second Avenue Subway Corridor

Noise Receptor Site	Land Use Category	Noise Receptor	Existing Noise Level	Allowable Project-Generated Noise Levels		Calculated Project-Generated Noise Level	Result	Total (Build) Noise Level with the Proposed Project
				Impact	Severe Impact			
1	3	L_{eq}	73.3	70.0	76.9	less than 60	No Impact	74.0
2	2	L_{dn}	75.6	65.0	73.8	less than 60	No Impact	76.2
3	2	L_{dn}	80.3	65.0	75.0	less than 60	No Impact	80.8
4	2	L_{dn}	77.5	65.0	75.0	less than 60	No Impact	78.2
5	2	L_{dn}	75.0	65.0	73.2	less than 60	No Impact	75.7
6	2	L_{dn}	77.3	65.0	75.0	less than 60	No Impact	77.9
7	3	L_{eq}	84.1	70.0	80.0	less than 60	No Impact	84.7
8	2	L_{dn}	67.8	62.7	68.0	less than 60	No Impact	68.9
9	2	L_{dn}	78.4	65.0	75.0	less than 60	No Impact	79.1
10	2	L_{dn}	77.7	65.0	75.0	less than 60	No Impact	78.4
11	2	L_{dn}	81.4	65.0	75.0	less than 60	No Impact	81.9
12	2	L_{dn}	78.1	65.0	75.0	less than 60	No Impact	78.8
13	2	L_{dn}	76.8	65.0	74.6	less than 60	No Impact	77.4
14	2	L_{dn}	73.9	65.0	72.4	less than 60	No Impact	74.6
15	2	L_{dn}	66.9	62.1	67.4	less than 60	No Impact	68.1
16	2	L_{dn}	74.3	65.0	72.7	less than 60	No Impact	75.0
17	2	L_{dn}	76.0	65.0	74.0	less than 60	No Impact	76.7

Note: For definition of land use categories, see Table 12-2.

NOISE AT TRAIN STORAGE YARDS

As described in Chapter 2, "Project Alternatives," the existing 36th-38th Street Yard[1] in Brooklyn is under consideration for nighttime storage of Second Avenue Subway trains. This analysis considers the potential for noise impacts from train storage at this yard. No significant noise impact would result from the trains traveling to and from the yard on existing subway tracks in the NYCT system, because the small number of trains that would be added to existing tracks traveling to the yard or to maintenance facilities elsewhere in the system would not perceptibly increase noise levels along these existing tracks. Although trains could also be stored underground beneath Second Avenue north and west of 125th Street, adjacent to the alignment tracks between approximately 21st and 9th Streets, and south of the Hanover Square Station in Lower Manhattan, these underground activities would not result in a significant increase in noise beyond that analyzed for the train operations.

The potential for noise impacts due to the yard operations at the existing 36th-38th Street Yard in Brooklyn was assessed using the FTA's general noise assessment procedures. For purposes of

[1] As described previously, the potential expansion to the Coney Island Yard discussed in the SDEIS has been eliminated from further consideration as a result of continuing engineering investigations.

a general assessment, the guidance allows existing noise levels to be estimated based on either distance from interstate highways, other roadways, rail lines, or on population density.

Table 12-11 shows estimated existing noise levels, allowable project-generated noise levels based on the FTA criteria, and predicted project-generated noise level. As shown in Table 12-11, all of the predicted noise levels would be well below the impact criteria, and noise from the yards would not be expected to perceptibly increase ambient noise levels.

Table 12-11
Noise Impact Evaluation Due to Operation of Proposed Project at Receptor Sites Adjacent to Rail Yards

Rail Yard	Land Use Category	Noise Descriptor	Existing Noise Level	Allowable Project-Generated Noise Levels		Predicted Project-Generated Noise Levels	Result
				Impact	Severe Impact		
36th-38th Street Yard	2	L_{dn}	65	60.8	66.2	55.2	No Impact

AIRBORNE NOISE MITIGATION

MITIGATION DURING CONSTRUCTION: AIRBORNE NOISE

As described above, the airborne noise analysis concluded that construction activities would result in significant adverse impacts at many locations throughout the study area along the proposed alignment. In general, these impacts would occur because the distance between receptors and construction equipment and operations is necessarily small (i.e., 20 to 60 feet), given the densely developed nature of the corridor where the project would be constructed. As a result, no significant amount of sound attenuation is achieved by distance.

Although the Second Avenue Subway alignment was carefully chosen to avoid passing beneath buildings wherever possible, its location within a very dense metropolitan area means that there are residents or sensitive land uses on almost every block. This proximity to sensitive uses limits opportunities for developing feasible, cost-effective mitigation. Nevertheless, despite these constraints, NYCT is committed to developing mitigation measures that would reduce and, where practicable, eliminate significant impacts due to construction in accordance with FTA criteria. At NYCT's direction, project engineers are continuing to explore three categories of noise control approaches: design considerations and project layout, sequence of operations, and alternative construction methods.

Design Considerations and Project Layout

Design considerations and project layout approaches include such measures as constructing noise barriers, rerouting traffic, placing construction equipment farther from noise-sensitive receptors, constructing walled enclosures around especially noisy activities, etc. For the Second Avenue Subway, there are two such measures that have the potential to significantly reduce project impacts: the use of acoustic barriers and walled enclosures around certain construction activities, and the placement of construction equipment in shielded locations, such as underground. Both of these measures will continue to be refined for use by the project as engineering continues.

Current plans call for acoustical sound barriers to be employed at various parks located near the project's construction activities, including Crack is Wack Playground (if underground storage tracks are constructed in the adjacent area), Playground 96, St. Vartan Park, Sara D. Roosevelt Park, St. James Triangle, Pearl Street Playground, Vietnam Veterans Plaza, and Coenties Slip. At these locations, use of these barriers would help shield parks or portions of parks that are still open to the public from intrusive noise and visual impacts at construction areas, though their necessary height (typically up to 12 feet tall) would also block views from neighbors or passers-by who normally look into these parks.

A typical barrier would consist of panels or acoustic fencing mounted on the ground or on concrete jersey barriers. Jersey barriers with 6- to 8-foot high barriers attached to them would generally be used at cut-and-cover sections of roadways and along sidewalks. Ground-mounted barriers measuring approximately 12 feet tall would be used at parks and other locations where practicable. To be most effective at mitigating noise, no gaps between panels or between the ground and the enclosure could be permitted with the exception of their entrances. In addition, to avoid noise deflections from the barrier to adjacent buildings, the source side of the barrier could be lined with sound absorptive materials, such as 1-inch-thick fiberglass. If employed, the 12-foot-high barriers could be very effective at controlling noise produced at levels low to the ground; for example, a barrier of this sort could reduce the noise levels created by a jack hammer at a distance of 50 feet from 88 dBA to approximately 60 dBA. In cases where barriers do not block lines of sight, little to no attenuation would be provided.

Such types of noise barriers would be used around the construction activities planned in portions of Playground 96 and St. Vartan Park. They would also be used at other locations to shield parks from nearby construction activities. Even at these locations, however, tall machinery such as cranes would not be enclosed. There are several reasons why enclosures could be feasible and effective in these two locations. First, both of these sites are set back off the adjacent roadways on all four sides. Therefore, in neither case would the enclosures extend into traffic lanes. Second, both sites are also separated from residential or other buildings by at least the width of a cross-street and its accompanying sidewalks. Therefore, the erection of 12-foot-high walls surrounding the sites would create less severe visual impacts than if the sites directly bordered occupied buildings. Third, both sites are also large, and consequently, could accommodate most of the necessary construction activities within the four walls of the enclosures. Finally, both of these sites would be used for substantially longer than any of the other properties planned for spoils removal and other construction activities. Please see Figure 12-4 for an illustration of how noise barriers at these parks might appear.

In addition, within the construction sites at Playground 96 and St. Vartan Park, stationary equipment that generates noise—such as compressors—would be enclosed within temporary buildings or other enclosures, where possible and where required to ensure that construction noise does not exceed the limits identified in Table 12-6. This would further reduce the noise emanating from these construction sites.

Noise walls at the two major off-street construction sites (Playground 96 and St. Vartan Park) would be effective in reducing noise only to receptors at locations lower than the height of the walls (i.e., at receptors where the line of sight to the construction is blocked). Fully enclosing the construction sites with tall walls and roofs is not practicable because tall construction equipment—most notably, the cranes that would be required at all stations and at other locations—could not operate within the confines of these walls. An enclosure tall enough to enclose the site including the cranes could be several stories high (or higher, depending on the construction activity), and would therefore be a substantial structure, the construction of which would require significant piles, bracing, and foundation systems to support the walls. Further, installing such structures would also create noise and other disruptions. In addition, such enclosures would require occupation of more space for construction than areas without enclosures. Even where technically feasible, these enclosures would be expensive to construct, may restrict construction operations, could exacerbate significant impacts to traffic flow at construction sites by requiring extended lane closures, and would also result in visual impacts. Specifically, light would be minimized and views could be blocked from adjacent buildings because of the height and mass of the enclosures. Please see Chapter 6, "Social Conditions," for more information on the visual impacts of enclosures.

As described in Chapter 3, another type of enclosure would also be employed during the station construction period. During most cut-and-cover activities, once the slurry walls are completed and the street excavation reaches an appropriate depth, it would be possible to install a deck over most of the excavation area. This deck would effectively function as a "roof," and the slurry walls would behave as the enclosure's walls. The "door" would be the shaft area where spoils conveying equipment and other machinery would be located. This "door" would move during different phases of station construction. It is also possible that the above-ground spoils-conveying construction equipment at stations (hoppers, vertical conveyors, and the truck loading facilities) could be partially enclosed; please see Figure 12-5 for a conceptual illustration. Along with lining hoppers and truck beds with rubber or similar "softening" surfaces, such partial enclosures would help to ensure that the construction noise does not exceed the limits identified in Table 12-6.

In addition, at locations where stations would be constructed using the cut-and-cover method, it may be possible to place some compressors, generators, and other noisy equipment below-ground where they would be either partially or completely shielded from nearby residences or other sensitive land uses. This appears to be a viable option provided that sufficient space and ventilation can be provided at each location where such underground equipment placement would occur, and if approved by the FDNY. In addition, as described above in Chapter 3, NYCT is continuing to evaluate the practicability of using mining techniques to construct tunnels, stations, and portions of stations as much as practicable to minimize street-level impacts. Since publication of the SDEIS, project engineers have determined that several additional stations and portions of the alignment can be constructed without extensive surface disruption.

Finally, at locations where blasting is required within the stations or tunnels, blast matsmats placed directly over the rock being blasted as a protective measure—would reduce the peak noise levels generated from the blasting. In addition, the use of multi-delayed chargers in combination with the blast mats would further reduce the peak noise levels.

At this time NYCT is committed to using some enclosures and/or below-grade operations for noise mitigation. Table 12-9 above identifies, by location, the various measures that would be implemented along the alignment based on current planning. NYCT will require contractors to choose among these or other approved measures to ensure that the construction noise does not exceed the limits identified in the CEPP. The process that NYCT will employ to obtain public input and to keep the public informed about mitigation measures following completion of this FEIS is described on the following page of this chapter under "Summary of Airborne Noise Mitigation Measures During Construction."

Sequence of Operations

Other types of mitigation measures involve the sequencing of operations. Measures of this type include changing construction sequencing to reduce noise impacts by either combining noisy operations to occur in the same time period or spreading them out, avoiding nighttime activities, etc. For the Second Avenue Subway project, NYCT has considered the feasibility of sequencing operations to minimize noise impacts; however, given the overall density of development along the alignment and the project's 8.5-mile length, there is little flexibility in this regard. Permitting construction to occur only during daytime hours, for example, would result in a much longer construction schedule, with disturbances occurring in each geographic area for a longer period of time. Nevertheless, NYCT is continuing to refine the construction's scheduling to minimize noise impacts.

For example, NYCT is currently exploring which construction operations can be limited to daytime operations only, without significantly affecting schedule and costs. NYCT is committed to restricting the timing of vertical blasting operations (and any associated surface drilling) except where it is not appropriate, given localized conditions, to require daytime blasting. NYCT will also limit the hours when most of the noisiest surface activities related to cut-and-cover construction—such as building retaining walls, pile installation, and street surface excavation—can occur. Such activities would not occur during the late evening and early morning hours (10 PM to 7 AM) unless these activities were enclosed or far away from sensitive land uses, such as residences. However, it is possible that some relatively quiet activities could occur overnight.

One general exception to the policy of avoiding overnight activities would involve utility work. Because utility work requires the complete closure of the roadway and shutting off utility service for several hours, utility work is normally undertaken at night. Some cut and cover construction would be needed, and noisy equipment, such as jackhammers, would at times be required. Where practicable, work would occur during the day. Moreover, late evening construction would occur during a limited number of evenings over the course of a year, which is the expected length of utility relocation work at a site.

Alternative Construction Methods

Finally, alternative construction methods, including such measures as avoiding impact pile installation in noise-sensitive areas, using low noise emission level equipment (such as machinery clad with acoustic panels to reduce noise), selecting and specifying quieter demolition methods, and enclosing jack hammer use or other small operations within portable noise tents are among the other measures that contractors will be able to employ to ensure that the construction noise does not exceed the limits specified in the CEPP. In some cases, impact or vibratory/sonic pile installation can be eliminated with bored or drilled piles used instead. This would eliminate a particularly annoying and disturbing operation. Similarly, infrared lighting and/or flagmen, instead of backup horns for trucks, would also mitigate noise somewhat. Backup horns, which are designed to attract attention, tend to produce noise that is generally annoying and disturbing, particularly late at night, to nearby residents. Another example of measures that fall into the category of alternative construction methods are specifications to reduce the intrusive nature of blasting. Construction specifications would require the use of modern blasting techniques, including timed multiple charges, blast mats, etc. These measures would lessen the severity of blasting noise levels. In addition, NYCT will require that specially quieted equipment will be specified where feasible and effective. Cladding stationary cranes is one such example.

Summary of Airborne Noise Mitigation Measures During Construction

The project's goal is to minimize noise levels during construction. However, due to the proximity to residential properties and the duration of many construction activities, significant noise impacts during construction will be unavoidable. Therefore, NYCT is committed to implementing measures to reduce significant noise impacts resulting from construction, and all of the measures described above will be considered for feasibility and practicability of implementation. In some, but not all cases, such measures could substantially reduce noise levels during construction.

Table 12-9 (above) provides a site-by-site description of the kinds of noise mitigation that would be implemented for each station or other construction activity area (such as a shaft site/spoils removal site). Contractors will be able to choose among these or other approved measures in order to meet the construction noise limits specified in the Table 12-6 above. Once construction begins, 24-hour noise monitoring locations will be established within or alongside the various construction sites.

Since issuing the SDEIS, NYCT has consulted with each of the local Community Boards through which the project would pass to update the public on a variety of issues related to project design and construction. At these meetings, NYCT has provided information and sought input on locations of station entrances and ancillary facilities, as well as noise and vibration issues. NYCT has also made a good faith effort to answer questions and refine mitigation measures with the public's comments in mind; the commitments above reflect such input. Since issuing the SDEIS, NYCT has also continued its outreach efforts to sensitive uses—such as hospitals—that could be particularly affected by various project disturbances.

In addition, following publication of the FEIS and FTA issuance of its Record of Decision (ROD), NYCT will continue to meet with the public to discuss refinements to the mitigation measures identified in the FEIS and ROD. Prior to and throughout construction of the project, NYCT and its contractors will also present information concerning construction activities specifically relevant to Community Boards.

MITIGATION ONCE OPERATIONAL: AIRBORNE NOISE

Operation of the proposed Second Avenue Subway is not expected to cause any significant adverse airborne noise impacts, because most operations would occur below-ground or would occur within specially designed enclosed structures. Therefore, no special noise mitigation measures are proposed for the completed subway.

C. VIBRATION AND GROUND-BORNE NOISE

Construction activities and subway operations have the potential for producing high vibration levels that may be perceptible. In the case of construction activities, architectural and even structural damage could also occur if appropriate precautions are not taken. NYCT will implement special measures to protect structures. Even where vibration levels are lower or imperceptible, vibrations can nonetheless produce ground-borne noise.

IMPACT CRITERIA AND METHODOLOGY FOR VIBRATION AND GROUND-BORNE NOISE

To examine potential vibration and ground-borne impacts during construction, the FTA guidance document provides a screening procedure to determine the magnitude of vibratory levels to determine the potential for significant impacts and whether mitigation measures may be necessary to prevent damage to buildings. To examine potential vibration and ground-borne noise impacts during operation, the FTA guidance lays out a three-step approach: a screening procedure, a general assessment methodology, and a detailed analysis methodology. The analysis discussed below follows the general assessment methodology. The detailed analysis is usually performed as part of the design process, when the general vibration assessment prepared as part of the EIS indicates that a proposed facility could cause potential impacts.

IMPACT CRITERIA

Although the perceptibility threshold for ground-borne vibration is about 65 VdB, human response to vibration is not usually significant unless the vibration exceeds 70 VdB. Vibration levels for typical human and structural responses and sources are shown in Table 12-12. 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, and laser and optical equipment are typical of equipment that is highly sensitive to vibration.

Table 12-12
Typical Levels of Ground-borne Vibration

Human/Structural Response	Velocity Level (VdB)	Typical Sources (at 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	70	Bus or truck over bump
		Rapid transit rail, typical range
Limit for vibration-sensitive equipment.	60	Bus or truck, typical
Approximate threshold for human perception of vibration	50	Typical background vibration

Source: *Transit Noise and Vibration Impact Assessment*, FTA, April 1995.

The FTA-developed criteria for environmental impact from ground-borne vibration and noise from transit operations are based on the maximum levels for a single event. The impact criteria are shown in Table 12-13 and are used to determine whether the project would result in significant vibration and ground-borne noise impacts.

The limits are specified for the three land use categories defined below:

- Vibration Land Use Category 1: High Sensitivity—Buildings where low ambient vibration is essential for the operations within the building (e.g. vibration-sensitive research, hospitals with vibration-sensitive equipment, etc.), which may be well below levels associated with human annoyance. Although the FTA methodology does not classify historic structures in this category, this analysis does. Historic buildings are potentially sensitive to architectural damage from frequent vibration levels higher than 65 VdB. Architectural damage (e.g., cracked plaster) can adversely affect a building's historic features.

Table 12-13
Ground-borne Vibration and Noise Impact Criteria

Land Use Vibration Category	Ground-borne Vibration Impact Levels (VdB re 1 micro inch/second)		Ground-borne Noise Impact Levels (dBA re 20 micro Pascals)	
	Frequent Events[1]	Infrequent Events[2]	Frequent Events[1]	Infrequent Events[2]
1	65 VdB[3]	65 VdB[3]	See note [4]	See note [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. However, historic structures may include residences. Therefore ground-borne noise levels for category 1 land use will match those for category 2.
Source: *Transit Noise and Vibration Impact Assessment*, FTA, April 1995, pages 8-2 through 8-3.

- Vibration Land Use Category 2: Residential—This category covers all residential land uses and any buildings where people sleep, such as hotels and hospitals.
- Vibration Land Use 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.

In terms of construction activities, the focus of vibration criteria has been the levels that should not be exceeded to prevent architectural and structural damage, particular to old, fragile buildings of historical significance. The generally accepted criteria for avoidance of construction-related damage, which the FTA has adopted in its guidance manual, is 0.20 inches per second (approximately 100 VdB) for fragile buildings or 0.12 inches per second (approximately 95 VdB) for extremely fragile buildings. Where there is concern on the avoidance of levels that would result in perceptible ground-borne noise and vibration, particularly at vibration-sensitive sites, the FTA recommends using the criteria contained in Table 12-13. Please see the "Mitigation During Construction: Vibration and Ground-Borne Noise" section below for an overview on how vibration criteria levels may be obtained.

VIBRATION PREDICTION METHODOLOGY

Modeling to Predict Impacts Due to Construction Activities

The FTA guidance manual provides some simple screening methodologies for determining where there is a significant potential for impact from construction activities. Such activities include pile installation, demolition, drilling, excavation, or blasting in close proximity to sensitive structure. The procedure includes: (1) selecting the equipment and determining the vibratory levels at a reference distance of 25 feet; (2) determining peak particle velocity at a receptor location using a formula that accounts for the peak particle velocity of the equipment and the distance from the receptor; and (3) if consideration of annoyance or interference with vibration-sensitive activities is of concern, estimating the vibration level and apply the vibration impact criteria discussed above.

Modeling to Predict Impacts Due to Subway Operations

The general vibration assessment estimates the vibration level at specific locations as a function of distance from the track centerline, and a series of adjustment factors affecting the vibration source (i.e., train speed, crossovers and other special track work, type of transit structure, etc.), factors affecting the vibration path (i.e., geologic conditions that affect vibration propagation), and factors affecting the vibration receiver (i.e., floor-to-floor attenuation, amplification due to resonances of floors, walls, and ceilings, and radiated sound). More information on modeling is provided in Appendix J.

EXISTING CONDITIONS: VIBRATION AND GROUND-BORNE NOISE

Currently, throughout most of the Second Avenue Subway corridor, there are no activities that would be expected to produce high vibration or ground-borne noise levels. While there are high traffic volumes at most locations in the corridor, vibration levels are generally not perceptible, even in locations adjacent to major roadways with high bus and truck volumes, except when there are trains operating with untrued wheels or on defective tracks, buses and/or trucks on rough roads, or construction activities involving blasting, impact equipment, or heavy earth-moving equipment.

FUTURE CONDITIONS COMMON TO ALL ALTERNATIVES: VIBRATION AND GROUND-BORNE NOISE

In the future without the Second Avenue Subway, vibration levels are expected to be comparable to those currently existing in the corridor.

CONSTRUCTION IMPACTS OF THE PROJECT ALTERNATIVES: VIBRATION AND GROUND-BORNE NOISE

Construction would result in varying degrees of ground vibration, depending on the stage of construction, the equipment and construction methods employed, and the distance from the construction to buildings and vibration-sensitive structures. Due to the close proximity of sensitive receptors, vibration levels during a large portion of the period of the construction would be perceptible. As described below, NYCT is committed to implementation of a rigorous program of special measures to minimize potential impacts to uses (such as hospitals and other medical facilities) and structures (such as historic buildings) that are sensitive to vibration levels. As noted in Chapter 4, "Public Outreach and Review Process," NYCT has begun implementing a noise and vibration outreach program to institutions and businesses along the alignment that may be particularly sensitive to vibration. As part of this process, NYCT has already sent letters to potentially sensitive users, including hospitals, along the entire alignment, notifying them of the project and requesting their participation in the planning process.

With regard to uses that are sensitive to vibration levels, during ongoing engineering, NYCT will identify those uses along the project corridor that are particularly sensitive to high vibration levels. These uses would include medical facilities (i.e., hospitals, eye clinics, etc.), laboratories containing sensitive instrumentation, concert halls, auditoriums, theaters, TV and/or recording studios, etc. At each location where a sensitive use is identified, outreach will be conducted to develop a detailed understanding of the specific types of equipment employed at the facility.

Analyses will be performed to determine the maximum vibration levels that would be expected at that location due to construction activities, and to assess the ability of the equipment to function properly during the construction period. Finally, each location will also be examined structurally, to determine how the project's construction activities would interact with the building's foundation and construction type. Once these studies are completed, a determination will be made as to what specific mitigation measures could be feasibly implemented to reduce the vibratory levels caused by project construction. As part of this process, a decision would also be made as to whether, even with implementation of these mitigation measures, construction activities would still produce vibration levels that would temporarily impede or interfere with the normal operations at the site. At locations where construction activities might have the potential to interfere with vibration-sensitive activities, NYCT would coordinate closely with the affected party to minimize the duration and severity of these impacts.

With regard to structures that may be sensitive to vibration levels—particularly those that have been defined by the FTA criteria as "fragile" in its noise assessment manual—NYCT is committed to implementation of properly managed measures designed to minimize or avoid architectural or structural damage that could occur as a result of vibrations and ground-borne noise produced by certain construction operations (described below). As described in Chapter 9, NYCT has identified all the historic properties that could be affected by subway construction or operation based on current engineering plans, including from ground-borne noise and vibration impacts. NYCT has worked with the FTA, the New York State Historic Preservation Office and the New York City Landmarks Preservation Commission to develop a Programmatic Agreement that, among other measures, outlines a process that would be used to protect historic buildings, including any resources not previously identified that could be affected if project plans were to change.

NYCT has developed both a fragile buildings identification strategy and guidelines to limit vibrations for the various types of structures along the alignment. These strategies are described below.

PROCEDURES FOR IDENTIFYING FRAGILE BUILDINGS AND ESTABLISHING VIBRATION LIMITS GUIDELINES

For the Second Avenue Subway project, the assessment of fragile buildings is being considered within the broader context of assessing all buildings along the alignment that may be affected by ground-borne noise or vibrations associated with the construction process. The FTA's noise assessment manual recommends the use of vibration damage threshold criteria for fragile and extremely fragile buildings. Those FTA vibration criteria are derived from vibration damage threshold criteria developed from a Swiss standard[1]. As defined by the Swiss standard, buildings' sensitivity to vibration depends on their structural type and susceptibility to construction damage. As Preliminary and Final Engineering progress, surveys to classify all buildings along the alignment will be conducted to identify buildings that are extremely susceptible to vibration, based on the Swiss standard. All buildings where subway entrances or ancillary facilities are proposed would also receive the same scrutiny. Buildings considered extremely susceptible to vibration are those listed in Category IV in Table 12-14 below.

[1] Swiss Standard SN640312a, April 1992, "Effects of Vibration on Constructed Facilities," Swiss Consultants for Road Construction Association.

Table 12-14
Building Classification Guidelines

Structural Category	Definition	
I	Foundation: Framing: Interior Finish: Examples:	Competent Reinforced concrete No plaster Industrial buildings, bridges, masts, concrete retaining walls, unburied pipelines, underground structures such as cavern tunnels and lined and unlined galleries
II	Foundation: Framing: Interior Finish: Examples:	Concrete or competent masonry Any framing, except as described for Category III below No plaster Engineered concrete and masonry buildings, masonry retaining walls, and buried pipelines
III	Foundation: Framing: Interior Finish: Examples:	Less competent masonry Horizontal timber framing supported on masonry walls Any finish, including plaster "Non-engineered" buildings
IV	Buildings that are extremely susceptible to damage from vibration, such as all historic structures	
Note: This table is new for the FEIS.		

The FTA's noise assessment manual uses the terms "fragile" and "extremely fragile historic" to define vibration sensitive buildings that may be subject to architectural and/or structural damage due to construction activities. That manual recommends, based upon values from a Swiss report[1], that the vibration damage threshold criterion for fragile buildings exposed to construction vibration should be 0.20 inches per second. For extremely fragile historic buildings exposed to construction vibration, the recommended criterion is 0.12 inches per second. Because of the unique conditions along the Second Avenue Subway corridor and the large number of potentially fragile buildings present, the FTA-recommended vibration levels for fragile and extremely fragile buildings will be used only for guidance, and site-specific values will be developed for each structure classified as fragile or extremely fragile based on physical surveys and other research. Prior to construction, each of the buildings that fall within Structural Category IV (defined in Table 12-14, above) will be physically examined by the contractors under NYCT's supervision using both internal and external inspections. Using this information, maximum permissible vibration levels will then be determined on a site-specific basis to ensure that no architectural or structural damage will occur due to construction activities. These site-specific values may be the same as, or potentially higher or lower than, the FTA recommended values, but will achieve the same objective—namely, protecting against cosmetic or structural damage to the buildings. For fragile and/or historic structures that fall within the zone of potential construction influence[2], buildings will be documented using photographs to identify any existing cracks or other cosmetic or structural damage at the buildings.

[1] Swiss Consultants for Road Construction Association, "Effects of Vibration on Construction," VSS-SN640-312, Zurich, Switzerland, November 1978.

[2] The project's engineers have identified zones of influence for both ground movement and vibrations.

CONSTRUCTION EQUIPMENT OPERATION

Table 12-15 shows typical construction equipment and vibration levels at various distances without mitigation measures. As shown in the table, with the exception of pile installation machines and clam shovel drops (needed for the slurry walls), at distances greater than 20 feet, all of the vibration values for the types of equipment likely to be used during subway construction are below the vibration damage threshold criterion for fragile buildings and for extremely fragile historic buildings. Similarly, at distances greater than 20 feet, vibration levels for the TBM would be below both thresholds. Ground-borne noise from the TBM would be perceptible, but would only occur for a limited period of time at any particular location, since the equipment is continuously moving. As noted above, sensitive buildings, including all historic structures, will receive careful consideration to determine appropriate vibration thresholds. In addition, as described below under "Mitigation During Construction: Vibration and Ground-borne Noise," special measures would be taken at all phases of construction to avoid damaging fragile and extremely fragile (including historic) structures.

Table 12-15
Vibration Source Levels Due to Construction Equipment

Equipment	Peak Particle Velocity (inches per second)					
	5 feet	10 feet	20 feet	30 feet	40 feet	50 feet
Pile driver (typical impact)	7.20	2.55	0.90	0.49	0.32	0.23
Clam shovel drop (slurry wall)	2.26	0.80	0.28	0.15	0.10	0.07
Hydromill slurry wall in soil	0.09	0.03	0.01	0.01	0.00	0.00
Hydromill slurry wall in rock [1]	0.19	0.07	0.02	0.01	0.01	0.01
Large bulldozer	1.00	0.35	0.12	0.07	0.04	0.03
Caisson drilling	1.00	0.35	0.12	0.07	0.04	0.03
Loaded trucks	0.85	0.30	0.11	0.06	0.04	0.03
Jackhammer	0.39	0.14	0.05	0.03	0.02	0.01
Small bulldozer	0.03	0.01	0.00	0.00	0.00	0.00
Tunnel Boring Machine[2]	1.1	0.45	0.18	0.1	0.07	0.05

Notes: [1] Data based on Boston project with softer rock than exists in New York City, where levels would be higher.
[2] Levels based on TBM vibration rates in Buffalo limestone.

SPOILS REMOVAL TRAIN OPERATION

Vibration levels from operation of the underground trains that could be used to convey spoils from the face of the rock being drilled by the boring machines back to the shaft site where the spoils are being raised to street level have the potential, though unlikely, to cause ground-borne vibration and noise concerns. Vibratory levels from such trains would be minimal, because the trains would be moving at a very slow speed compared to the ultimate operating conditions in the tunnels. If spoils removal trains are used, levels of ground-borne noise and vibrations from the train operations would be minimized through careful installation and continued maintenance of these trains and rails.

BLASTING

To reduce vibration and ground-borne noise levels associated with blasting, construction specifications would require adherence to all applicable rules and regulations (including the rules and regulations of the FDNY) and would require the use of modern blasting techniques including timed multiple charges, blast mats, etc. These techniques would be used to reduce vibration levels to the extent practicable. For fragile buildings, alternative techniques including hydraulic or chemical rock splitting or hand excavation if warranted, would also be employed to minimize the potential for any inadvertent damage to such structures.

PERMANENT IMPACTS OF THE PROJECT ALTERNATIVES: VIBRATION AND GROUND-BORNE NOISE

The fact that there is no subway currently running beneath the Second Avenue corridor means that in comparison to the existing condition, the introduction of the Second Avenue Subway line would result in the introduction of ground-borne noise and vibration to an area where neither currently occurs. The extent of ground-borne noise and vibration depends on the geological conditions (higher levels are more likely in rock than in soil, for example), the distance from the running trains, and the type of foundation and construction of the affected buildings. Because of the advances in technology that have occurred since the construction of New York City's other subway lines, it is likely that the Second Avenue Subway line would produce less ground-borne noise and vibration than the existing subway lines. One reason for this is that it would be substantially deeper along the majority of the alignment than most of the existing subway system.

Since the SDEIS was published, the proposed subway alignment has been adjusted somewhat as a result of ongoing engineering. In several locations, the alignment is now deeper than described in the SDEIS, reducing the potential to create ground-borne noise and vibration impacts to structures nearby. In addition, project engineers have now completed a more detailed, site-specific examination of the alignment in certain locations in order to calibrate the results of the general assessment provided in the SDEIS. The results of this refined analysis (based on the project design as of May 2003) shows that impacts from ground-borne noise and vibrations would be reduced from the levels shown in the SDEIS.

Based on the refined analyses, the general vibration analysis indicates that train operations would not produce ground-borne vibration levels that would exceed the FTA impact criteria.[1] Train operations would produce ground-borne noise that would exceed FTA impact criteria by up to 14 dBA if no mitigation is employed. This would occur at one or both sides of 29 blocks adjacent to locations where tangent tracks would be located, and at one or both sides of 12 blocks adjacent to where crossovers would be located (see Figure 12-6).[2] (Tangent tracks are standard tracks, while crossovers are locations where rails from two different tracks diverge or join.) Crossovers produce physical discontinuities that can result in elevated ground-borne noise levels; however, as described below, NYCT would implement a variety of mitigation measures to reduce these impacts. Generally, without mitigation, the Second Avenue Subway's tangent tracks at selected locations could result in ground-borne noise levels of up to 41 dBA, which would exceed FTA ground-borne noise criteria of 35 dBA by up to 6 dBA. At crossovers,

[1] This is a reduction from the impacts predicted in the SDEIS, where ground-borne vibration levels would have exceeded FTA criteria on one or both sides of six blocks.

[2] This too is a reduction from the impacts predicted in the SDEIS, where ground-borne noise levels would have exceeded FTA criteria on one or both sides of 63 blocks.

ground-borne noise levels would be up to 49 dBA, which would exceed FTA criteria by up to 14 dBA without mitigation. (More information is provided in Appendix J.) In general, impacts could occur at crossovers and principally at locations where the building foundation and subway tunnel are in rock. (Rock provides less attenuation than soil, particularly at high frequencies.) As described later, NYCT is committed to implementing mitigation measures so that FTA impact criteria for ground-borne noise are not exceeded. These mitigation measures (described in the next section of this chapter under "Mitigation for Operational Impacts: Vibration and Ground-Borne Noise") would effectively mitigate the operational ground-borne noise impacts throughout the alignment.

It is important to note that as engineering continues, the locations of the tangent tracks and crossovers could change. Therefore, the locations of some ground-borne noise impacts could also shift. Based on the results of this analysis, revised crossover or tangent track locations would also be likely to result in the same types of significant adverse impacts described above, only in different locations.

VIBRATION AND GROUND-BORNE NOISE MITIGATION

MITIGATION DURING CONSTRUCTION: VIBRATION AND GROUND-BORNE NOISE

As described above, construction activities would result in significant vibration and ground-borne noise impacts due to construction equipment operation, muck train operation, and blasting. However, NYCT is currently in the process of exploring a variety of mitigation measures to minimize such impacts.

Design and Construction Measures

One such potential measure includes such design and construction measures as rerouting heavily loaded trucks away from residential streets, and operating earthmoving and other equipment away from vibration-sensitive sites. With the exception of moving the spoils extraction locations away from vibration-sensitive sites, there would be no feasible control approaches from this category of mitigation measures that could be implemented to reduce project impacts, since impacts would merely be shifted, as opposed to eliminated, if such adjustments were made. Moving the material extraction locations away from vibration-sensitive sites would reduce, and possibly mitigate, some problems, but would not mitigate all of the problems, since there would still be impacts at station locations and all other locations where either cut-and-cover or mining construction takes place.

Sequence of Operations

Another type of mitigation measure would involve changing the project's sequence of operations, such as altering the phasing of construction activities so that multiple operations producing high vibratory levels do not take place in the same time period, avoiding nighttime activities, etc. As shown above in Table 12-9, NYCT would restrict certain late-night construction activities. Aside from these measures, however, no feasible control approaches of this type have been identified, since many activities, such as boring tunnels with TBMs need to occur overnight in order to avoid an excessively long construction schedule.

Alternative Construction Methods

Project construction engineers have explored alternative construction techniques and special low-impact equipment to mitigate or avoid ground-borne noise impacts where practicable. These include such measures as avoiding impact pile installation and equipment with high vibratory levels in vibration-sensitive areas, using non-impact construction technology, instituting special control measures to reduce the transmission of high vibratory levels to vibration-sensitive areas, etc. As discussed previously, where feasible, these types of measures would be used.

A number of controls would be implemented with respect to mitigation of vibration during construction. A preconstruction survey of any structure or use (e.g., operation of vibration-sensitive equipment) likely to be adversely affected by the construction activities would be performed and threshold or limiting values would be established that take into account each structure's or use's ability to withstand the loads and displacements due to construction vibrations. NYCT, through its contractors, would also meet with hospitals or other users of especially sensitive equipment prior to construction to survey them regarding their special needs and schedule activities appropriately. Outreach to sensitive uses along the alignment is currently underway and will continue. Detailed construction specifications that impose reasonable acceptance criteria would be included in construction contracts.

A project-wide vibration monitoring program would also be developed and implemented to monitor and identify vibration levels from construction activities at nearby sensitive receptors. A complaint response procedure would be implemented to promptly address community concerns and implement additional control methods where necessary. In addition, in advance of certain activities that are likely to result in vibrations, NYCT and its contractors will conduct extensive outreach to those in the surrounding blocks that could be affected. Additionally, vibration control plans would be developed and best management practices to limit vibration would be employed in sensitive areas, depending on the construction method required. These plans and practices would include the following measures.

Pavement Breaking

To reduce or eliminate the impact of pavement breaking, deep saw cuts would be made between areas of pavement breaking and the sidewalk areas in front of buildings. Additionally, where practical, concrete cutters would be used on pavement surfaces in conjunction with pavement breakers.

Pile Driving

As previously discussed in the noise mitigation section, NYCT has committed to avoiding use of impact pile driving methods wherever practicable; however, it will still be necessary to use impact piles to drive the steel sheeting needed to construct the various retaining walls. Where piles must be driven, vibratory, sonic or other types of pile drivers that produce slightly lower values would be used.

NYCT is exploring whether bored or drilled piles can be used in place of impact or vibratory/sonic piles. It is anticipated that this technique would be utilized to eliminate potential architectural or structural problems at nearby buildings. Without the use of this alternative construction technique, special measures would have to be implemented to protect damage to nearby buildings, especially nearby fragile and extremely fragile historic buildings (see the discussion below).

Drilling and Controlled Blasting

NYCT will include a specification in construction contracts with regard to blasting operations requiring the contractor to implement a monitoring program and to protect nearby structures from damage, particularly if the structure is within the zone of influence.

Vibration levels would be monitored in the foundations of nearby buildings during all blasting activities. Blasting activities resulting in peak particle velocity (vibration) levels in excess of appropriate damage criteria as measured in the foundations of nearby structures would be immediately stopped until further precautionary measures are taken to reduce blasting-related vibration impacts. Work would not begin again until the steps proposed to stabilize and/or prevent further damage to the designated buildings were approved. In addition, the project would carry insurance to cover the expense of restoration caused by any damage that might occur despite this precaution.

Special Provisions for Historic Structures

In addition to the mitigation measures described above, NYCT would voluntarily refer to, as guidance, the special measures set forth by the New York City Landmarks Preservation Commission to protect historic resources from increased vibration levels associated with construction activities. At any construction locations where historic resources, and particularly older fragile buildings, are within an area of potential effect, NYCT, through its construction contractors, would implement special vibration protection measures. These measures, to be included as part of the construction protection program for historic resources would include the following:

- Inspect and report on current foundation and structural conditions of any historic resources.
- Set up a vibration monitoring program to measure vertical and lateral movement and vibration to the historic structures within the zone of impact identified as part of the fragile buildings assessment process detailed above. Details as to the frequency and duration of the vibration monitoring program would be determined as part of the project's ongoing consultation process with the State Historic Preservation Office.
- Establish and monitor construction methods to limit vibrations to levels that would not cause structural damage to the historic structures, as determined by the condition survey;
- Issue "stop work" orders to the construction contractor, as required, to prevent damage to the structures, based on any vibration levels that exceed the design criteria in lateral or vertical direction. Work would not begin again until the steps proposed to stabilize and/or prevent further damage to the designated buildings were approved.

Spoils Removal Trains

If trains are used to transport spoils in the project's tunnels, a program of careful installation and maintenance of rails would be instituted to mitigate vibration levels from this source. Vibratory levels from these potential train impacts would also be minimized by the fact that the trains would be moving at a very slow speed compared to the ultimate operating conditions that would exist within the tunnels once the subway opens to serve the public.

Conclusions

With implementation of the measures discussed above, vibration levels during construction would be reduced below the levels that would cause architectural or structural damage.

However, vibration levels would still be at levels that are perceptible, and are likely to cause annoyance to residents adjacent to locations where significant construction operations are taking place (i.e., locations adjacent to where excavated material is being removed from tunnel and/or station construction, and locations where tunnel boring, cut-and-cover, and/or mining operations take place). At most of these locations, this vibration would occur for a considerable period of time. As described, above, NYCT would not permit many types of operations to occur between 10 PM and 7 AM (see the airborne noise mitigation section above for a description) as one means of mitigating such impacts. Moreover, throughout the construction period, NYCT would maintain an extensive outreach system to advise the affected communities of construction impacts.

MITIGATION FOR OPERATIONAL IMPACTS: VIBRATION AND GROUND-BORNE NOISE

As described above, no mitigation to address vibration issues is required, since FTA criteria would not be exceeded.

NYCT is committed to implementation of measures to mitigate potential ground-borne noise impacts from train operations at all locations where ground-borne noise impacts are predicted so that no exceedances of FTA impact thresholds would occur. NYCT will mitigate ground-borne noise impacts through application of a menu of several options that provide progressively greater potential to mitigate impacts depending on the situation.

In general, the level of ground-borne noise would be reduced by increasing the vertical resilience of the trackform. Vertical resilience can be increased through use of resilient rail fasteners, certain types of which are currently employed in the NYCT system. These types of resilient fasteners are being considered for sections of standard tangent track along the Second Avenue alignment where the predicted ground-borne noise levels exceed the FTA criteria. The current predictions indicate that a reduction of up to 6 dBA is required at one other both sides of 29 blocks of the alignment. This level of mitigation is readily achievable through use of resilient rail fasteners.

At locations where crossovers would be located, the general assessment predicts that a reduction of up to 14 VdB would be required to mitigate the predicted impacts. NYCT will incorporate design measures into the project at all crossovers so that FTA's impact criteria for ground-borne noise are not exceeded. To provide the required mitigation at crossovers, NYCT is considering different track options, including the use of resiliently supported concrete tie blocks or Direct-Fixation (DF) rail fasteners, both of which have the potential to provide the necessary level of mitigation to meet the FTA criteria at crossovers. In addition, all crossover areas will incorporate NYCT's redesigned frog, which was redesigned to produce lower levels of noise and vibration, by reducing the impacts that occur when a train's wheel traverses the flangeway area of the frog. Incorporating resilience in the track support structure would provide the necessary level of mitigation to meet FTA impact criteria.

During ongoing engineering, more research on these and other measures will be conducted, including meeting with suppliers of the various products and reviewing detailed field test data. Based on the current array of products available on the market to control ground-borne noise impacts on train tracks around the world, NYCT is committed to mitigating all ground-borne operational noise impacts at these or other locations where FTA impact criteria would be exceeded.

MITIGATION CONCLUSION: VIBRATION AND GROUND-BORNE NOISE

As described above, NYCT is committed to implementing measures to reduce significant ground-borne noise impacts due to construction. At some locations, such as medical facilities and laboratories, that are very sensitive to vibration levels, it may not be feasible to implement mitigation measures to reduce vibration levels during construction below levels that would interfere with normal operations. In these cases, NYCT would coordinate closely with the affected party to minimize the duration and severity of these impacts as described above. However, at all locations, sufficient mitigation would be provided to reduce ground-borne noise levels due to train operations to below the FTA impact levels.

D. SUMMARY OF SIGNIFICANT ADVERSE IMPACTS AND MITIGATION MEASURES

SIGNIFICANT ADVERSE IMPACTS

- During construction, there would be significant impacts from airborne and ground-borne noise and vibration. These impacts would occur in the vicinity where construction work is occurring.
- Significant adverse airborne noise impacts would result at all stations and at all shaft sites/spoils removal locations during certain construction periods because of the proximity of construction to certain sensitive uses. The types and extent of the impacts would be comparable in all construction phases. Some activities creating such impacts would not occur during late night and early morning hours (e.g., 10 PM to 7 AM). However, some activities would occur during these nighttime hours and extra mitigation (summarized below) would be implemented by NYCT.
- Significant adverse impacts from ground-borne noise and vibration would also occur in certain locations during certain construction activities. Protective measures will be implemented to protect all structures, especially fragile and extremely fragile historic buildings, from architectural or structural damage. However, some vibration-sensitive uses may temporarily experience adverse impacts during construction.
- During operations, no significant adverse impacts on airborne noise or ground-borne vibration would result, either along the alignment or at potential storage yards, so no mitigation is needed.
- During operations, significant adverse impacts from ground-borne noise would occur at a number of blocks, unless mitigation is employed, because a subway would be introduced where no subway currently operates. However, as described below, these impacts would all be mitigated.

MITIGATION MEASURES

- NYCT is committed to developing and implementing an extensive mitigation program to reduce and alleviate the project's airborne noise, vibration, and ground-borne noise impacts. Table 12-9 provides a list of proposed mitigation measures on a site-by-site basis. Contractors will be required to implement mitigation measures to achieve the levels specified in the performance standards identified in Table 12-6.

- Potential mitigation measures for construction airborne noise include: enclosing areas where spoils from tunnel operations would be loaded into trucks, or at station locations where spoils removal will take place for long durations during the daytime or at night; placing some equipment or operations below grade in shielded locations; changing construction sequencing to reduce noise impacts by combining noisy operations to occur in the same time period or by spreading them out; avoiding nighttime activities; and using alternative construction methods, such as avoiding impact pile installation in sensitive areas, using special low noise emission level equipment, and selecting and specifying quieter demolition methods. Despite these measures, it will not be possible to fully mitigate all airborne noise impacts because of the proximity of residences and other sensitive uses to construction.
- Potential mitigation measures for construction ground-borne noise and vibration include development of a project-wide vibration monitoring program to minimize vibration levels and respond to community complaints and concerns as they arise. Multi-delay blasting techniques, careful installation of tracks for spoils removal trains, or other site-specific vibration control measures would be employed.
- To mitigate ground-borne noise impacts from train operations, the project would include resilient track fasteners or track support structures or other similar measures at all locations where operational ground-borne noise impacts are predicted. Ground-borne noise levels would be reduced at all locations to below FTA's impact thresholds.
- Since issuing the SDEIS, NYCT has consulted with each of the local Community Boards through which the project would pass to update the public on a variety of issues related to project design and construction. At these meetings, NYCT has provided information and sought public input on the locations of station entrances and ancillary facilities, as well as on noise and vibration issues. NYCT has also made an effort to refine mitigation measures with the public's comments in mind; the commitments above reflect such input. NYCT has also continued its outreach efforts to sensitive uses—such as hospitals—that could be particularly affected by various project disturbances.
- After publication of the FEIS and FTA issuance of its Record of Decision (ROD), NYCT will continue to meet with the public to discuss any refinements to the mitigation measures identified in the FEIS and ROD. Prior to and throughout construction of the project, NYCT and its contractors will also present information to Community Boards concerning construction activities specifically relevant to them. ✷