Chapter 6.7: Noise and Vibration

A. INTRODUCTION

This chapter assesses the potential for noise and vibration effects from operation and construction of the Cross Harbor Freight Program (CHFP). Noise from increased freight terminal and facility operations and equipment may result in higher ambient levels at locations adjacent to these facilities. Noise from vehicular sources, specifically trucks and employee vehicles, would be generated at the freight facilities and along local roadways that provide access to those facilities. The Rail Tunnel Alternatives and the Enhanced Railcar Float Alternative would also result in an increase in noise levels along at-grade, elevated, or depressed sections of the affected train routes. These increases in noise would be most perceptible along rights-of-way that currently experience little or no activity and/or horn noise near grade crossings. Noise from marine horn signals would increase near terminals for the Waterborne Alternatives. With the Rail Tunnel Alternatives, vibration and ground-borne noise would be generated in areas above the proposed tunnel.

The fundamentals of airborne noise, and vibration and ground-borne noise impacts are discussed in the following text. 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 on a playground. Ground-borne noise is the rumbling sound caused by vibration (or oscillatory motion). With ground-borne noise, interior surfaces of buildings and other structures radiate low-frequency sounds resulting from low-amplitude vibration (vibration levels that are below those detectable by sense of human touch).

Subsequent sections of this chapter present the applicable standards, analysis methodologies, and impact criteria for both airborne noise and vibration and ground-borne noise that could result from the Build Alternatives. Where the potential for significant effects is identified, the need for further assessment in the Tier II analysis is identified and the feasibility and effectiveness of various measures that could be implemented to minimize those effects are examined.

The chapter's analysis of the noise and vibration effects of future activities as a result of the project alternatives was conducted following the Federal Railroad Administration (FRA) noise and vibration assessment procedures. The FRA uses the methodology in the Federal Transit Administration's (FTA) guidance manual *Transit Noise and Vibration Impact Assessment* (May 2006). This FTA guidance document presents methodologies for analyzing noise and vibration for a wide range of mass transit projects and as such is the standard U.S. Department of Transportation (USDOT) methodology for assessing potential impacts of new and expanded rail transit systems. The FTA guidance document provides methodologies for examining potential effects of fixed-guideway sources, highway (roadway)/transit sources, and stationary sources associated with transit projects. The FRA methodology uses a supplemental freight rail analysis spreadsheet tool developed for the Chicago Rail Efficiency and Transportation Efficiency (CREATE) program, which incorporates the FTA procedures. The preliminary findings of the Tier I assessment are described in this chapter.

NOISE FUNDAMENTALS, STANDARDS, AND IMPACT CRITERIA

AIRBORNE NOISE FUNDAMENTALS

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

Sound pressure levels are measured in units called “decibels” (dB). The particular character of the noise that we hear (a whistle compared with a French horn, for example) is determined by the rate, or “frequency,” at which the air pressure fluctuates, or “oscillates.” Frequency defines the oscillation of sound pressure in terms of cycles per second. One cycle per second is known as 1 Hertz (Hz). People can hear over a relatively limited range of sound frequencies, generally between 20 Hz and 20,000 Hz, and the human ear does not perceive all frequencies equally well. High frequencies (from a whistle, for example) are more easily discerned and therefore more intrusive than many of the lower frequencies (the lower notes on the French horn, for example).

“A”-Weighted Sound Level (dBA)

To bring a uniform noise measurement that simulates people’s perception of loudness and annoyance, the decibel measurement is weighted to account for those frequencies most audible to the human ear. This is known as the A-weighted sound level, or “dBA,” and it is the most often used descriptor of noise levels where community noise is the issue. As shown in **Table 6.7-1**, the threshold of human hearing is defined as 0 dBA; very quiet conditions (as in a library, for example) are approximately 40 dBA; levels between 50 dBA and 70 dBA define the range of acceptable daily activity; levels above 70 dBA would be considered noisy, and then loud, intrusive, and deafening as the scale approaches 130 dBA. For most people to perceive an increase in noise, the increase must be at least 3 dBA. At 5 dBA, the change will be readily noticeable (Bolt, Beranek and Newman, 1973). An increase of 10 dBA is generally perceived as a doubling of loudness.

It is also important to understand that combinations of different sources are not additive in an arithmetic manner, because of the dBA scale’s logarithmic nature. For example, two noise sources—for instance, a vacuum cleaner operating at approximately 72 dBA and a telephone ringing at approximately 58 dBA—do not combine to create a noise level of 130 dBA, the equivalent of a jet airplane or air raid siren (see **Table 6.7-1**). In fact, the noise produced by the telephone ringing may be masked by the noise of the vacuum cleaner and not be heard. The logarithmic combination of these two noise sources would yield a noise level of 72.2 dBA.

Table 6.7-1
Common Noise Levels

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

Note: A 10 dBA increase in level appears to double the loudness, and a 10 dBA decrease halves the apparent loudness.
Source: Cowan, James P. *Handbook of Environmental Acoustics*. Van Nostrand Reinhold, New York, 1994. Egan, M. David, *Architectural Acoustics*. McGraw-Hill Book Company, 1988.

Effects of Distance on Noise

Noise varies with distance. For example, highway traffic 50 feet away from a receptor (such as a person listening to the noise) typically produces sound levels of approximately 70 dBA. The same highway noise measures 66 dBA at a distance of 100 feet, assuming soft ground conditions. This decrease is known as “drop-off.” The outdoor drop-off rate for line sources, such as traffic, is a decrease of approximately 4.5 dBA (for soft ground) for every doubling of distance between the noise source and receptor (for hard ground the outdoor drop-off rate is 3 dBA for line sources). Assuming soft ground, for point sources, such as amplified rock music, the outdoor drop-off rate is a decrease of approximately 7.5 dBA for every doubling of distance between the noise source and receptor (for hard ground the outdoor drop-off rate is 6 dBA for point sources).

Noise Descriptors Used in Impact Assessment

The sound-pressure level unit of dBA describes a noise level at just one moment, but since very few noises are constant, other ways of describing noise over more extended periods have been developed. One way of describing fluctuating sound is to describe the fluctuating noise heard over a specific period as if it were a steady, unchanging sound (i.e., as if it were averaged over that time period). For this condition, a descriptor called the “equivalent sound level,” L_{eq}, can be computed. L_{eq} is the constant sound level that, in a given situation and period (e.g., 1 hour, denoted by $L_{eq(1)}$, or 24 hours, denoted as $L_{eq(24)}$), conveys the same sound energy as the actual time-varying sound.

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

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

VIBRATION FUNDAMENTALS

Fixed railway operations have the potential to produce high vibration levels, since railway vehicles contact a rigid steel rail with steel wheels. Train wheels rolling on the steel rails create vibration energy that is transmitted into the track support system. The amount of vibrational energy is strongly dependent on such factors as how smooth the wheels and rails are and the vehicle suspension system. The vibration of the track structure “excites” the adjacent ground, creating vibration waves that propagate through the various soil and rock strata to the foundations of nearby buildings. As the vibration propagates from the foundation through the remaining building structure, certain resonant, or natural, frequencies of various components of the building may be excited.

The effects of ground-borne vibration may include discernible movement of building floors, rattling of windows, and shaking of items on shelves or hanging on walls. In extreme cases, the vibration can cause damage to buildings. The vibration of floors and walls may cause perceptible vibration, rattling of such items as windows or dishes on shelves. The movement of building surfaces and objects within the building can also result in a low-frequency rumble noise. The rumble is the noise radiated from the motion of the room surfaces, even when the motion itself cannot be felt. This is called ground-borne noise.

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

All vibration levels in this document are referenced to $1x10^{-6}$ inches per second. “VdB” (referenced to $1x10^{-6}$ inches per second) is used for vibration decibels to reduce the potential for confusion with noise decibels.

Effect of Propagation Path

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

Human Response to Vibration Levels

Although the perceptibility threshold for ground-borne vibration is about 65 VdB, the typical threshold of human annoyance is 72 VdB. As a comparison, buses and trucks rarely create vibration that exceeds 72 VdB unless there are significant bumps (or discontinuities) in the road and these vehicles are operating at moderate speeds. Vibration levels for typical human and structural responses and sources are shown in **Table 6.7-2**. Background vibration is usually well below the threshold of human perception and is of concern only when the vibration affects very sensitive manufacturing or research equipment. Electron microscopes, high-resolution lithography equipment, recording studios, and laser and optical benches are typical of equipment that is highly sensitive to vibration.

Table 6.7-2
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	Locomotive powered freight train
Residential annoyance, infrequent events	80	Rapid Transit Rail, upper range
		Commuter Rail, typical range
Residential annoyance, frequent events		Bus or Truck over bump
	70	Rapid Transit Rail, typical range
Limit for vibration-sensitive equipment. Approximate threshold for human perception of vibration		Bus or truck, typical
	60	Typical background vibration
	50	

Source: U.S. Department of Transportation, FTA, *Transit Noise and Vibration Impact Assessment,* May 2006.

NOISE STANDARDS AND CRITERIA

Airborne Noise Standards and Criteria

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 6.7-3** describes the land use categories defined in the FTA report and provides noise metrics used for determining operational noise impacts. As described in **Table 6.7-3**, 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.

Table 6.7-3
FTA's Land Use Category and Metrics for Transit Noise Impact Criteria

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

Note: * L_{eq} for the noisiest hour of transit-related activity during hours of noise sensitivity.
Source: *Transit Noise and Vibration Impact Assessment*, FTA, May 2006.

Table 6.7-3 shows FTA's noise impact criteria for transit projects. The FTA impact criteria are keyed to the noise level generated by the project (called "project noise exposure") in locations of varying existing noise levels. Two types of impacts—moderate and severe—are defined for each land use category, depending on existing noise levels. Thus, where existing noise levels are 40 dBA, for land use categories 1 and 2, the respective L_{eq} and L_{dn} noise exposure from the project would create moderate impacts if they were above approximately 50 dBA and would create severe impacts if they were above approximately 55 dBA. For category 3, a project noise exposure level above approximately 55 dBA would be considered a moderate impact and above approximately 60 dBA would be considered a severe impact. The difference between "severe impact" and "moderate impact" is that a severe impact occurs when a change in noise level would be found annoying by a significant percentage of people, while a moderate impact occurs when a change in noise level would be noticeable to most people but not necessarily sufficient to result in strong adverse reactions from the community.

Vibration Standards and Criteria

With the construction of new rail rapid transit systems in the past 20 years, considerable experience has been gained about how communities would react to various levels of building vibration. This experience, combined with the available national and international standards, represents a good foundation for predicting annoyance from ground-borne noise and vibration in residential areas. **Table 6.7-2** summarizes typical human or structural responses to various levels of vibration.

The FTA criteria for environmental impact from ground-borne vibration and noise are based on the maximum levels for a single event. The impact criteria as defined in the FTA guidance manual are shown in **Table 6.7-4**. The criteria for acceptable ground-borne vibration are expressed in terms of velocity levels in decibels, and the criteria for acceptable ground-borne noise are expressed in terms of A-weighted sound level. As shown in the table, the FTA methodology provides three different impact criteria: one for "infrequent" events, when there are fewer than 30 vibration events per day; one for "occasional" events, when there are between 30 and 70 vibration events per day; and one for "frequent" events, when there are more than 70 vibration events per day. It should be noted that these impacts would occur only if a project would cause ground-borne noise or vibration levels that are higher than existing vibration levels.

Thus, if the vibration level for a building in category 1 is already 70 VdB (5 VdB above the 65 VdB threshold listed in **Table 6.7-4**) but the proposed project would not increase that level, then the proposed project would not be considered to have an impact.

Table 6.7-4
Ground-Borne Vibration (GBV) and Ground-Borne Noise (GBN) Impact Criteria for General Assessment

Land Use Category	GBV Impact Levels (VdB re 1 micro-inch/sec)			GBN Impact Levels (dB re 20 micro Pascals)		
	Frequent Events[1]	Occasional Events[2]	Infrequent Events[3]	Frequent Events[1]	Occasional Events[2]	Infrequent Events[3]
Category 1: Buildings where vibration would interfere with interior operations	65 VdB[4]	65 VdB[4]	65 VdB[4]	N/A[5]	N/A[5]	N/A[5]
Category 2: Residences and buildings where people normally sleep	72 VdB	75 VdB	80 VdB	35 dBA	38 dBA	43 dBA
Category 3: Institutional land uses with primarily daytime use	75 VdB	78 VdB	83 VdB	40 dBA	43 dBA	48 dBA

Notes:
1 "Frequent Events" is defined as more than 70 vibration events of the same source per day. Most rapid transit projects fall into this category.
2 "Occasional Events" is defined as between 30 and 70 vibration events of the same source per day. Most commuter trunk lines have this many operations.
3 "Infrequent Events" is defined as fewer than 30 vibration events of the same kind per day. This category includes most commuter rail systems.
4 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 heating, ventilation, and air conditioning (HVAC) systems and stiffened floors.
5 Vibration-sensitive equipment is not sensitive to ground-borne noise.

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

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

There are some buildings (such as concert halls, TV and recording studios, auditoriums, and theaters) that can be very sensitive to vibration and ground-borne noise but do not fit into any of these three categories. Special vibration level thresholds are defined for these land uses.

B. METHODOLOGY

AIRBORNE NOISE ANALYSIS METHODOLOGY

The preliminary Tier I assessment of airborne noise was performed following the procedures in the FTA guidance manual. Increases in noise would result from the increase in activity at freight terminals and facilities for both Waterborne and Rail Tunnel Alternatives. In addition, the Rail Tunnel Alternatives and the Enhanced Railcar Float Alternative would result in an increase in the number of freight trains along the affected rail corridor. With the Rail Tunnel Alternatives, the ventilation systems for the tunnel would also generate noise. Following the methodologies presented in the FTA guidance, airborne noise impacts should be analyzed using a three-step process that consists of a screening procedure, a general noise assessment, and a detailed noise analysis. The screening procedure is performed first to determine whether any noise-sensitive receptors are within distances where impacts are likely to occur. If the screening reveals that there are noise-sensitive receptors in locations where impacts are likely to occur, then a general noise assessment is performed to determine locations where noise impacts could occur. If this general assessment indicates that a potential for noise impact does exist, then a detailed noise analysis may be necessary. The detailed analysis methodology is used to predict impacts and evaluate the effectiveness of mitigation with greater precision than can be achieved with the general noise assessment. The noise analysis for a Tier I EIS typically consists of a screening procedure and general noise assessment. The detailed analysis would typically be conducted for a project-specific or Tier II EIS.

NOISE SCREENING AND GENERAL NOISE ASSESSMENT

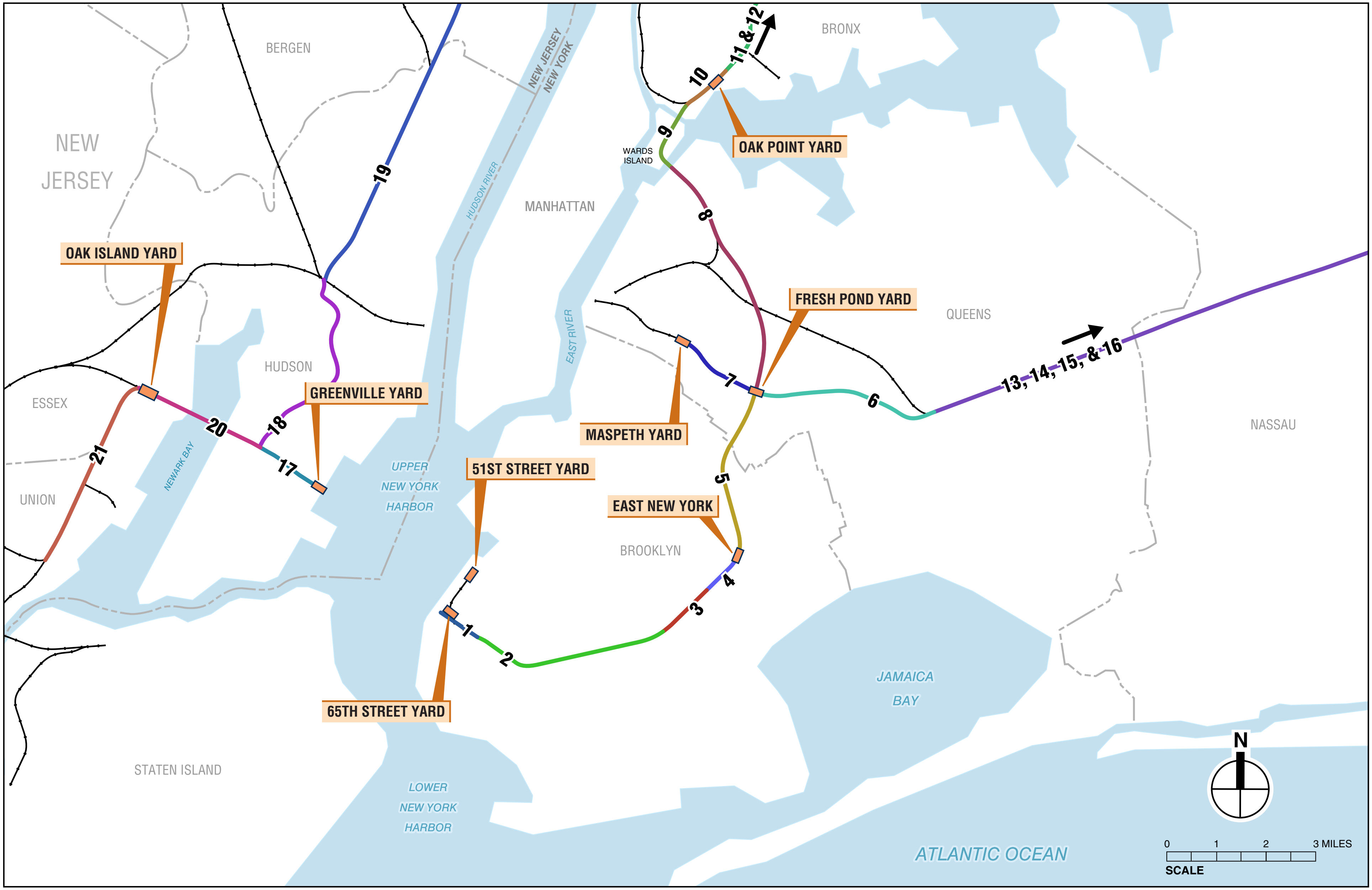
Rail Line Segments

Noise Screening Procedure.
The FTA methodology begins with a noise screening procedure to determine whether any noise-sensitive land uses are located within a distance of noise impact potential. The FTA screening method uses a distance of 750 feet from rail centerline for unobstructed potential noise-sensitive land uses along commuter rail lines, and 375 feet for obstructed noise-sensitive land uses. Potential noise effects from the project alternatives were considered along the rail line segments shown in **Figure 6.7-1**. Based on information provided by land use assessment and aerial photographs, noise-sensitive land uses exist within 375 feet from the track centerline along all rail line segments of the proposed project. This indicated the need for a general noise assessment analysis.

General Noise Assessment.
A general noise assessment analysis using FTA methodology was conducted to evaluate potential freight train noise for the No Action Alternative and the Build Alternatives involving Rail—the Rail Tunnel Alternatives and the Enhanced Railcar Float Alternative. The noise impact assessment used in the FTA methodology evaluates project-generated $L_{eq(1)}$ noise levels for land use categories 1 and 3, and L_{dn} noise levels for land use category 2. A supplemental freight rail analysis spreadsheet tool developed for the CREATE program, which incorporated the FTA procedures, was used for this Tier I assessment.

For purposes of this Tier I EIS, existing noise levels were based on measured noise levels in the majority of the project corridors as part of the 2004 Draft Environmental Impact Statement (DEIS), and estimated existing noise levels using FTA methodology (i.e., FTA *Transit Noise*

12.5.12



20 *Rail Segments*

FIGURE 6.7-1

Rail Segments

CROSS HARBOR FREIGHT PROGRAM

and Vibration Impact Assessment, Table 5-7: Estimating Existing Noise Exposure for General Assessment) for areas of the project corridor for which no measured noise data were available.

Freight Terminals and Facilities Noise Screening Procedure.

The FTA methodology begins with a noise screening procedure to determine whether any noise-sensitive land uses are located within a distance of noise impact potential. For active rail yards, the FTA screening methodology uses a screening distance of 2,000 feet in obstructed areas and 1,000 feet where there are no intervening buildings between the rail yard and the receptors. Based on information provided by land use assessment and aerial photographs, noise-sensitive land uses exist within these distanced from the rail yards. This indicated the need for a general noise assessment analysis. Freight terminals for the alternatives that don't involve rail, namely the Truck Ferry/Float Alternatives and Lift On-Lift (LOLO)/Roll On-Roll Off (RORO) Container Barge Alternatives would be less noisy than the alternatives that include rail. Based on the tons of goods projected for these alternatives, it is unlikely that the noise levels would be severe. Noise impacts at freight facilities would be assessed in greater detail in Tier II, when more information would be available.

General Noise Assessment.

A general noise assessment analysis using FTA methodology was conducted to evaluate potential noise effects from increased activities at rail yards due to the No Action, Rail Tunnel and Waterborne Alternatives. The noise impact assessment utilized in the FTA methodology evaluates project-generated $L_{eq(1)}$ noise levels for land use categories 1 and 3, and L_{dn} noise levels for land use category 2. Consistent with the FTA methodology, the closest receptor distance to the center of each rail yard was used in the assessment. Allowable CHFP noise exposure levels were identified based on existing noise levels, as measured for the 2004 DEIS or calculated using FTA methodology. The predicted noise exposure levels from the alternatives were compared with the allowable noise exposure for moderate and significant noise impact levels.

VIBRATION ANALYSIS METHODOLOGY

The vibration analysis for the project alternatives was performed using the procedures described in the FTA guidance manual. To examine potential effects during operation, the FTA guidance document (similar to the approach for assessing noise) lays out a three-step approach for the analysis of vibration and ground-borne noise: a screening procedure, a general assessment, and a detailed analysis. The screening procedure is used to determine whether any noise-sensitive receptors are within distances where impacts are likely to occur; the general assessment is used to determine locations or rail segments where there is the potential for impacts; and the detailed analysis is used to predict impacts and evaluate the effectiveness of mitigation with greater precision than can be achieved with the general assessment. The vibration analysis for a Tier I EIS typically consists of a screening-level assessment and general assessment for potential impacts in the vicinity of project elements. A detailed analysis would typically be conducted for a project-specific or Tier II EIS. Based on the amounts of freight handled by alternatives that would not involve rail as a mode and the expected activities at freight facilities with those alternatives, vibration is unlikely to be significant.

VIBRATION SCREENING

The first step in the FTA vibration analysis is to determine if there is the potential for a vibration impact based on the type of project, the land use categories in the area of the project, and the distance to the nearest receptors of the land use categories. From these inputs, determination of the need for a general vibration and ground-borne noise assessment is made based on a screening distance as defined in **Table 6.7-5**.

The Rail Tunnel Alternatives and the Enhanced Railcar Float Alternative would include steel wheel/steel rail with heavy locomotives and long slow-moving freight railcars. The Truck Ferry/Truck Float and LOLO/RORO Container Barge Alternatives would have a limited potential for impacts due to surrounding uses and the marine vessel and trucks traffic generated by these alternative would be unlikely to generate noise at levels that would be considered significant. The FTA guidance manual does not include rail freight. Consequently, for this screening analysis, the most conservative screening distances for rail operation were utilized. The screening analysis assumed critical distances of 600 feet for category 1,200 feet for category 2, and 120 feet for category 3. Almost all rail segments of the proposed project include land use category receptors that are located within these screening distances, indicating the need for a general assessment.

Table 6.7-5
Screening Distances for Vibration Assessment

Type of Project	Critical Distances for Land Use Categories * Distance from Right-of-Way or Property Line (in feet)		
	Category 1	**Category 2**	**Category 3**
Conventional Commuter Railroad	600	200	120
Rail Rapid Transit	600	200	120
Light Rail Transit	450	150	100
Intermediate Capacity Transit	200	100	50
Bus Project (if not previously screened out)	100	50	N/A

Note:
* The land use categories are defined in Chapter 8 of the FTA Manual. Some vibration-sensitive land uses are not included in these categories. Examples include: concert halls and TV studios, which, for the screening procedure, should be evaluated as category 1; and theaters and auditoriums, which should be evaluated as category 2.
Source: *Transit Noise and Vibration Impact Assessment,* FTA, May 2006, pages 9-1 through 9-4.

GENERAL VIBRATION AND GROUND-BORNE NOISE ASSESSMENT

The procedures outlined in the FTA guidance manual for preparing a general vibration and ground-borne noise assessment were used for this preliminary impact analysis, appropriate for a Tier I study. The general vibration assessment estimates the vibration level at specific locations, based on generalized ground surface vibration curves that yield vibration levels 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 trackwork, 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). In order to determine ground-borne noise, these vibration velocity levels are converted to A-weighted sound levels.

C. EXISTING CONDITIONS

RAIL FREIGHT ROUTES

The following describes existing conditions for rail freight routes within the CHFP study corridor. For the evaluation, the corridor was divided into 21 segments based on similarities in train operations within those portions of the project area. The segments analyzed are illustrated in **Figure 6.7-1**. Based on information discussed in Chapter 6.1, “Land Use, Neighborhood Character, and Social Conditions,” and aerial photographs, various noise-sensitive land uses located in the vicinity of the project routes were identified.

BROOKLYN—SEGMENTS FROM 1 TO 5 RAIL FREIGHT ROUTES

The alignment is the Long Island Rail Road (LIRR) Bay Ridge Branch between 65th Street Yard and Fresh Pond Yard. It passes through a portion of Brooklyn through various land uses (i.e., residential, commercial, industrial, institution, open space, etc.). Existing LIRR service includes 2 freight trains per day. The depressed alignment of segments 1 and 2 are shared with commuter subway rail service, the Metropolitan Transportation Authority (MTA) N line. Segment 5 is shared with the L line subway service.

QUEENS—SEGMENTS FROM 6 TO 8

Segment 6 is along the LIRR Main Line between Fresh Pond Yard and Van Wyck. The line passes through a portion of Queens through various land uses (i.e., residential, commercial, industrial, institution, open space, etc.). Existing LIRR Main line service includes 2 freight trains per night, 20 passenger trains per day, and 2 passenger trains per night.

Segment 7 is along the LIRR Lower Montauk Branch between Maspeth and Fresh Pond Yard. The branch passes through a portion of Queens through various land uses (i.e., residential, commercial, industrial, open space, etc.). Existing LIRR service includes 2 freight trains per night, 20 passenger trains per day, and 2 passenger trains per night.

Segment 8 is along the Fremont Secondary Line between Fresh Pond Yard and Hell Gate Bridge. The line passes through a portion of Queens through various land uses (i.e., residential, commercial, industrial, institution, open space, etc.). Existing Fremont Secondary Line service includes 3 freight trains per night, 36 passenger trains per day, and 6 passenger trains per night.

THE BRONX AND WESTCHESTER—SEGMENTS FROM 9 TO 12

Segment 9 is along the Fremont Secondary Line between Hell Gate Bridge and Harlem River Yard. The line passes through a portion of Queens to the Bronx through various land uses (i.e., residential, commercial, industrial, institution, open space, etc.). Existing Fremont Secondary Line service includes 1 freight train per day and 2 freight trains per night.

Segment 10 is along the Hellgate Line between Harlem River Yard and Oak Point Yard. The line passes through a portion of Bronx through various land uses (i.e., residential, commercial, industrial, institution, open space, etc.). Existing Hellgate Line service includes 1 freight train per day, 2 freight trains per night, 36 passenger trains per day, and 6 passenger trains per night.

Segment 11 is along the Hellgate Line between Oak Point Yard and New Rochelle. The line passes through a portion of Bronx through various land uses (i.e., residential, commercial, industrial, institution, open space, etc.). Existing Hellgate Line service includes 1 freight train per night, 36 passenger trains per day, and 6 passenger trains per night.

Segment 12 is along the Hellgate Line from New Rochelle to north. The line passes through a portion of Bronx/Westchester through various land uses (i.e., residential, commercial, industrial, institution, open space, etc.). Existing Hellgate Line service includes 1 freight train per night, 212 passenger trains per day, and 52 passenger trains per night.

LONG ISLAND—SEGMENTS FROM 13 TO 16

Segment 13 is along the LIRR Main Line between Van Wyck Expressway and Hicksville. The line passes through a portion of Queens to Long Island through various land uses (i.e., residential, commercial, industrial, institution, open space, etc.). Existing LIRR Line service includes approximately 2 freight trains per night, 165 passenger trains per day, and 56 passenger trains per night.

Segments 14 through 15 are along the Ronkonkoma Branch between Hicksville and Ronkonkoma. The branch passes through a portion of Long Island through various land uses (i.e., residential, commercial, industrial, institution, open space, etc.). Existing Ronkonkoma Branch service includes approximately 2 freight trains per night, 52 passenger trains per day, and 18 passenger trains per night.

Segment 16 is along the Ronkonkoma Branch between Ronkonkoma and Greenport. The branch passes through a portion of Long Island through various land uses (i.e., residential, commercial, industrial, institution, open space, etc.). Existing Ronkonkoma Branch service includes approximately 1 freight train per night, 10 passenger trains per day, and 2 passenger trains per night.

NEW JERSEY—SEGMENTS FROM 17 TO 21

Segment 17 is along the Greenville Yard Lead Track between Greenville Yard and Constable Junction. The branch passes through a portion of New Jersey through various land uses (i.e., industrial, transportation and utility, open space, and others). Existing Greenville Yard Lead Track service includes approximately 4 freight trains per day only.

Segment 18 is along the National Docks Secondary between Constable Junction and Nave (near Bergen Tunnel). The branch passes through a portion of New Jersey through various land uses (i.e., residential, commercial, industrial, institution, open space, etc.). Existing National Docks Secondary service includes approximately 2 freight trains per day and 4 freight trains per night.

Segment 19 is along the Northern Branch (also referred to as Northern Running Track) between North Bergen and Tenafly. It passes through a portion of New Jersey through various land uses (i.e., residential, commercial, industrial, institution, open space, etc.). Existing Northern Branch service includes approximately 2 freight trains per night only.

Segment 20 is along the Greenville Branch between Constable Junction and Oak Island Yard. The line passes through a portion of New Jersey through various land uses (i.e., residential, commercial, industrial, institution, open space, etc.). Existing Greenville Branch service includes approximately 2 freight trains per day and 6 freight trains per night.

Segment 21 is along the Chemical Coast Secondary between Oak Island Yard and E-Rail Terminal. The line passes through a portion of New Jersey through various land uses (i.e., residential, commercial, industrial, institution, open space, etc.). Existing Chemical Coast Secondary service includes approximately 2 freight trains per day and 8 freight trains per night.

EXISTING NOISE LEVELS AND IMPACT CRITERIA

Existing noise levels with appropriate moderate impact and severe impact thresholds throughout the project corridor and the corresponding monitoring/estimated locations according to rail line segment are summarized in the **Table 6.7-6**. Existing noise levels at freight facilities that are not along the rail corridor but may be used as terminals for the Waterborne Alternatives are characteristic of industrial and freight uses and would not be expected to change.

Table 6.7-6
Existing Noise Levels and Land Use Category Impact Thresholds

Rail Line Segment	Area	Points	Noise Monitor Location	Nearest Receptor Type/Loc	FTA Land Use Category	Distance to Railway (feet)	Existing Noise Levels (dBA)		Noise Impact Threshold (L_{dn})	
									Moderate Impact	Severe Impact
1	Brooklyn	65th Yard to 8th/9th Ave.	61st Street b/w 11th/12th Ave.	Residence at 170 ft.	2	170	71.3	L_{dn}	65.4	70.4
2	Brooklyn	8th/9th Ave. to 13th Ave.	61st Street b/w 11th/12th Ave.	Residence at 170 ft.	2	170	71.3	L_{dn}	65.4	70.4
3	Brooklyn	13th Ave. to Albany Ave.	Dead end E 22nd St. b/w Campus Rd. and Ave. I	Residence at 55 ft.	2	55	58.5	L_{dn}	57.0	62.7
				Brooklyn College at 55 ft.	3	55	61.8	$L_{eq(1)}$	58.8	64.3
4	Brooklyn	Albany Ave. to POW Highway	Dumont and Van Sicklen Aves.	Residence at 80 ft.	2	80	85.1	L_{dn}	77.8	81.6
				Institute at 80 ft.	3	80	82.0	$L_{eq(1)}$	74.7	78.9
5	Brooklyn	POW Highway to Fresh Pond	Felix Ave. b/w Woodward and Cyprus Aves.	Residence at 110 ft.	2	110	65.9	L_{dn}	61.4	66.8
				School at 110 ft.	3	110	64.7	$L_{eq(1)}$	60.6	66.0
6	Queens	Fresh Pond to Van Wyck	Crossing on 73rd St. b/w Central Ave. and Lutheran Cemetery	Residences at 45 ft.	2	45	69.2	L_{dn}	63.8	68.9
7	Queens	Maspeth to Fresh Pond	Dead end of 60th Place b/w 60th Drive and 62nd Ave.	Residences at 100 ft.	2	100	61.4	L_{dn}	58.6	64.1
8	Queens	Fresh Pond to Hell Gate Bridge	72nd St. b/w 41st Ave. and Woodside Ave.	Residence at 80 ft.	2	80	64.7	L_{dn}	60.6	66.0
				Church at 80 ft.	3	80	60.5	$L_{eq(1)}$	58.1	63.7
9	Bronx	Hell Gate Bridge to Harlem River Yard	19th St. b/w 22nd Dr. and 22nd Rd.	Residence under tracks	2	25	71.1	L_{dn}	65.2	70.3
				Park under tracks	3	25	70.5	$L_{eq(1)}$	64.7	69.8
10	Bronx	Harlem River Yard to Oak Point Yard	138th St./ Bruckner	Residence at 60 ft.	2	60	75.0*	L_{dn}	68.4	73.2
11	Bronx/ Westchester	Oak Point Yard to New Rochelle	Elm Tree Ln/Forest Rd. – Pelham Bay	Residence at 200 ft.	2	200	65.0*	L_{dn}	60.8	66.2
12	Bronx/ Westchester	New Rochelle and north	Palmer Ave/Spencer Dr. – New Rochelle	High rise at 120 ft.	2	120	60.0*	L_{dn}	57.8	63.4
13	L.I.	Main Line at Van Wyck to Hicksville	Kinkell St./Railroad Ave. – New Cassel	Residence at 100 ft.	2	100	65.0*	L_{dn} *	60.8	66.2

Table 6.7 6 (cont'd)
Existing Noise Levels and Land Use Category Impact Thresholds

Rail Line Segment	Area	Points	Noise Monitor Location	Nearest Receptor Type/ Location	FTA Land Use Category	Distance to Railway (feet)	Existing Noise Levels (dBA)		Noise Impact Threshold (L_{dn})	
14	L.I.	Hicksville to Bethpage	Lawnview Ave./Lawnside Dr – Hicksville	Residence at 75 ft.	2	75	65.0*	L_{dn}	60.8	66.2
15	L.I.	Bethpage to Ronkonkoma	L.I. Ave. / W. 2nd St – Deer Park	Residence at 120 ft.	2	120	60.0*	L_{dn}	57.8	63.4
16	L.I.	Ronkonkoma to Greenport	River Road – Calverton	Residence at 120 ft.	2	120	60.0*	L_{dn}	57.8	63.4
17	NJ	Greenville Yard to Constable Junction	Catherine Ct. adj. to tracks – Jersey City	Residence at 120 ft.	2	120	69.1	L_{dn}	63.7	68.9
18	NJ	Constable Junction to Nave (near Bergen Tunnel)	Wayne St. b/w Ristaino Dr. and Chopin St. – Jersey City	Residence at 50 ft.	2	50	68.8	L_{dn}	63.5	68.7
19	NJ	North Bergen to Tenafly	41st St. b/w Dell and Tonnelle Ave. – West N.Y.	Residence at 320 ft.	2	320	66.4	L_{dn}	61.8	67.1
20	NJ	Constable Junction to Oak Island Yard	Roanoke Ave. b/w Hawkins and Vincent Sts.	Residence at 100 ft.	2	100	76.3	L_{dn}	69.5	74.2
21	NJ	Oak Island Yard to E-Rail Terminal	Zamorski Dr. b/w 3rd Ave. and 2nd Ave – Elizabeth	Residence at 120 ft.	2	120	75.5	L_{dn}	68.8	73.6

Notes: An asterisk denotes existing noise levels estimated per FTA methodology – "Transit Noise and Vibration Impact Assessment" Table 5-7. Other existing noise levels were based on the measurements obtained for the 2004 DEIS.

Existing land use category 2 L_{dn} noise levels (at residences and buildings where people normally sleep) range between 58.5 dBA and 85.1 dBA. Existing land use category 2 $L_{eq}(1)$ noise levels (at institutional land uses with primarily daytime and evening uses) range between 61.8 and 82.0 dBA. The locations toward the top end of these ranges would be considered "very noisy" under FTA characterization. Contributing factors to existing noise levels include high volumes of commuter subway service and regional rail service along the transportation corridors of the project rail lines. A summary of existing train movements is provided in **Table 6.7-7**.

Table 6.7-7
Existing Train Movements Along the Segments of the Cross Harbor Freight Program Corridor

Segment Number	Rail Line	Segment Description	Freight Day Trains	Freight Night Trains	Freight Cars/ Train	Freight Locos/ Train	Freight Max Speed	Passenger Day Trains	Passenger Night Trains	Passenger Cars/ Train	Passenger Locos/ Train	Passenger Max Speed
Brooklyn												
1	Bay Ridge Branch	NY Harbor to 8th/9th Avenue	2	0	18	1	25	0	0	--	--	--
2	Bay Ridge Branch	8th/9th Avenue to 13th Avenue	2	0	18	1	25	0	0	--	--	--
3	Bay Ridge Branch	13th Avenue to Albany Avenue	2	0	18	1	25	0	0	--	--	--
4	Bay Ridge Branch	Albany Avenue to POW Highway	2	0	18	1	25	0	0	--	--	--
5	Bay Ridge Branch	POW Highway to Fresh Pond	2	0	18	1	25	0	0	--	--	--
Queens												
6	LIRR Main Line	Fresh Pond to Van Wyck	0	2	38	2	45	20	2	5	1	60
7	Lower Montauk Branch	Maspeth to Fresh Pond	0	2	24	2	45	20	2	5	1	35
8	Fremont Secondary	Fresh Pond to Hell Gate Bridge	0	3	41	2	45	36	6	8	1	35
The Bronx/Westchester												
9	Fremont Secondary	Hell Gate Bridge to Harlem River Yard	1	2	40	2	25	0	0	--	--	--
10	Hellgate Line	Harlem River Yard to Oak Point Yard	1	2	100	3	25	36	6	8	1	35
11	Hellgate Line	Oak Point Yard to New Rochelle	0	1	100	3	25	36	6	8	1	35
12	Hellgate Line	New Rochelle and north	0	1	100	3	45	212	52	8	1	80
Long Island												
13	LIRR Main Line	Mainline at Van Wyck to Hicksville	0	2	38	2	45	165	56	10	1	80
14	Ronkonkoma Branch	Hicksville to Bethpage	0	2	38	2	45	52	18	10	1	80
15	Ronkonkoma Branch	Bethpage to Ronkonkoma	0	2	38	2	45	52	18	10	1	80
16	Ronkonkoma Branch	Ronkonkoma to Greenport	0	1	48	2	45	10	2	2	1	60
New Jersey												
17	Greenville Yard Lead Track	Greenville Yard to Constable Junction	4	0	60	3	25	0	0	--	--	--
18	National Docks Secondary	Constable Junction to Nave (near Bergen Tunnel)	2	4	110	6	25	0	0	--	--	--
19	Northern Branch	North Bergen to Tenafly	0	2	50	2	45	0	0	--	--	--
20	Greenville Branch	Constable Junction to Oak Island Yard	2	6	110	6	25	0	0	--	--	--
21	Chemical Coast Secondary	Oak Island Yard to E-Rail Terminal	2	8	110	6	25	0	0	--	--	--

EXISTING VIBRATION LEVELS AND IMPACT CRITERIA

Currently, there are rail activities along the existing rail lines that would be expected to produce high ground-borne vibration and noise levels at 50 feet from the tracks. Critical distances for three land use categories are shown in **Table 6.7-5**.

D. PROBABLE EFFECTS OF THE ALTERNATIVES

PROBABLE NOISE EFFECTS

Using the methodology previously described, calculations to predict the noise levels from the increased train activity along the corridor take into account the number of trains and the number of locomotives on each train, the speed of the trains, and time of day. These alternatives would result in ambient noise level increments that could exceed FTA criteria along most of the segments. If any of these alternatives are advanced to Tier II, a detailed analysis would be performed as part of the environmental review process to more fully evaluate site-specific impacts and the effectiveness of potential mitigation measures.

Regarding truck activities for the alternatives, truck volumes would increase on roadways that would provide access to freight facilities and terminals (details see Chapter 5, “Transportation”). In general, depending on existing traffic volumes on roadways near the freight facilities, the incremental truck trips generated by the alternatives would have the potential to result in moderate or severe impacts at sensitive receptors. To assess the magnitude of the increases in noise levels due to increased truck traffic, detailed studies of truck routes to and from the freight facilities, as well as hourly traffic data (volumes, vehicle mixes, and speeds), are required. This detailed information has not been developed for this Tier I analysis, but would be developed as part of the studies for a Tier II analysis.

NO ACTION ALTERNATIVE

Table 6.7-8 shows the results of the general noise assessment for the No Action Alternative. The assessment concludes that the potential for moderate impacts would occur at Segment 5 (land use category 3 only), and segments 7, 8, and 21 (land use category 2 only), and the potential for severe impacts would occur at segments 3 and 9, segments 6, 8, 12 through 16, and Segment 18 (land use category 2 only).

The No Action Alternative would also result in an increase in ambient noise levels at the freight facilities (i.e., 51st Street Yard, 65th Street Yard, Maspeth Yard, and Long Island facilities) and along the roadways that would be used by trucks to access those facilities. When the detailed traffic information is available, the potential for moderate or severe impacts due to added truck traffic would be explored in any future Tier II documentation.

WATERBORNE ALTERNATIVES

Enhanced Railcar Float Alternative

Table 6.7-8 shows the results of the general noise assessment for the Enhanced Railcar Float Alternative. The assessment concludes that the potential for moderate impacts would occur at Segment 5, and segments 7, 17, and 21 (land use category 2 only), and the potential for severe impacts would occur at segments 3, 8, and 9, and segments 6, 12 through 16, and Segment 18 (land use category 2 only).

The Enhanced Railcar Float Alternative would also result in an increase in ambient noise levels at the potential freight facilities (i.e., 51st Street Yard, 65th Street Yard, Maspeth Yard, Oak Point Yard, and Long Island facilities) and along the roadways that would be used by trucks to access those facilities. When the detailed traffic information is available, the potential for moderate or severe impacts due to added truck traffic would be explored in any future Tier II documentation.

Truck Ferry Alternative

The Truck Ferry Alternative would result in an increase in ambient noise levels at the potential terminals/freight facilities (i.e., Port Newark/Port Elizabeth, 51st Street Yard, 65th Street Yard, South Brooklyn Marine Terminal, Maspeth Yard, Oak Point Yard, and Hunts Point) and along roadways due to trucks deliveries. When the detailed traffic information is available, the potential for moderate or severe impacts due to added truck traffic would be explored in any future Tier II documentation.

Truck Float Alternative

The Truck Float Alternative would result in a similar increase in ambient noise levels at the terminals/freight facilities and along the roadways as the Truck Ferry Alternative, and further study would be required.

Lift On-Lift Off (LOLO) Container Barge Alternative

The LOLO Container Barge Alternative would result in an increase in ambient noise levels at the potential terminals/freight facilities (i.e., Greenville Yard, Port Newark/Port Elizabeth, 51st Street Yard, 65th Street Yard, South Brooklyn Marine Terminal, Red Hook Container Terminal) and along roadways due to trucks deliveries. When the detailed traffic information is available, the potential for moderate or severe impacts due to added truck traffic would be explored in any future Tier II documentation.

Roll On-Roll Off (RORO) Container Barge Alternative

The RORO Container Barge would result in a similar increase in ambient noise levels at the potential terminals/freight facilities and along the roadways as the LOLO Container Barge Alternative, and further study would be required.

RAIL TUNNEL ALTERNATIVES

Rail Tunnel Alternative

Table 6.7-8 shows the results of the general noise assessment for the Rail Tunnel Alternative. The assessment concludes that the potential for moderate impacts would occur at segments 1 and 2 (land use category 2 only), and Segment 5 (land use category 3 only), and the potential for severe impacts would occur at segments 3, 8, and 9, and segments 6, 7, and segments 10 through 21 (land use category 2 only). The Rail Tunnel Alternative would also result in an increase in ambient noise levels at the potential freight facilities (i.e., 51st Street Yard, Maspeth Yard, Oak Point Yard, and Long Island facilities) and along the roadways that would be used by trucks to access those facilities. When the detailed traffic information is available, the potential for moderate or severe impacts due to added truck traffic would be explored in any future Tier II documentation.

Rail Tunnel with Shuttle ("Open Technology") Service Alternative

Based on the train movements, the effect of Rail Tunnel with Shuttle Service Alternative would be similar to those described under the Rail Tunnel Alternative. However, due to a slight greater number of trains projected at most of the segments, the impacts would be somewhat greater at those segments. Potential impacts were estimated based on the analysis results of Rail Tunnel Alternative (see the estimated results in **Table 6.7-8)**. In this way, the potential for moderate impacts would occur at segments 1 and 2 (land use category 2 only), and Segment 5 (land use category 3 only), and the potential for severe impacts would occur at segments 3, 8, and 9, and segments 6, 7, and segments 10 through 21 (land use category 2 only).

The Rail Tunnel with Shuttle Service Alternative would also result in an increase in ambient noise levels at the potential freight facilities (i.e., 51st Street Yard, Maspeth Yard, Oak Point Yard, and Long Island facilities) and along the roadways that would be used by trucks to access those facilities. When the detailed traffic information is available, the potential for moderate or severe impacts due to added truck traffic would be explored in any future Tier II documentation.

Rail Tunnel with Chunnel Service Alternative

Table 6.7-8 shows the results of the general noise assessment for the Rail Tunnel with Chunnel Service Alternative. The assessment concludes that the potential for moderate impacts would occur at segments 1, 2, and 11 (land use category 2 only), and Segment 5 (land use category 3 only), and the potential for severe impacts would occur at segments 3, 8, and 9, and segments 6, 7, 10, and segments 12 through 21 (land use category 2 only).

The Rail Tunnel with Chunnel Service Alternative would also result in an increase in ambient noise levels at the potential freight facilities (i.e., Oak Island Yard, 51st Street Yard, East New York Yard, Maspeth Yard, Oak Point Yard, and Long Island facilities) and along the roadways that would be used by trucks to access those facilities. When the detailed traffic information is available, the potential for moderate or severe impacts due to added truck traffic would be explored in any future Tier II documentation.

Rail Tunnel with Automated Guided Vehicle (AGV) Technology Alternative

Based on the train movements, the effect of the Rail Tunnel with AGV Technology Alternative would be similar to those described under the Rail Tunnel with Chunnel Service Alternative. However, due to the greater number of trains projected at 1-4 segments, the impacts would be greater at those segments. Potential impacts were estimated based on the analysis results of Rail Tunnel with Chunnel Service Alternative (see the estimated results in **Table 6.7-8)**. In this way, the potential for moderate impacts would occur at segments 4 and 10 (land use category 2 only), and Segment 5 (land use category 3 only), and the potential for severe impacts would occur at segments 3, 8 and 9, and segments 1, 2, 6, 7, 10, and segments 12 through 21 (land use category 2 only).

The Rail Tunnel with AGV Technology Alternative would also result in an increase in ambient noise levels at the potential freight facilities (i.e., Oak Island Yard, 51st Street Yard, East New York Yard, Maspeth Yard, Oak Point Yard, and Long Island facilities) and along the roadways that would be used by trucks to access those facilities. When the detailed traffic information is available, the potential for moderate or severe impacts due to added truck traffic would be explored in any future Tier II documentation.

Rail Tunnel with Truck Access Alternative

With the exception of Segment 7, the Rail Tunnel with Truck Access Alternative would project the same number of trains as the Rail Tunnel Alternative, and the noise effect would be similar to those described under the Rail Tunnel Alternative. At Segment 7, due to two fewer trains projected, the noise impacts would be somewhat less. Potential impacts were estimated based on the analysis results of Rail Tunnel Alternative (see estimated results in **Table 6.7-8)**. In this way, the potential for moderate impacts would occur at segments 1 and 2 (land use category 2 only), and Segment 5 (land use category 3 only), and the potential for severe impacts would occur at segments 3, 8 and 9, and segments 6, 7, and segments 10 through 21 (land use category 2 only).

The Rail Tunnel with Truck Access Alternative would also result in an increase in ambient noise levels at the potential freight facilities (i.e., Oak Island Yard, 51st Street Yard, East New York

Yard, Maspeth Yard, Oak Point Yard, and Long Island facilities) and along the roadways that would be used by trucks to access those facilities. When the detailed traffic information is available, the potential for moderate or severe impacts due to added truck traffic would be explored in any future Tier II documentation.

Table 6.7-8
Likely Noise Impacts Along the Rail Corridor

Rail Line Segment	FTA Land Use Category	Noise Descriptor	No Action	Waterborne Alternatives[1]	Rail Tunnel Alternatives				
				Enhanced Railcar Float	Rail Tunnel	Rail Tunnel with Shuttle Service[2]	Rail Tunnel with Chunnel Service	Rail Tunnel With AGV Technology[2]	Rail Tunnel With Truck Access[2]
1	2	L_{dn}	-	-	M	M	M	S	M
2	2	L_{dn}	-	-	M	M	M	S	M
3	2	L_{dn}	S	S	S	S	S	S	S
	3	$L_{eq(1)}$	S	S	S	S	S	S	S
4	2	L_{dn}	-	-	-	-	-	M	-
	3	$L_{eq(1)}$	-	-	-	-	-	-	-
5	2	L_{dn}	-	M	S	S	S	S	S
	3	$L_{eq(1)}$	M	M	M	M	M	M	M
6	2	L_{dn}	S	S	S	S	S	S	S
7	2	L_{dn}	M	M	S	S	S	S	S
8	2	L_{dn}	M	S	S	S	S	S	S
	3	$L_{eq(1)}$	S	S	S	S	S	S	S
9	2	L_{dn}	S	S	S	S	S	S	S
	3	$L_{eq(1)}$	S	S	S	S	S	S	S
10	2	L_{dn}	-	-	S	S	S	S	S
11	2	L_{dn}	-	-	S	S	M	M	S
12	2	L_{dn}	S	S	S	S	S	S	S
13	2	L_{dn}	S	S	S	S	S	S	S
14	2	L_{dn}	S	S	S	S	S	S	S
15	2	L_{dn}	S	S	S	S	S	S	S
16	2	L_{dn}	S	S	S	S	S	S	S
17	2	L_{dn}	-	M	S	S	S	S	S
18	2	L_{dn}	S	S	S	S	S	S	S
19	2	L_{dn}	-	-	S	S	S	S	S
20	2	L_{dn}	-	-	S	S	S	S	S
21	2	L_{dn}	M	M	S	S	S	S	S

Note: No Moderate or Severe Impact:
Moderate Impact: M
Severe Impact: S
[1] Other Waterborne Alternatives would not affect the rail corridor.
[2] Estimated results.

PROBABLE VIBRATION EFFECTS

Using the methodology previously described, calculations to predict vibration and vibration-induced noise levels from the increased train activity along the corridor take into account the number of trains, length of trains, number of locomotives on each train, the speed of the trains, and time of day. These alternatives would result in ambient vibration and vibration-induced noise level increments that could exceed FTA criteria along most of the segments. If any of these alternatives are advanced to Tier II, a detailed analysis would be performed as part of the environmental review process to more fully evaluate site-specific impacts and the effectiveness of potential mitigation measures. The general assessment results of these alternatives are presented below.

As descripted previously, truck volumes would increase on roadways that would provide access to freight facilities and terminals. According to the FTA guidance, transit projects that involve rubber-tire vehicles (i.e., trucks rather than trains) are unlikely to result in vibration impacts unless (1) there may be expansion joints, speed bumps, or other design features in the road surface near vibration-sensitive buildings (2) heavy vehicles will be operating close to a sensitive building; or (3) the project includes operation of vehicles inside or directly beneath buildings that are vibration-sensitive buildings. This detailed information has not been developed for this Tier I analysis, but would be developed as part of the studies for a Tier II analysis.

NO ACTION ALTERNATIVE

Based upon the assessment results, vibration and vibration-induced noise impacts are anticipated for rail segments 1, 3, 6 through 10, 12 through 16, 18, 20 and 21. In addition, anticipated vibration levels at the closest receptors of rail segments 1, 6, and 9 would be strong enough to warrant concern over possible minor cosmetic damage to fragile buildings.

In addition, the No Action Alternative would not be expected to result in vibration and vibration-induced (ground-borne) noise impacts due to truck activities.

WATERBORNE ALTERNATIVES

Enhanced Railcar Float Alternative

With the Enhanced Railcar Floor Alternative, vibration and vibration-induced noise impacts would be anticipated for rail segments 1, 3, 6 through 10, 12 through 16, 18, 20 and 21 for the Enhanced Railcar Float Alternative. In addition, anticipated vibration levels at the closest receptors of rail segments 1, 6, and 9 would be strong enough to warrant concern over possible minor cosmetic damage to fragile buildings.

In addition, the Enhanced Railcar Floor Alternative would not be expected to result in vibration and vibration-induced (ground-borne) noise impacts due to truck activities.

Truck Ferry Alternative

The Truck Ferry Alternative would not be expected to result in vibration and vibration-induced (ground-borne) noise impacts due to truck activities.

Truck Float Alternative

The Truck Float Alternative would not be expected to result in vibration and vibration-induced (ground-borne) noise impacts due to truck activities.

Lift On-Lift Off (LOLO) Container Barge Alternative

The LOLO Container Barge Alternative would not be expected to result in vibration and vibration-induced (ground-borne) noise impacts due to truck activities.

Roll On-Roll Off (RORO) Container Barge Alternative

The Truck Ferry Alternative would not be expected to result in vibration and vibration-induced (ground-borne) noise impacts due to truck activities.

RAIL TUNNEL ALTERNATIVES

Rail Tunnel Alternative

With the Rail Tunnel Alternative, vibration and vibration-induced noise impacts would be anticipated for rail segments 1, 3, 6 through 10, 12 through 18, 20, and 21. In addition, anticipated vibration levels at the closest receptors of rail segments 1, 6, and 9 would be strong enough to warrant concern over possible minor cosmetic damage to fragile buildings.

In addition, the Rail Tunnel Alternative would not be expected to result in vibration and vibration-induced (ground-borne) noise impacts due to truck activities.

Rail Tunnel with Shuttle ("Open Technology") Service Alternative

Based on the train movements, the effect of Rail Tunnel with Shuttle Service Alternative would be similar to those described under the Rail Tunnel Alternative. Potential impacts were estimated based on the analysis results of Rail Tunnel Alternative. In this way, vibration and vibration-induced noise impacts would be anticipated for rail segments 1, 3, 6 through 10, 12 through 18, 20, and 21. In addition, anticipated vibration levels at the closest receptors of rail segments 1, 6, and 9 would be strong enough to warrant concern over possible minor cosmetic damage to fragile buildings. Due to truck activities, the Rail Tunnel with Shuttle Service Alternative would not be expected to result in vibration and vibration-induced (ground-borne) noise impacts.

In addition, the Rail Tunnel with Shuttle Service Alternative would not be expected to result in vibration and vibration-induced (ground-borne) noise impacts due to truck activities.

Rail Tunnel with Chunnel Service Alternative

The Rail Tunnel with Chunnel Service Alternative would add more trains to the rail segments of the proposed project between New Jersey and Brooklyn, which would change vibration and vibration-induced noise impact criteria at a number of receptor locations from the "infrequent event" category to the "occasional event" category. Because of this, vibration and vibration-induced noise impact criteria would be lower, thereby resulting in more impacts along the project corridor. For the Rail Tunnel with Chunnel Service Alternative, vibration and vibration-induced noise impacts would be anticipated for rail segments 1 through 4 , 6 through 10, 12 through 21. In addition, anticipated vibration levels at the closest receptors of rail segments 1, 6, and 9 would be strong enough to warrant concern over possible minor cosmetic damage to fragile buildings.

In addition, the Rail Tunnel with Chunnel Service Alternative would not be expected to result in vibration and vibration-induced (ground-borne) noise impacts due to truck activities.

Rail Tunnel with Automated Guided Technology (AGV) Technology Alternative

Based on the train movements, the effect of the Rail Tunnel with AGV Technology Alternative would be similar to those described under the Rail Tunnel with Chunnel Service Alternative. Potential impacts were estimated based on the analysis results of Rail Tunnel with Chunnel Service Alternative. In this way, vibration and vibration-induced noise impacts would be anticipated for rail segments 1 through 4, 6 through 10, and 12 through 21. In addition, anticipated vibration levels at the closest receptors of rail segments 1, 6, and 9 would be strong enough to warrant concern over possible minor cosmetic damage to fragile buildings.

In addition, the Rail Tunnel with AGV Technology Alternative would not be expected to result in vibration and vibration-induced (ground-borne) noise impacts due to truck activities.

Rail Tunnel with Truck Access Alternative

Based on the train movements, the effect of Rail Tunnel with Truck Access Alternative would be similar to those described under the Rail Tunnel Alternative. Potential impacts were estimated based on the analysis results of Rail Tunnel Alternative. In this way, vibration and vibration-induced noise impacts would be anticipated for rail segments 1, 3, 6 through 10, 12 through 18, 20, and 21. In addition, anticipated vibration levels at the closest receptors of rail segments 1, 6, and 9 would be strong enough to warrant concern over possible minor cosmetic damage to fragile buildings.

In addition, the Rail Tunnel with Truck Access Alternative would not be expected to result in vibration and vibration-induced (ground-borne) noise impacts due to truck activities.

VIBRATION MITIGATION MEASURES

For project alternatives involving rail 16 dB to over 21 dB of vibration attenuation and 18 dB to over 23 dB of vibration-induced noise would likely be required. Those levels of attenuation would likely require significant upgrades to existing railways in the project corridor. Specialized measures, such as floating slab trackbed or ballast mats, may be needed in some areas. As stated previously, a detailed analysis of effective vibration mitigation measures as part of a detailed vibration analysis would typically be conducted for a project-specific or Tier II EIS.

E. CONSTRUCTION

Noise and vibration from construction equipment operation and noise from construction worker vehicles/trains and delivery vehicles/trains traveling to and from the project area would occur during construction of all four project alternatives. The level of impact of these noise sources would depend on the characteristics of the construction operations being performed and the location of sensitive receptors. Noise and vibration levels at a given location are dependent on the type and number of pieces of construction equipment being operated, the acoustical utilization factor of the equipment (i.e., the percentage of time a piece of equipment is operating at full power), the distance from the construction site, and any shielding effects (from structures such as buildings, walls, or barriers).

FHWA's Construction Noise Handbook includes the following:

> *While noise impact and abatement criteria have been established for the operation of transportation facilities in the United States, standardized criteria have not yet been established related to noise associated with the construction of such facilities. However, since the publication of the original 1977 Report, additional guidance has been disseminated (through agencies such as FHWA and FTA) and analysis tools developed to better address construction noise. For example, the FTA Transit Noise and Vibration Impact Assessment document presents guidelines that "can be considered reasonable criteria for assessment" of construction noise impacts.*

Like most construction projects, construction of the Build Alternatives would result in increased noise and vibration levels for a limited time period. At this time, information needed to perform a quantitative construction noise analysis is not available. A detailed construction noise and vibration analysis would be performed for the chosen Build Alternative as part of the Tier II environmental review process. This detailed analysis would evaluate alternative-specific construction noise and vibration impacts and, if impacts are predicted to occur, would provide an evaluation of potential mitigation measures. A qualitative discussion and quantified information are presented in the following sections.

NOISE

Typical noise levels of construction equipment that may be employed during the construction process are provided in **Table 6.7-9**. Noise from construction equipment is regulated by the U.S. Environmental Protection Agency (EPA) noise emission standards. These federal requirements mandate that: (1) certain classifications of construction equipment and motor vehicles meet specified noise emissions standards; and (2) construction materials be handled and transported in such a manner as not to create unnecessary noise. These regulations would be carefully followed. In addition, appropriate low-noise emission level equipment would be used and operational procedures implemented. Compliance with noise control measures would be ensured by including them in the contract documents as material specifications and by directives to the construction contractor. The contractor would be encouraged to use quiet construction equipment.

Table 6.7-9
Construction Equipment Noise Emission Levels

Equipment	Typical Noise Level (dBA) 50 feet from source
Air compressor	81
Backhoe	80
Bulldozer	85
Compactor	82
Concrete Mixer	85
Concrete Pump	82
Concrete Vibrator	76
Crane, Derrick	88
Crane, Mobile	83
Generator	81
Grader	85
Impact Wrench	85
Jackhammer	88
Loader	85
Paver	89
Pile Driver (Impact)	101
Pile Driver (Sonic)	96
Pneumatic Tool	85
Pump	76
Rail Saw	90
Rock Drill	98
Roller	74
Saw	76
Scarifier	83
Scraper	89
Shovel	82
Spike Driver	77
Tie Cutter	84
Tie Handler	80
Tie Inserter	85
Truck	88

Source: Transit Noise and Vibration Impact Assessment, FTA-VA-90-1003-06, May 2006.

Noise generated by construction equipment would decrease with distance. In general, the outdoor drop-off rate for moving noise sources is a decrease of 4.5 dBA for every doubling of distance between the noise source and the receiver. For stationary sources, the outdoor drop-off rate is a decrease of 6 dBA for every doubling of distance between the noise source and the receiver. In general, noise caused by construction activities would vary widely in volume, duration, and location, depending on the task being undertaken and the piece of equipment used.

Noise caused by delivery trucks, delivery trains, employees traveling to and from the construction sites, and other construction vehicles would not be severe in volume or duration, and would be limited to the major access roadways leading to the construction sites. While some components would be delivered daily by truck, the number of trucks would not be expected to result in substantial noise increases at any residential receptors. Major removal of excavation material would be handled by rail and not result in substantial noise increases at residential receptors.

Construction activities related to the development of terminals and freight facilities for all Build Alternatives and tunnel construction for the Rail Tunnel Alternatives would be substantial near the terminals, freight facilities, and tunnel entry points, but of relatively short duration.

A major source of construction noise with the Waterborne Alternatives would be pile-driving operations, which would be expected to occur early in the construction process and relatively far from potentially sensitive noise receptors.

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. Removal of tunnel excavation material would be expected to occur daily during times of tunnel boring.

Table 6.7-10 shows the FTA's construction assessment impact values for both the general noise assessment and the detailed noise assessment contained in the FTA guidance manual. For purposes of impact assessment, a noise impact would occur if noise levels during construction exceed the FTA-recommended values in **Table 6.7-10**. Based on the information currently available, it cannot be ruled out that construction of each of the four project alternatives would have the potential for causing construction-related noise impacts at one or more locations.

Table 6.7-10
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.

VIBRATION

For evaluating potential annoyance from vibration due to construction, the FTA guidance manual recommends using the criteria above in **Table 6.7-4**. However, in most cases, the primary concern regarding construction vibration relates to potential architectural and structural damage, particularly to old, fragile buildings of historical significance. FTA has adopted the vibration damage criteria shown in **Table 6.7-11** for evaluating potential structural impacts on buildings located near construction sites.

Table 6.7-11
FTA Construction Vibration Damage Criteria

Building Category	PPV (in/sec)	Approximate L_v[2]
I. Reinforced-concrete, steel, or timber (no plaster)	0.5	102
II. Engineered concrete and masonry (no plaster)	0.3	98
III. Non-engineered timber and masonry buildings	0.2	94
IV. Buildings extremely susceptible to vibration damage	0.12	90

Notes:
[1] PPV – Peak particle velocity.
[2] Root mean square (RMS) velocity in decibels (VdB) referenced to 1 micro-inch/second.
Source: *Transit Noise and Vibration Impact Assessment*, FTA-VA-90-1003-06, May 2006.

Table 6.7-22 shows architectural and structural damage risk and perceptibility distances for residential and historic structures in proximity to the types of activities that would occur during construction of the proposed project. Architectural damage usually includes cosmetic damage, such as cracked plaster, etc. Architectural damage is not considered potentially dangerous. As shown in **Table 6.7-12**, pile driving has the greatest potential to result in architectural damage to most building types. While not shown in the table, controlled blasting also can result in high vibration levels in excess of 100 VdB with resultant damage to existing structures; however, it is unlikely that blasting would be required for the construction of any of the project alternatives. (If blasting is later determined to be necessary, the effects of blasting would be evaluated as part of the Tier II analysis.) Most other construction activities require very small (i.e., less than 25 feet) distances between the structure and the construction equipment or the presence of highly fragile buildings for impacts to occur. For fragile and highly fragile buildings, respectively, FTA recommends a limit of peak particle velocities of 0.2 and 0.12 inches per second or 94 and 90 VdB. Since the use of driven piles would be limited, and no controlled blasting is currently anticipated, the likelihood of vibration-related adverse effects would be small.

Table 6.7-12
Vibration Source Levels for Construction Equipment

Equipment	PPV at 25 ft (in/sec)	Approximate L_{v^*} at 25 ft
Pile driver (impact)	0.644	104
Pile driver (sonic)	0.170	93
Clam shovel drop (slurry wall)	0.202	94
Hydromill (slurry wall in soil)	0.008	66
Hydromill (slurry wall in rock)	0.017	75
Vibratory roller	0.210	94
Hoe ram	0.089	87
Large bulldozer	0.089	87
Caisson drilling	0.089	87
Loaded trucks	0.076	86
Jackhammer	0.035	79
Small bulldozer	0.003	58

Note: * RMS velocity in decibels (VdB) re 1 micro-inch/second
Source: *Transit Noise and Vibration Impact Assessment*, FTA-VA-90-1003-06, May 2006.

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 would be continuously moving. These activities would occur primarily under water, with limited land-based TBM activities in populated areas. Vibration levels from operation of the underground construction-related soil movement trains that would be used to convey excavation materials from the face of the TBMs back to the shaft site where the excavation materials would be raised to surface 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 tunnel. 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.

As part of the Tier II analysis, detailed studies of construction-related vibration effects would be performed. These studies would examine both impacts related to architectural and/or structural damage, as well as potential annoyance issues. If impacts are identified, mitigation options would be examined.

F. TIER II ANALYSIS AND POTENTIAL MITIGATION MEASURES

RAILWAY

The Rail Tunnel Alternatives and the Enhanced Railcar Float Alternative are predicted to generate noise impacts at receptor locations adjacent to most, if not all, rail segments. The feasibility, practicability, and effectiveness of mitigation measures would typically be examined as part of the detailed noise evaluation and would be conducted for a project-specific or Tier II EIS. In general, effective mitigation measures for rail projects fall into three basic categories: source treatments, path treatments, and receiver treatments.

Source treatment mitigation measures reduce the intensity of the noise source and include, but are not limited to, stringent vehicle and equipment specifications, operational restrictions, wheel treatments, vehicle treatments, guideway controls on turns, speed restrictions, and alternative warning devices.

Path treatment mitigation measures interrupt the path between the noise source and the receiver, thereby inserting attenuation and reducing noise levels at the receiver. Path treatments include sound barriers, enclosures, alteration of railway alignments, alteration of design of at-grade and aerial guideways, and ballast and/or resilient track support, etc. Sound barriers can be designed to achieve up to approximately 15 dBA of attenuation and must break the line-of-sight to be effective. Consequently, typical sound barriers in the 10- to 20-foot-tall range are most effective in reducing noise levels at the first floors of buildings but are generally less effective at elevated receptor locations.

Receiver treatment mitigation measures include measures that reduce the noise intensity at the receiver and mostly include building construction modifications, such as building façade insulation and/or upgrade, window upgrades or window treatments (additional sound attenuating windows), and alternate means of ventilation. Additional receiver treatments may include acquisition of property rights for construction of sound barriers, etc. Building reduction measures are generally only used in limited cases where other means are ineffective, undesirable, and/or impractical.

All three types of mitigation options would need to be considered for the proposed project due to the relatively high project-generated noise levels anticipated and the urban density and diversity of uses near the rail corridor.

FREIGHT FACILITIES

Freight facility operations would include some of the noise mitigation measures mentioned above. Alternatives involving rail would also use smaller/quieter shuttle locomotives for local movements of railcars.

Preventative noise measures would be implemented at truck staging areas at the terminals for the Rail Tunnel with Chunnel Service, Rail Tunnel with Shuttle Service, Rail Tunnel with AGV Technology, and Rail Tunnel with Truck Access alternative. Such measures could include clearly posted signs instructing drivers not to blow horns unless for emergency conditions. All trucks would need to comply with state regulations regarding noise control measures, such as installation of proper mufflers, etc. All trucks would limit any idling operations to comply with state and local noise regulations.

FIXED NOISE SOURCES

The Rail Tunnel Alternatives would include ventilation shafts located near Greenville Yard and along the Bay Ridge Branch, near the 65th Street Yard. Although this ventilation equipment would likely be very large, readily available noise control design measures, such as stringent fan selection, sound attenuators, and/or custom air discharge, would be included as part of the ventilation shaft design. The ventilation shafts would be designed to comply with all federal, state, and local noise standards. Examination of state and local noise regulation applicability would need to be conducted for a project-specific or Tier II EIS. This may require limited coupling/decoupling operations at night in New Jersey.

MARINE NOISE

Coast Guard-approved horn signals and their usage by watercraft are required for safe marine operations when backing out of docking or moorings. The distinctive and frequent sound of a horn blowing would likely be clearly discernible near the terminals for the Waterborne Alternatives. Alternate signal means for float dock operations would be investigated at a project-specific or Tier II EIS, as a possible way to mitigate marine noise. ✷