5.11 NOISE AND VIBRATION

5.11.1 Introduction

This section assesses the potential for noise and vibration impacts from construction and operation of the proposed South Ferry Terminal Project. Because the project is proposed to be funded by the Federal Transit Administration (FTA), the noise and vibration analyses were conducted according to FTA guidelines published as *Transit Noise and Vibration Impact Assessment* (1995). This section is divided into two main analyses: 1) airborne noise; and 2) vibration and ground-borne noise. Each of the analyses includes a description of the assessment standards and criteria, a description of existing conditions, a description of future conditions with and without the Proposed Action for both the construction and operational phases of the project, and mitigation measures where impacts are identified.

5.11.2 Environmental Performance Commitments

The Proposed Action will be implemented with Environmental Performance Commitments (EPCs). These are measures that will be proactively implemented within the design and construction of the project to avoid or reduce potential adverse impacts with regard to noise and vibration. They include the following:

- Where practicable, individual project construction activities will be scheduled to avoid or minimize adverse impacts.
- Construction activities will be coordinated with projects under construction in adjacent and nearby locations to avoid or minimize impacts.
- The condition of surrounding buildings, structures, infrastructure, and utilities shall be considered, where appropriate.
- Contingency measures such as sequencing of operations, alternative construction methods, and source reduction measures will be prepared in the event established limits are exceeded (for the South Ferry Project, the FTA construction noise criteria apply).

5.11.3 Noise Characteristics

Noise is typically measured in units called decibels (dB). Because the volume of audible sound is perceived as loudness, the dependence of loudness on frequency must be taken into account in the noise scale used in environmental assessments. One of the simplified scales that accounts for the dependence of perceived loudness on frequency is a weighting network known as "A" –weighting. Through the use of this weighting scale, a measurement system may simulate the response of the human ear. Sound levels that are measured using an A-weighted decibel scale are generally expressed as dBA. Throughout this section, noise levels are expressed as dBA. Several examples of noise

pressure levels in dBA are listed in Table 5-26. Table 5-27 shows the average ability of the human ear to perceive changes in noise levels.

Table 5-26
A-Weighted (dBA) Levels of Typical Noise Environment

A-weighted	Overall Level	Noise Environment
120	Uncomfortably loud (32 times as loud as 70 dBA)	Military jet airplane takeoff at 50 feet.
100	Very loud (8 times as loud as 70 dBA)	Jet flyover at 1,000 feet Locomotive pass-by at 100 feet.
80	Loud (2 times as loud as 70 dBA)	Propeller plane flyover at 1,000 feet. Diesel truck moving 40 mph at 50 feet.
70	Moderately loud	Freeway at 50 feet from pavement edge at 10 a.m. Vacuum cleaner (indoor).
60	Relatively quiet (1/2 as loud as 70 dBA)	Air condition unit at 100 feet. Dish washer at 10 feet (indoor).
50	Quiet (1/4 as loud as 70 dBA)	Large transformers. Small private office (indoor).
40	Very quiet (1/8 as loud as 70 dBA)	Birds calls. Lowest limit of urban ambient sound.
10	Extremely quiet (1/64 as loud as 70 dBA)	Just audible.
0	Threshold of hearing	

Source: Federal Agency Review of Selected Airport Noise Analysis Issues, 1992
Modified by Louis Berger Group, October 1998

Table 5-27
Average Ability to Perceive Changes in Noise Levels

Change (dBA)	Human Perception of Sound
2-3	Barely perceptible
5	Readily noticeable
10	A doubling or halving of the loudness of sound
20	A “dramatic change”
40	Difference between a faintly audible sound and a very loud sound

Source: Bolt Beranek and Neuman, Inc., *Fundamentals and Abatement of Highway Traffic Noise*, Report No. PB-222-703. Prepared for Federal Highway Administration, June 1973.

It is also possible to characterize the effects of noise on people by studying the aggregate response of people in communities (see Table 5-28). The rating method used for this purpose is based on a statistical analysis of the fluctuations in noise levels in a community, and integrating the fluctuating sound energy over a known period of time, most typically during one hour or 24-hours.

Table 5-28
Community Response to Increases in Noise Levels

Change (dBA)	Category	Description
0	None	No observed reaction
5	Little	Sporadic complaints
10	Medium	Widespread complaints
15	Strong	Threats of community action
20	Very strong	Vigorous community action

Source: International Standards Organization, Noise Assessment with Respect to Community Responses, ISO/TC 43. (New York: United Nations, November 1969).

Because the sound pressure level unit of dBA describes a noise level at just one moment and very few noises are constant, other ways of describing noise over more extended periods have been developed. One way of describing fluctuating sound is to describe the fluctuating noise heard over a specific period as if it had been a steady, unchanging sound. For this condition, a descriptor called the "equivalent sound level," L_{eq}, is used. 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. L_{dn} is the day-night average sound level or cumulative noise exposure over a 24-hour period, with events between 10 p.m. and 7 a.m. increased by 10 dBA to account for greater nighttime sensitivity to noise. The L_{dn} (or DNL), which represents 24-hour levels with a 10 dBA penalty for nighttime hours, is useful for evaluating residential land uses and others with sleeping accommodations.

5.11.4 Airborne Noise

5.11.4.1 Federal Transit Administration Criteria

The FTA *Transit Noise and Vibration Impact Assessment Manual* describes a recommended noise screening and assessment methodology, based on various transportation-related and acoustic professional sources, for assessment of ambient and transit-related noise. As part of the methodology, an initial screening is conducted (the *general noise assessment*) to determine the need for a more detailed noise assessment. The initial screening comprises an evaluation of distance between source and receptor distance. Receptors are noise-sensitive locations where human activity may be adversely affected when noise levels exceed predefined thresholds of acceptability or when noise levels increase by an amount exceeding a predefined threshold of change. The noise analysis begins with the identification of existing receptors in the study area based on existing land use. Should this result in the identification of potentially sensitive receptors, a more detailed investigation is required to assess potential noise impacts (the *detailed noise assessment*). Land use categories used in the analysis are defined below (Table 5-29). Qualification of a receptor as sensitive under the FTA standards depends on the distance of the receptor from the proposed facility, and on the type of facility.

Table 5-29
Land Use Categories and Metrics for Transit Noise Impacts

Land Use Category	Noise Metric (dBA)	Description of Land Use Category
1	Outdoor L_{eq}*	A tract of land where quiet is an essential element in their intended purpose. This category includes lands set aside for serenity and quiet, and such land uses as outdoor amphitheaters and concert pavilions, as well as National Historic Landmarks with significant outdoor use.
2	Outdoor L_{dn}	Residences and buildings where people normally sleep. This category includes homes, hospitals and hotels where a nighttime sensitivity to noise is assumed to be of utmost importance.
3	Outdoor L_{eq}*	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.

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

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. Existing land uses in the project vicinity are shown in Figure 16 in Section 5.2 Land Use and Zoning.

The FTA guidance manual contains criteria for noise levels that, if exceeded, may result in adverse community reaction; these stated criteria are used as the reference impact criteria for the Proposed Action. These criteria are a function of the land use of the affected areas near a transit project, and day and night, 1-hour and 8-hour L_{eq} levels, and L_{dn} noise levels.

In the case of construction noise criteria, FTA guidelines identify a set of threshold L_{eq} and L_{dn} levels for various construction activities. In urban areas with very high ambient noise levels (L_{dn} > 65 dB), L_{dn} from construction operations should not exceed existing ambient by 10 dB or more. The noise criteria and the descriptors used to evaluate project noise, including operation and construction noise are dependent on the type of land use in the vicinity of the proposed project.

Table 5-30 shows the FTA construction noise criteria for both the *general noise assessment* and the *detailed noise assessment* conducted in accordance with FTA methodologies. Using FTA guidelines, an airborne noise impact would occur if noise levels during construction exceed the FTA recommended values in Table 5-30. The criteria do not identify park/recreation/museum/church land uses, which are the types of land uses that would be most affected by the Proposed Action. The analysis in this section uses the FTA commercial criteria for these uses, since it is not anticipated that there are sensitive uses at the park, or museum during the night time hours (i.e., between 10 p.m. and 7 a.m.). The FTA residential criterion is also applied to the rectory at the church site because the rectory is a residence for church staff. It should be noted, as reflected in the existing conditions analysis, that the ambient noise levels at these receptors in the study area are relatively high, reflecting their urban/commercial environment.

Table 5-30
FTA Construction Noise Criteria

	One-hour L_{eq} (dBA)		8-hour L_{eq} (dBA)		L_{dn} (dBA)
Land Use	**Day**	**Night**	**Day**	**Night**	**30-day Average**
Residential	90	80	80	70	75(a)
Commercial	100	100	85	85	80(b)
Industrial	100	100	90	90	85(b)

(a) In urban areas with very high ambient noise levels (L_{dn} > 65 dB), L_{dn} from construction operations should not exceed existing ambient + 10 dB.

(b) Twenty-four hour L_{eq}, not L_{dn}.

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

FTA operational noise criteria are based on a comparison of the existing and future outdoor noise levels from the proposed project (see Figure 27). There are two noise criteria curves in the FTA guidelines. The curves are defined in terms of the project noise exposure and the existing noise exposure, respectively. It is the increase in the *overall* noise level, including existing and project-related noise, which forms the basis for the criteria.

The FTA impact criteria for airborne operational noise are based on operational noise generated by the project, termed "project noise exposure." Impacts are classified as "severe impact" or "impact" within each land use category, depending on existing ambient noise levels. A severe impact occurs when a change in noise level would adversely affect a high percentage of people, while an impact is noticeable to most people but not necessarily sufficient to result in strong adverse reactions from the community. With respect to the threshold for this assessment, an airborne noise impact during operations would occur if noise levels during operation fall into the "impact" or "severe impact" areas of the curve represented in Figure 27. For example, based on the operational impact criteria in Figure 27, in the case of Land Use Category 2, if subject to an existing noise exposure of 60 dBA, a project noise exposure of 65 dBA would constitute a "severe impact," while a project noise exposure of 60 dBA in this case 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.

5.11.4.2 Existing Airborne Noise Conditions

A group of four sensitive receptor locations, including a residential building, park, government office/museum, and church with rectory, were selected in the study area. Noise levels at these four sites were measured in November 2003; the locations of the measurement sites are presented in Figure 28. The site locations are as follows:

1. The Ocean Apartments residential building on Battery Place between West Street and Washington Street (address is 17 Battery Place);
2. In the plaza next to Broadway adjacent to Bowling Green Park and the Alexander Hamilton US Custom House, which houses the National Museum of American Indian as well as several government offices;
3. Inside Battery Park at a location near where project construction is anticipated to occur; and
4. At a public open space area, in front of the historical James Watson House (which houses the Rectory and Church of Our Lady of the Rosary) at 7 and 17 State Street across from Peter Minuit Plaza.

The sites were selected based on a field-verified land use map of the project area and anticipated future land use conditions. Generally, the sites were chosen on the basis of proximity to the project corridor, proximity to sensitive land uses (i.e. residential and/or institutional), and potential for increase in future noise levels. Table 5-31 presents the range of the measured L_{eq} noise levels for each site. The measured existing noise levels ranged between 62 and 78 dBA. These levels indicate a relatively noisy urban environment, with streets experiencing a high level of vehicular activity. Predominant noise sources included vehicular traffic, helicopters, emergency vehicles (ambulances, fire trucks, police sirens), garbage trucks, and construction noise (from the Whitehall Ferry Terminal reconstruction project).

Table 5-31
24-Hour Ambient Noise Measurement Results

Site ID	Site Name & Address	Land Use	Date	One-hour L_{eq} (dBA)	24-hour L_{eq} (dBA)	L_{DN} (dBA)
1	17 Battery Place	Residential	10/28/2003	64 – 78	72	78
2	Bowling Green Park/US Custom House	Park/Museum	10/29/2003	63 – 74	68	76
3	Battery Park	Park/Recreation	11/19/2003	62 - 73	66	70
4	7 & 17 State Street	Church/Rectory /Historic Building	11/12/2003	65 - 75	71	75

Source: Louis Berger Group, 2003

5.11.4.3 Analysis Year 2005/2006 (Construction)

No Build Condition
Under the No Build Condition, the South Ferry Terminal Project would not be constructed and airborne noise from construction activities would not occur. The existing station would continue to operate in its current state. Minor maintenance and rehabilitation activities could occur, including typical station and transit infrastructure maintenance and repair. These activities would not have adverse effects on noise conditions in the study area. Under the No Build Condition, the Battery Place component of the Route 9A project would be under construction in the study area in 2005/2006, and the Castle Clinton redevelopment project could conceivably be under construction at this time as well. The construction of these projects would be expected to result in temporary increased noise levels in the study area during 2005/2006.

Proposed Action
Airborne noise from project-related construction activities was estimated using the methodologies set forth in the FTA guidance manual. Both the general noise assessment and detailed noise assessment procedures were followed. 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. The combination of noise from several pieces of equipment operating during the same time period is calculated from addition of the noise level values for each piece of equipment. Cumulative construction-related noise is discussed in Chapter 6 of this EA.

For the general airborne noise assessment, it was assumed that the two noisiest pieces of equipment would operate continuously at the same time. For the detailed airborne noise assessment, 8-hour L_{eq} values and 30-day average L_{dn} (residential sites) or L_{eq} (park and church, etc.) values were calculated assuming all appropriate usage factors for the specified time periods. The noise emission levels and acoustical usage factor, which represents the percent of time that equipment is assumed to be running at full power while working on site, are presented in Table 5-32. Typical peak-hour noise levels from construction operations are presented in Table 5-33. These tables are used to predict construction-related noise impacts.

Construction of the proposed project will be divided into three general segments:

1) Tunnel bellmouth and fan plant;
2) Approach tunnels, including a newly constructed tunnel underneath the eastern edge of Battery Park between the tunnel bellmouth and the new terminal under Peter Minuit Plaza;
3) Terminal, including construction of a two-level station enclosure with tracks and platform at the lower level, and mezzanine and facility space at the upper level.

Table 5-32
Construction Equipment Noise Emission Levels and Acoustical Usage Factors

Equipment Description	Emission Levels at 50 feet (dB)	Acoustic Usage Factor
All other equipment > 5 HP	85	50%
Auger Drill Rig	85	20%
Backhoe	80	40%
Ballast Equalizer	82	40%
Ballast Tamper	83	40%
Bar Bender	80	20%
Blasting	94	1%
Boring Jack Power Unit	80	50%
Chain Saw	85	20%
Clam Shovel	93	20%
Compactor (ground)	82	20%
Compressor (air)	81	40%
Concrete Batch Plant	83	15%
Concrete Mixer Truck	85	40%
Concrete Pump	82	20%
Concrete Saw	90	20%
Concrete Vibrator	76	40%
Crane (mobile or stationary)	83	20%
Derrick Crane	88	20%
Dozer	85	40%
Dump Truck	88	40%
Excavator	85	40%
Flat Bed Truck	84	40%
Front End Loader	85	40%
Generator	81	100%
Grader	85	40%
Horizontal Boring Hydraulic Jack	80	25%
Hydra Break Ram	90	10%
Impact Pile Driver (diesel or drop)	101	20%
Impact Wrench	85	20%
Insitu Soil Sampling Rig	84	20%
Jackhammer	88	20%
Mounted Impact Hammer (hoe ram)	90	20%
Paver	89	50%
Pickup Truck	55	40%
Pneumatic Tools	85	50%
Pumps	76	50%
Rock Drill	98	20%
Roller	74	20%
Saw	76	40%
Scarifier	83	40%
Scraper	89	40%
Shovel	82	20%
Slurry Plant	78	100%
Slurry Trenching Machine	82	50%
Soil Mix Drill Rig	80	50%
Spike Driver	77	20%
Tie Cutter	84	20%
Tie Handler	80	20%
Tie Inserter	85	20%
Tractor	84	40%
Vacuum Street Sweeper	80	10%
Vibratory Concrete Mixer	80	20%
Vibratory Pile Driver	96	20%
Welder	73	40%

Note: Noise emission levels and acoustical usage factors are developed based on information provided in the FTA Transit Noise and Vibration Impact Assessment, 1995 and Parsons Brinckerhoff "Construction Noise Control Program and Mitigation Strategy at the Central Artery/Tunnel Project", 2000. Acoustical Usage Factor represents the percent of time that equipment is assumed to be running at full power while working on site.
Source: FTA Transit Noise and Vibration Impact Assessment, 1995 and Noise Control Engineering, J. 48 (5), Sept-Oct, 2002.

Table 5-33
Typical Noise Levels for Peak Hour Construction

Equipment Utilized	Quantity	Lmax (dBA) at 50 feet	Acoustical Usage Factor	One-Hour L_{eq} (dBA)							
				5ft	20ft	50ft	60ft	100ft	200ft	300ft	400ft
Air Compressor	1	81	40%	97	85	77	75	71	65	61	59
Backhoe	1	80	40%	96	84	76	74	70	64	60	58
Wheel loader	1	85	40%	101	89	81	79	75	69	65	63
Hydraulic truck crane	1	83	20%	96	84	76	74	70	64	60	58
Crawler crane	1	83	20%	96	84	76	74	70	64	60	58
Jack Hammer	1	88	20%	101	89	81	79	75	69	65	63
Water pump	1	76	50%	93	81	73	71	67	61	57	55
Portable generator	1	81	50%	98	86	78	76	72	66	62	60
Pick up truck	1	55	40%	71	59	51	49	45	39	35	33
Blasting	1	94	1%	94	82	74	72	68	62	58	56
Compactor	1	82	20%	95	83	75	73	69	63	59	57
Space heater (propane), Chainsaw (gasoline), Welding machine (diesel)	1	85	50%	102	90	82	80	76	70	66	64

Source: Louis Berger Group, 2003

The subway tunnel, fan plant, and South Ferry Terminal would be constructed mostly by cut and cover excavation method. A concrete retaining wall would be constructed by the slurry trench method of construction. Noise would mostly be attributable to the clam shovel used in slurry construction, pavement breakers, and jack hammers during utility relocations. Noise during excavation would mostly be attributable to cranes and trucks on site.

Tunneling operations will be required to construct facilities beneath the existing 1 9 loop and the 4 5 line. The tunneling operations will be performed from within the existing tunnels and from the surface. Since most of the tunneling operation will be underground, noise and vibration, with the exception of blasting (which is unlikely to be used, but is considered in this analysis to provide a conservative estimate), would not affect sensitive receptors at aboveground locations. However, noise from dump trucks moving to and from the construction site may affect the receptors near the loading area and along the transport routes.

Construction of the terminal, subway structure, and fan plant will be mostly underground and sometimes fully or partially covered. Noise during these stages would be substantially reduced compared to those of earlier construction stages.

Construction noise levels at five locations, including the four receptor measurement sites and Castle Clinton, were calculated based on FTA methodology, and are presented in Tables 5-34 through 5-36. Castle Clinton (Site 3A) has been included in the noise level calculations because it is a National Monument located inside Battery Park. As shown,

construction-related noise impacts would occur at Site 2, Site 3, and Site 4 during the peak 8-hour and peak 30-day construction periods.

Table 5-34
Construction Noise Impacts (Peak 1-Hour)
FTA General Analysis

Site ID	Site Name & Address	Land Use Category	Distance	Criteria Threshold (dBA)	Peak-hour L_{eq} (dBA)	Impact?
1	17 Battery Place	Residential	200	90	76	No
2	Bowling Green Park/US Custom House	Park/Museum	50	100	88	No
3	Battery Park	Park/Recreation	50	100	94	No
3a	Battery Park/ Castle Clinton	Park/National Monument	300	100	78	No
4	7 & 17 State Street	Church/Historic Building	50	100	93	No
		Rectory	50	90	93	Yes

Source: Louis Berger Group, 2004

Table 5-35
Construction Noise Impacts (Peak 8-Hour)
FTA Detailed Analysis

Site ID	Site Name & Address	Land Use Category	Distance	Criteria Threshold (dBA)	Peak 8-hour L_{eq} (dBA)	Impact?
1	17 Battery Place	Residential	200	80	77	No
2	Bowling Green Park/US Custom House	Park/Museum	50	85	90	Yes
3	Battery Park	Park/Recreation	50	85	90	Yes
3a	Battery Park/ Castle Clinton	Park/National Monument	300	85	75	No
4	7 & 17 State Street	Church/Historic Building	50	85	92	Yes
		Rectory	50	80	92	

Source: Louis Berger Group, 2004

Table 5-36
Construction Noise Impacts (Peak 30-Days)
FTA Detailed Analysis

Site ID	Site Name & Address	Land Use Category	Distance	Criteria Threshold (dBA)*	Peak 30-days L_{dn} /L_{eq} (dBA)	Impact?
1	17 Battery Place	Residential	200	88	78	No
2	Bowling Green Park/US Custom House	Park/Museum	50	78	87	Yes
3	Battery Park	Park/Recreation	50	76	88	Yes
3a	Battery Park/ Castle Clinton	Park/National Monument	300	76	75	No
4	7 & 17 State Street	Church/Historic Building Rectory	50 50	81 85	89 91	Yes

*Criteria is 10 dB above ambient measured at each site, if ambient exceeds 65 dBA.
Source: Louis Berger Group, 2004

Noise level histograms were calculated at these five receptors in the project area based on detailed construction plans and schedules developed for the proposed project. The peak one-hour L_{eq}, eight-hour L_{eq}, and 30-day average L_{dn}/L_{eq} are presented in the histogram for every quarter between first quarter 2004 and fourth quarter 2006, for each of the monitoring sites. The results are presented in Tables 5-37 through 5-41 (Source: Louis Berger Group, 2004). It should be noted that the commercial noise criteria have been applied to Sites 2 through 4, since FTA guidance does not include construction criteria thresholds for open space or institutional receptors. In addition, the FTA residential threshold was also applied to Site 4, since it is also used as a rectory.

Predicted noise levels at Site 1 (a residential site) would not exceed any of the FTA construction noise threshold criteria during any time of the construction period. Predicted construction noise levels would exceed FTA threshold criteria at Site 2 (Bowling Green Park/U.S. Custom House) in the second and third quarters of 2006. Construction noise levels would not exceed FTA threshold criteria during any other part of the construction period at this site. Construction noise levels at Site 3 (Battery Park) would exceed FTA threshold criteria in the third and fourth quarters of 2004, as well as first and second quarters of 2005. Construction noise levels at Castle Clinton (Site 3A) would not exceed FTA criteria during any part of the construction period due to larger distances between the construction activities and this site. Construction noise levels at Site 4 (church and rectory) would exceed FTA threshold criteria (either based on commercial or residential land use) for most of the construction period from first quarter 2005 through third quarter 2006.

It should be noted that individuals using the outdoor sensitive receptor sites (i.e., parks) do not experience the relatively prolonged noise exposure, specifically eight-hour or 30-

day exposure, reflected in the FTA methodology. In addition, noise levels at the U.S. Custom House (Site 2) and the Church of Our Lady of the Rosary (Site 4), represent predicted outdoor noise levels. Both of these buildings are of masonry construction, which would provide typically 40 dBA or more noise attenuation to the interior of the buildings. Doors and windows typically provide less noise attenuation. The typical noise attenuation provided by single-glazed windows is up to approximately 25 dB if they are closed. Double-glazed windows typically provide up to 35 dB noise attenuation. Both the U.S. Custom House and the church/rectory have central HVAC systems. There are no windows on the front of the church facing State Street. It is reasonable to assume, therefore, that indoor noise levels at these two receptors would be substantially reduced (25 dBA or more) due to structural attenuation of the construction noise levels, and that no adverse noise impacts would result. For example, the exterior construction-noise level at the church/rectory is projected to be 91 dBA (L_{dn}). Assuming a minimum 25 dBA reduction from structural attenuation, the indoor noise level would be 66 dBA.

Table 5-37
Projected Construction Noise Levels at Site 1
17 Battery Place - Residential

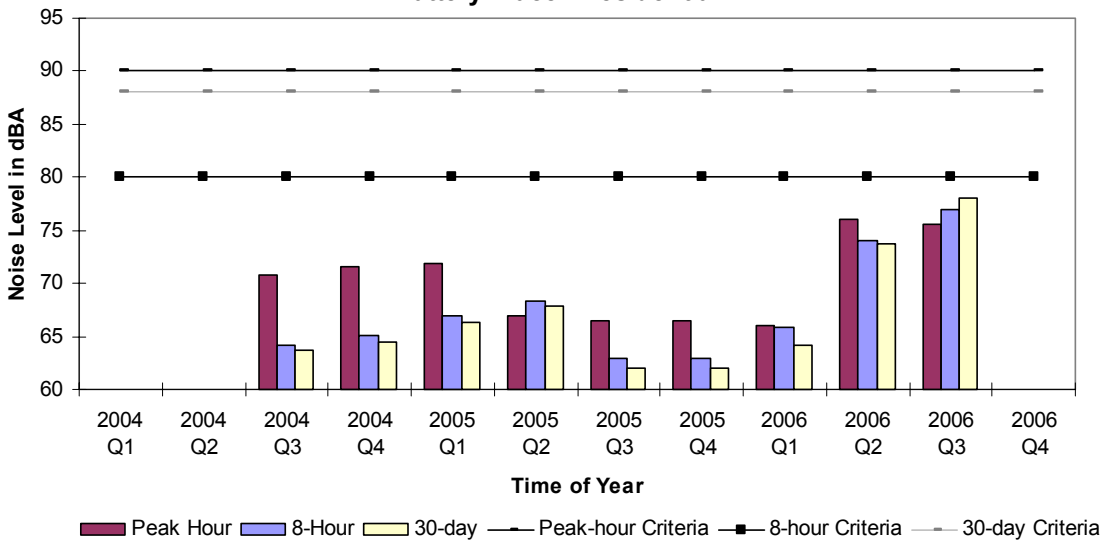


Table 5-38
Projected Construction Noise Levels at Site 2
Bowling Green Park/US Custom House

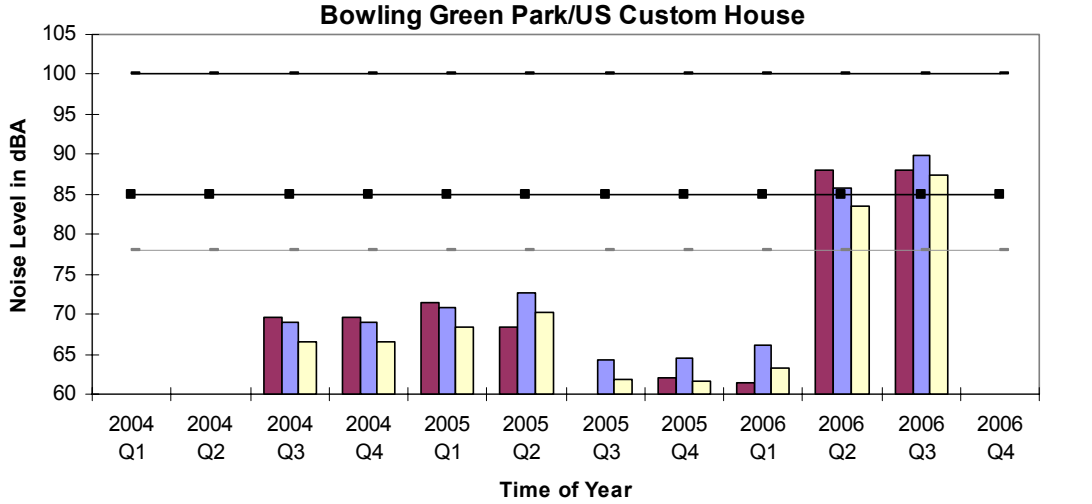


Table 5-39
Projected Construction Noise Levels at Site 3
Battery Park

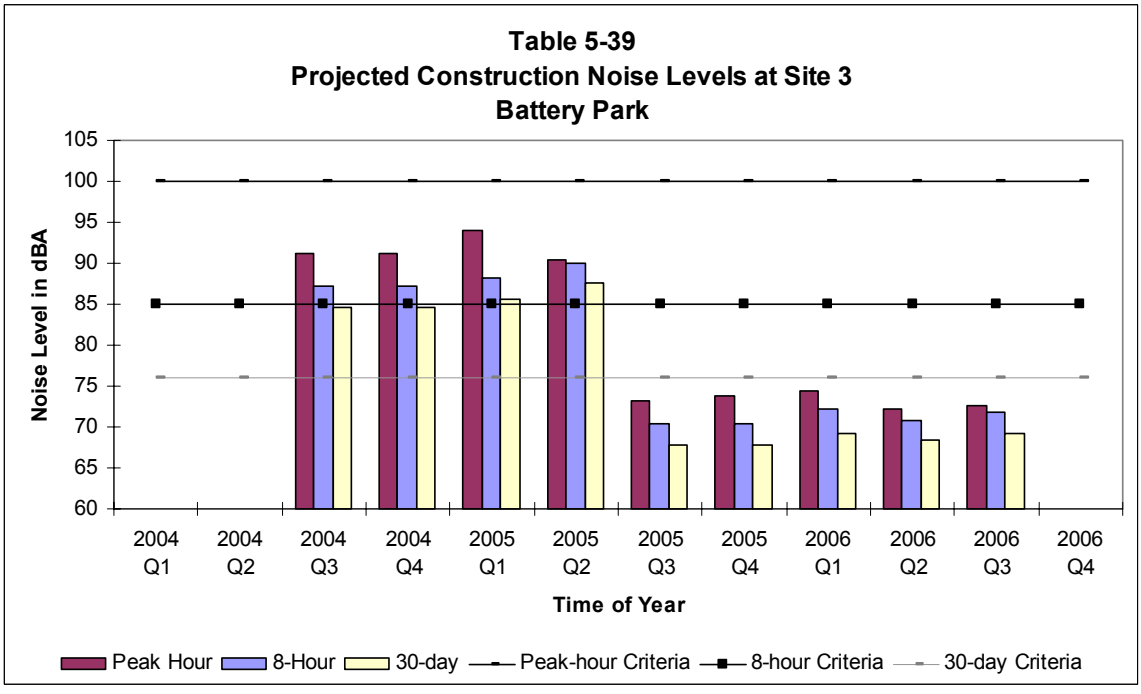


Table 5-40
Projected Construction Noise Levels at Site 3A
Castle Clinton

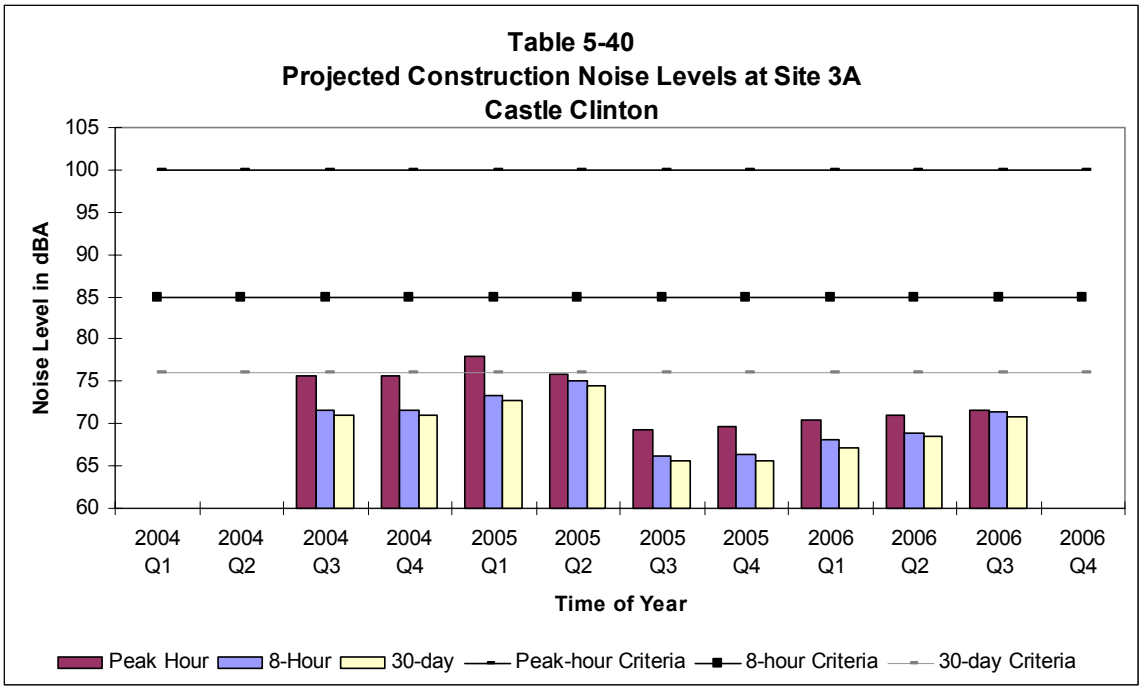


Table 5-41
Projected Construction Noise Levels at Site 4
Church
Based on Threshold Criteria for Commercial Uses

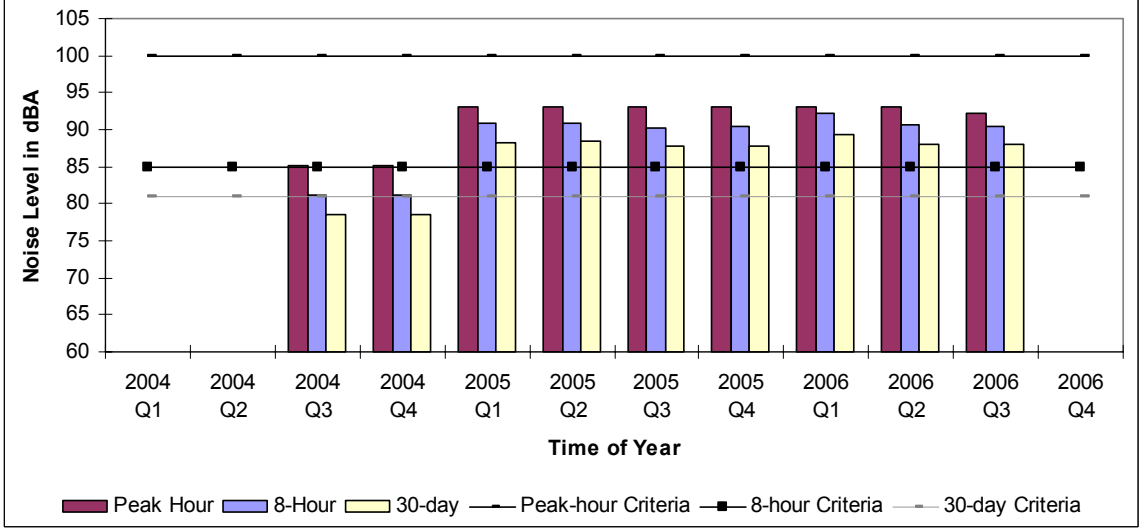
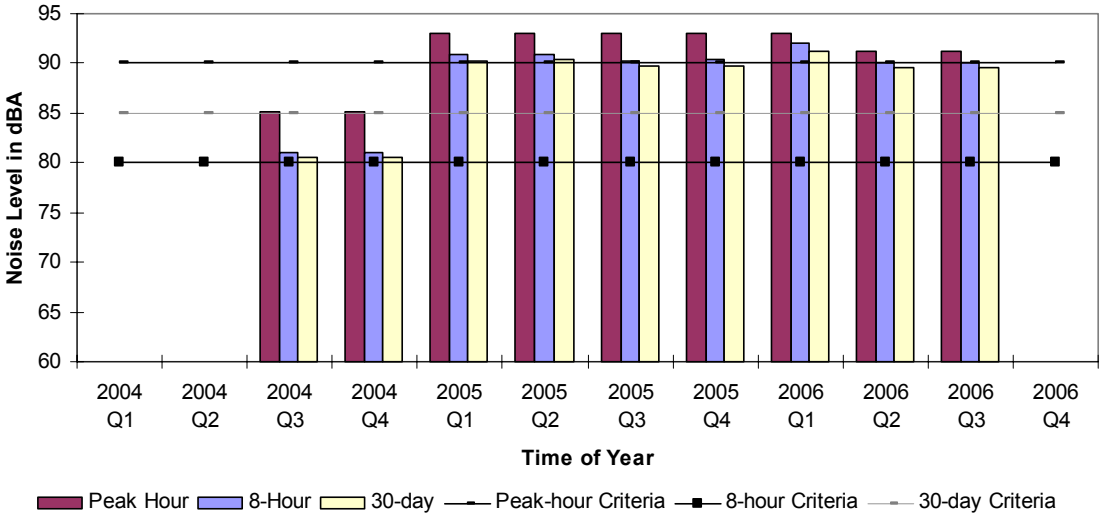


Table 5-41a
Projected Construction Noise Levels at Site 4
Rectory - Residential
Based on Threshold Criteria for Residential Uses



The South Ferry Terminal Project is located within a dense metropolitan area in close proximity to some sensitive land uses. These receptors would be located at relatively close distances to the proposed construction activities and, therefore, would experience elevated construction noise levels. Despite these constraints, MTA/NYCT will incorporate the following EPCs into the project design and construction to reduce and, where practicable, eliminate adverse noise impacts due to construction in accordance with FTA criteria. These EPCs will be incorporated into the project Construction Environmental Protection Plan (CEPP), and include:

- Scheduling individual project construction activities to avoid or minimize adverse noise impacts.
- Coordination with projects under construction in adjacent and nearby locations to avoid or minimize noise impacts.
- Preparation of contingency measures in the event established limits are exceeded.

To ensure that construction noise levels remain below FTA thresholds, the following specifications, among others, will be included in the construction contract for the South Ferry Terminal Project:

- Measure additional sound levels for noise due to construction at the street line of the structure adjacent to and along the area of the Contractor's operations and plant. Sound levels measured at the street line shall not exceed the following:
    - Residential structures:

        - 75 dBA: Daily, except Saturday and Sunday, 7:00 a.m. to 11:00 p.m.
        - 60 dBA: At all other times.
    - Business-Commercial structures:
        - Daily, including Saturday and Sunday, all hours, a maximum of 85 dBA, unless otherwise permitted by the Engineer.
    - Factory-Commercial structures:
        - Daily, including Saturday and Sunday, all hours, a maximum of 90 dBA.

- Provide equipment and sound-deadening devices and take such noise abatement measures necessary to comply with the requirements of the Contract, consisting of, for example, the following:
    - Shields or other physical barriers to restrict the transmission of noise.
    - Soundproof housings or enclosures for noise producing machinery.
    - Use of electrically operated hoists and compressor plants, unless otherwise permitted by the Engineer.
    - Silencers on air intakes of equipment.
    - Maximum sized intake and exhaust mufflers on internal combustion engines.
    - Gears on machinery designed to reduce noise to a minimum.
    - Line hoppers and storage bins with sound deadening material.
    - The prohibition of the use of air or gasoline driven saws, unless otherwise permitted by the Engineer.
    - Conducting the operation of dumping rock or other materials and carrying it away in trucks so that noise is kept to a minimum.
    - Routing of construction equipment and vehicles carrying rock, concrete or other materials over streets that will cause the least disturbance to residents in the vicinity of the work.

MTA/NYCT will also coordinate construction activities with special events that may be scheduled at Battery Park, Bowling Green Park, the U.S. Custom House, and the Church of Our Lady of the Rosary. In addition, a complaint response procedure would be implemented to promptly address community concerns and implement additional control methods where necessary.

5.11.4.4 Analysis Year 2008 (Initial Operation)

No Build Condition

Under the No Build Condition, the South Ferry Terminal Project would not be constructed or operational in 2008. The existing station would be maintained and operated in its current state. MTA/NYCT may build the fan plant in the No Build Condition at a nearby but undetermined location. As indicated in Chapter 1, the existing loop configuration of the tracks at the South Ferry Station result in loud wheel grinding

as the subway cars enter and exit the station. This noise situation would continue under the No Build Condition, and would affect transit customers on the platform. Minor maintenance and rehabilitation activities could occur, including typical station and transit infrastructure and repair. These activities would not have adverse impacts on noise conditions in the study area.

Proposed Action

Based on FTA guidelines, a screening analysis was performed for the Proposed Action to determine if there would be operational impacts to nearby receptors based on their distance from transit facilities. The screening distances are presented in the Table 5-42. If receptors are located within the distances noted, then further analysis is required. Table 5-43 shows the noise receptor distances and the screening distance results; the distances shown are to the nearest ventilation shaft or grate, as these are the only source of operational noise associated with the project. As a result of the screening analysis, it was identified that receptors at Sites 2 and 4 were within the FTA screening distances defined in Table 5-42.

The proposed terminal, like the existing station, would be located underground. As stated in the FTA's assessment guidelines, subway noise is generally not considered an issue for surrounding sensitive receptors because the ground acts as a barrier to noise transmission. The subway lines and terminal are underground and fully covered, with the exception of ventilation gratings and shafts. As a result, the noise from underground fixed-rail operations can propagate through these openings to reach the surface.

The South Ferry Terminal would be mechanically ventilated via a vent shaft in Peter Minuit Plaza. The approach tunnel and bellmouth would be ventilated by a street-level vent grate in Battery Place near State Street. Fans would be located below the surface. The design of the fan plants and ventilation shafts will consider all necessary measures to reduce noise emission from the equipment, so that Sites 2 and 4 would not be affected by this noise source. In addition, noise from this equipment is expected to be masked by the background noise from street traffic and other background noise sources. Therefore, noise impacts from operation of the proposed terminal are not expected to occur.

Because the project involves replacement of an existing subway station with a new terminal, and because these facilities are located below ground, the project would not result in an increase in vehicular traffic to surface streets. Therefore, increased traffic-related noise would not result from the project.

Table 5-42
FTA Screening Distances for Operational Noise Assessments

Type of Project		Screening Distance*(ft)	
		Unobstructed	Intervening Buildings
Fixed Guideway Systems:			
Commuter Rail Mainline		750	375
Commuter Rail Station		450	225
Rail Transit Guideway		700	350
Rail Transit Station		200	100
Access Roads		100	50
Low-and Intermediate-Capacity Transit	Steel Wheel	200	100
	Rubber Tire	125	75
	Monorail	300	150
Yards and Shops		2000	1000
Parking Facilities		150	75
Access Roads		100	50
Ancillary Facilities			
Ventilation Shafts		200	100
Power Substations		250	125
Bus Systems:			
Busway		500	250
Bus Facilities	Access Roads	100	50
	Transit Mall	250	125
	Transit Center	300	150
	Storage & Maintenance	1000	500
	Park & Ride Lots	300	150

* Measured from centerline of guideway/roadway for mobile sources; from center of noise-generating activity for stationary sources.

Source: Federal Transit Administration, Transit Noise and Vibration Assessment, April 1995.

Table 5-43
Summary of Screening Analysis

Receptor	Location	Land Use Category	Approximate Distance to Ventilation Shaft (feet)	Obstructed (Yes/No)	Screening Distance for Ventilation Shafts (feet)	Within the screening distance (Yes/No)
1	17 Battery Place	Residential	400	No	200	No
2	Bowling Green Park/US Custom House	Park/Museum	150	No	200	Yes
3	Battery Park	Park/Recreation	400	No	200	No
3a	Battery Park/ Castle Clinton	Park/National Monument	600	No	200	No
4	7 & 17 State Street	Church/Rectory/ Historic Building	150	No	200	Yes

Source: Louis Berger Group, December 2003

5.11.4.5 Analysis Year 2025 (Long-Term Operation)

No Build Condition
Under the No Build Condition, the South Ferry Terminal Project would not be constructed or operational in 2025. The existing station would be maintained and operated in its current state. MTA/NYCT may build the fan plant in the No Built Condition at a nearby but undetermined location. As indicated in Chapter 1, the existing loop configuration of the tracks at the South Ferry Station result in loud wheel grinding as the subway cars enter and exit the station. This noise situation would continue under the No Build Condition, and would affect transit customers on the platform. Minor maintenance and rehabilitation activities could occur, including typical station and transit infrastructure and repair. These activities would not have adverse impacts on noise conditions in the study area.

Proposed Action
During operation in 2025, the proposed terminal, like the existing station, would be located underground. As stated in the FTA's assessment guidelines, subway noise is generally not considered an issue for surrounding sensitive receptors because the ground acts as a barrier to noise transmission. The subway lines and terminal are underground and fully covered, with the exception of ventilation gratings and shafts. As a result, the noise from underground fixed-rail operations can propagate through these openings to reach the surface.

Similar to operations in 2008, the South Ferry Terminal would be mechanically ventilated via vent shafts in 2025. Noise from this equipment is expected to be masked by the background noise from street traffic and other background noise sources. Therefore, adverse noise impacts from long-term operation of the proposed terminal are not expected to occur.

5.11.5 Vibration and Ground-Borne Noise

5.11.5.1 Vibration Characteristics

Construction activities and subway operations have the potential for producing high vibration levels that may be perceptible or disruptive. In the case of construction activities, architectural and structural damage could also occur if construction is not properly managed. Even where vibration levels are low or imperceptible, vibrations can nonetheless produce ground-borne noise. Ground vibrations from most construction activities rarely reach the levels that can damage structures, but can achieve the audible and sensible ranges in buildings close to the site. However, some heavy construction activities, such as blasting, pile driving, clam shovel drops, pavement breakers, etc., can cause substantial damage to nearby buildings at closer distances depending on geological conditions.

Although the perceptibility threshold for ground-borne vibration is about 65 vibration decibels (VdB), human response to vibration is not usually substantial unless the

vibration exceeds 70 VdB. In terms of vibration during construction, vibration is described in Peak Particle Velocity (PPV) based on FTA guidelines. PPV relates to the maximum instantaneous peak of the vibration signal, and is often used in measuring the magnitude of vibration. 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 typically sensitive to vibration.

5.11.5.2 Vibration and Ground-Borne Noise Criteria

The FTA's *Transit Noise and Vibration Impact Assessment* guidelines include a set of threshold criteria for ground-borne vibration and noise during transit operations. Vibration levels for typical human and structural responses and sources are shown in Table 5-44. The threshold criteria are based on past experiences with human sensitivity and community responses to ground-borne vibration and noise. In terms of vibration during construction, which is more relevant for the South Ferry Terminal Project given that operational (subway-related) vibration is not anticipated to change from the existing condition, FTA defines a set of damage threshold criteria in Peak Particle Velocity (PPV) for fragile and extremely fragile buildings. PPV relates to the maximum instantaneous peak of the vibration signal, and is often used in measuring the magnitude of vibration.

Table 5-44
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. Approximate threshold for human perception of vibration.	60	Bus or truck, typical.
	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 5-45 and are used to determine whether the project would result in adverse vibration and ground-borne noise impacts.

Table 5-45
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[o]	Infrequent Events[1]	Frequent Events[o]	Infrequent Events[1]
1	65 VdB[2]	65 VdB[2]	See note[3]	See note[3]
2	72 VdB	80 VdB	35 dBA	43 dBA
3	75 VdB	83 VdB	40 dBA	48 dBA

[o] "Frequent events" are defined as those with more than 70 vibration events per day. Most rapid transit projects fall into this category.

[1] "Infrequent events" are defined as those with fewer than 70 vibration events per day. This category includes most commuter rail systems.

[2] 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.

[3] 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.

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

- Vibration Category 1: High Sensitivity. Buildings are considered to have high sensitivity when low ambient vibration is essential for the operations within the building (e.g. vibration-sensitive research, hospitals, etc.) This sensitivity may be well below levels associated with human annoyance. The criterion limit is based on levels that are acceptable for most moderately sensitive equipment such as optical microscopes. Ensuring lower vibration levels in a building often requires special design of the HVAC systems and stiffened floors. Although the FTA methodology does not classify designated historic structures in this category, they are considered sensitive for the purposes of this analysis. Historic buildings are potentially sensitive to architectural damage from frequent vibration levels higher than 65 VdB if construction is not properly managed. These impacts can adversely affect a building's historic features.

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

- Vibration Category 3: Institutional. This category includes schools, churches, other institutions, and quiet offices that do not have vibration-sensitive equipment, but still have the potential for activity interference.

5.11.5.3 Existing Vibration and Ground-borne Noise Conditions

The primary sources for potential vibration and ground-borne noise in the project area are the existing underground 1 9 and 4 5 subway facilities, the Battery Park Underpass, and the Brooklyn Battery Tunnel which runs underneath Battery Park west of the 1 9

subway tracks. Field observations made during the ambient noise measurements indicate that none of these existing facilities produce in any perceptible vibration and ground-borne noise in the project area or to nearby structures.

5.11.5.4 Analysis Year 2005/2006 (Construction)

Potential vibration and ground-borne noise from the construction of the South Ferry Terminal Project was assessed based on FTA guidelines and criteria by reviewing project construction plans and schedules as described in Chapter 4: Construction Methods and Activities. The construction information used in assessing ground-borne noise and vibration include time and duration of construction activities, equipment types, and equipment usage cycle. Typical vibration emission levels from construction equipment and stationary sources were utilized for the evaluation of potential impacts at receptor locations in the study area.

No Build Condition
Under the No Build Condition, the South Ferry Terminal Project would not be constructed, and vibration and ground-borne noise from construction activities would not occur. The existing station would continue to operate in its current state. Minor maintenance and rehabilitation activities could occur, including typical station and transit infrastructure maintenance and repair. These activities would not have adverse effects on vibration and ground-borne conditions in the study area. Under the No Build Condition, the Battery Place component of the Route 9A project would be under construction in the study area in 2005/2006, and the Castle Clinton redevelopment project could conceivably be under construction at this time as well. The construction of these projects could result in temporary vibration and ground-borne noise in the study area during 2005/2006.

Proposed Action
Construction of the Proposed Action will include activities in which vibration is an inherent part of the work. Examples potentially include the use of impact tools such as pile driving, jackhammers, soil compactors and rock blasting. Typical vibration levels for construction equipment at various distances are listed in Table 5-46. In general, the highest vibration levels are generated by the pile driving operations. The clam shovel used in slurry wall construction will also result in some impacts at a relative close distance, e.g. 25 feet.

Table 5-46
Vibration Levels for Construction Equipment

Equipment		PPV (ips)							
		5 ft	10 ft	25 ft	50 ft	100 ft	150 ft	200 ft	300 ft
Pile Driver (impact)	upper range	16.97	6.000	1.518	0.537	0.190	0.103	0.067	0.037
	typical	7.200	2.546	0.644	0.228	0.081	0.044	0.028	0.015
Pile Driver (sonic)	upper range	8.206	2.901	0.734	0.260	0.092	0.050	0.032	0.018
	typical	1.901	0.672	0.170	0.060	0.021	0.012	0.008	0.004
Clam shovel drop (slurry wall)		2.258	0.798	0.202	0.071	0.025	0.014	0.009	0.005
Hydromill (slurry mill)	in soil	0.089	0.032	0.008	0.003	0.001	0.001	0.000	0.000
	in rock	0.190	0.067	0.017	0.006	0.002	0.001	0.001	0.000
Large bulldozer		0.995	0.352	0.089	0.031	0.011	0.006	0.004	0.002
Caisson drilling		0.995	0.352	0.089	0.031	0.011	0.006	0.004	0.002
Loaded trucks		0.850	0.300	0.076	0.027	0.010	0.005	0.003	0.002
Jackhammer		0.391	0.138	0.035	0.012	0.004	0.002	0.002	0.001
Small bulldozer		0.034	0.012	0.003	0.001	0.000	0.000	0.000	0.000

Source: FTA; modified by Louis Berger Group, 2003

Recent research indicates that structures respond differently to vibration depending upon their construction and upon the frequency of the blast vibration. The recognized threshold for vibration damage criterion is 0.50 ips for historic buildings, 0.20 ips for fragile historic buildings, or 0.12 ips for extremely fragile historic buildings, according to FTA guidelines. The status of historic buildings in the study area with respect to level of fragility would be determined as engineering for the South Ferry Terminal Project advances; however, for the purposes of this EA, the most conservative criterion has been applied in this analysis. Table 5-47 presents the predicted vibration levels at receptor sites that may be affected by the Proposed Action. As shown, the estimated vibration levels from various types of project-related construction equipment at Castle Clinton, which is approximately 300 feet or more from closest construction activities, vary between 0.0 and 0.037 ips. These levels are below the threshold of 0.12 ips criterion for extremely fragile historic buildings. The International Mercantile Marine Building at One Broadway would experience a maximum vibration PPV of 0.798 ips during construction of the tunnel bellmouth. This level would exceed the FTA vibration criterion of 0.12 ips for extremely fragile historic buildings or fragile historic buildings.

Table 5-47
Predicted Construction Vibration Levels in PPV

Site ID	Site Name & Address	Land Use Category	Distance In feet	Criteria Threshold PPV (ips)	Maximum PPV during Slurry Wall Construction (ips)	Vibration Impact?
1	17 Battery Place	Residential	200	0.50	0.009	No
2	Bowling Green Park/US Custom House	Park/Museum/ Historic Building	50	0.12	0.071	No
2a	One Broadway	Historic Building	10	0.12	0.798	Yes
3a	Battery Park/ Castle Clinton	Park/National Monument	300	0.12	0.005	No
4	7 & 17 State Street	Church/Rectory/ Historic Building	50	0.12	0.071	No

Source: Louis Berger Group, 2003

The vibration levels at Castle Clinton as well as other receptor sites from blast operations could exceed the above-mentioned criterion for fragile historic buildings, if blasting is used for excavation purposes. Therefore, MTA/NYCT would design blast operations, or not use them at all, to minimize or avoid vibration impacts to historic structures.

Furthermore, monitoring of construction-related vibration at adjacent historic structures will be incorporated into the Construction Environmental Protection Plan (CEPP) that will be prepared for the project. MTA/NYCT will monitor vibration at these structures if high vibration equipment/techniques, e.g. clam shell drop, blasting, etc., are to be used in proximity to one of these structures. The CEPP would include initial, interim, and post-construction surveys of the structures with ongoing vibration monitoring. In addition, a complaint response procedure would be implemented to promptly address community concerns and implement additional control methods where necessary. 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. The vibration control and monitoring plan for the One Broadway Building is referenced in the Programmatic Agreement (see Appendix B) among the MTA/NYCT, the New York State Office of Parks, Recreation and Preservation (NYSOPRHP), and FTA.

In addition to the measures identified above, MTA/NYCT would voluntarily refer, as guidance, to the special measures set forth by the NYSOPRHP and 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, MTA/NYCT, through its construction contractors, would implement special vibration protection measures. These measures, to be included as part of the CEPP, could include the following:

- Inspect and report on pre-construction foundation and structural conditions of any historic resources.

- Establish a vibration monitoring program to measure vertical and lateral movement and vibration to the historic structures within 150 feet of construction activities. 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 Officer.
- 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 the 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.

5.11.5.5 Analysis Year 2008 (Initial Operation)

No Build Condition
Under the No Build Condition, the South Ferry Terminal Project would not be constructed or operational in 2008. The existing station would be maintained and operated in its current state. MTA/NYCT may build the fan plant in the No Build Condition at a nearby but undetermined location. Minor maintenance and rehabilitation activities could occur, including typical station and transit infrastructure and repair. These activities would not have adverse impacts on vibration or ground-borne noise conditions in the study area.

Proposed Action
Ground-borne vibration transmitted from transit operations to adjacent buildings and open spaces, in addition to radiated noise levels, can be a source of community complaints. The most likely source of vibration from operation of the subway trains is the wheel/rail interaction, which generates vibration forces traveling via the track supporting foundations into the soil and rock beneath. The amount of energy generated and transmitted is dependent upon factors such as the smoothness of the wheels and rails, and the resonant frequencies of the vehicle suspension system and track support system. For buildings, the maximum vibration energy amplitudes of floors and walls usually occur at the resonant frequencies of these building components. Vibration levels in buildings located adjacent to transit systems are usually not a problem unless the track and foundation are structurally attached to and/or located very close to the building.

The Proposed Action involves the construction of a new subway terminal, approach tunnel, tunnel bellmouth, and fan plant. The proposed approach tunnel would be placed underneath the existing South Ferry loop and would be further away from buildings on Broadway and State Street than the existing subway tunnel exiting the loop station. The track crossover would be approximately 200 feet from State Street, and 400 feet or more from any identified historic structures. Vibration and ground-borne noise generated at the crossover would be negligible at such distances.

Subway trains may approach the new terminal at a slightly faster speed than they presently do since the approach would be straighter than the existing loop configuration, but this design would not be expected to have an adverse effect on vibration or ground-borne noise. Site 4 (church and rectory) is located near the proposed terminal; however, since approaching and departing trains would be moving slowly in this location, adverse vibration and ground-borne noise impacts would not be expected at this site. In addition, the existing 1 9 loop tunnel and station have been in operation for approximately 100 years in this location, without visual or structural degradation of nearby structures. The existing 1 9 tunnel would be in between Site 4 and the new terminal, and the invert of the new terminal would be on rock approximately 50 feet below ground surface. For these reasons, the Proposed Action is not anticipated to result in an adverse change in vibration levels at adjacent sensitive receptors. The continued use of the existing South Ferry Station and approach tracks would not result in any additional vibration and ground-borne noise impacts in the project area. Consequently, it is reasonable to assume that there would not be any future increase in vibration and ground-borne noise impacts as a result of new terminal and approach track operations.

5.11.5.6 Analysis Year 2025 (Long-Term Operation)

No Build Condition
Under the No Build Condition, the South Ferry Terminal Project would not be constructed or operational in 2025. The existing station would be maintained and operated in its current state. MTA/NYCT may build the fan plant in the No Build Condition at a nearby but undetermined location. Minor maintenance and rehabilitation activities could occur, including typical station and transit infrastructure and repair. These activities would not have adverse impacts on vibration or ground-borne noise conditions in the study area.

Proposed Action
The South Ferry Terminal would be operational in 2025. As described for the 2008 Analysis Year above, it is not anticipated that there would be any future increase in vibration and ground-borne noise impacts as a result of new terminal and approach track operations.