South Station Expansion Project

Appendix 11 - Noise and Vibration Technical Report

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massDOT
Massachusetts Department of Transportation

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1. Introduction

The Massachusetts Department of Transportation (MassDOT), the Massachusetts Bay Transportation Authority (MBTA), and the National Railroad Passenger Corporation (Amtrak) have for decades identified the expansion of rail capacity at Boston South Station as a crucial transportation need, one that has been articulated in multiple local, regional, state, and Northeast Corridor (NEC)-wide planning documents.[1] In cooperation with the Federal Railroad Administration (FRA), Amtrak, and the MBTA, MassDOT is now pursuing the expansion of South Station to support existing NEC and commuter rail services and to provide for future Amtrak and MBTA service expansions. The current track capacity, layout, and operations of South Station limit the ability to accommodate projected future expanded services. In addition to expanding South Station terminal facilities, the South Station Expansion (SSX) project will also identify a solution to address existing and future intercity and commuter rail service layover needs. The SSX project includes planning, environmental reviews, and preliminary engineering for the five primary elements of the project:

1. **Expand the South Station terminal facilities**, including the addition of up to seven tracks and four platforms and construction of a new passenger concourse and other amenities.
2. **Acquire and demolish the U.S. Postal Service (USPS) General Mail Facility** located on Dorchester Avenue adjacent to South Station, which would provide an approximate 14-acre site on which to expand South Station. (Note that the relocation of the USPS facility will be the subject of a separate environmental review process by others.) Dorchester Avenue would be restored for public and station access.
3. **Create an extension of the Harborwalk along reopened Dorchester Avenue.**
4. **Provide for the possibility of future joint public/private development** adjacent to and over an expanded South Station.
5. **Provide adequate rail vehicle layover space** to address existing and future intercity and commuter rail service needs.

This Noise and Vibration Technical Report has been prepared in support of the Draft Environmental Impact Report (Draft EIR) and Environmental Assessment (EA) for the SSX project, in accordance with the Certificate of the Secretary of the Office of Energy and Environmental Affairs (EEA) on the Environmental Notification Form (ENF) for the SSX project (April 19, 2013), the Massachusetts Environmental Policy Act (MEPA) regulations, 301 CMR 11.00 (revised, May 10, 2013), and the FRA's Procedures for Considering Environmental Impacts, 64 Federal Register (FR) 101 (26 May 1999), pp. 28545-28556.

2. Summary of Findings

The Federal Transit Administration (FTA) *Transit Noise and Vibration Impact Assessment* guidance manual[2] sets forth the basic concepts, methods and procedures for evaluating the extent and severity of

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[1] Documents citing the need for an expanded South Station include: *Critical Infrastructure Needs on the Northeast Corridor* (2013), *The Northeast Corridor Infrastructure Master Plan* (2010); *The Amtrak Vision for High-Speed Rail in the Northeast Corridor* (2010), *A Vision for the Northeast Corridor* (2012), the Massachusetts Department of Transportation *Rail Plan* (2010), the Massachusetts Department of Transportation *Freight Plan* (2010), and the two most recent long range transportation plans of the Boston Region Metropolitan Planning Organization (2007, 2011).

[2] Federal Transit Administration. *Transit Noise and Vibration Impact Assessment Report No. FTA-VA-90-1003-06.* May 2006.

noise and vibration impacts from transit projects. The FTA guidelines assess noise impacts based on the selected land-use's sensitivity to noise. For example, the day-night noise level (or Ldn) is the noise metric used to assess project impacts at residential receptors while the hourly Leq noise level is used to assess impacts at non-residential and institutional receptors. The Leq represents a level of constant noise that has the same acoustic energy as the fluctuating noise level measured over a given time period such as an hour. The Ldn level represents the average noise level measured over a 24-hour period with a 10-dBA penalty added to the nighttime hours (10 p.m. to 7 a.m.) to account for people's increased sensitivity to noise while they are trying to sleep.

For each identified noise-sensitive receptor location, noise levels under the future year 2035 Build Alternatives were compared with the FTA noise criteria to determine impact. The train operations at South Station would be the same for all three 2035 Build Alternatives: Alternative 1 - Transportation Improvements Only, Alternative 2 - Joint/Private Development Minimum Build, and Alternative 3 - Joint/Private Development Maximum Build. As a result, the train operations noise modeling analysis results that were developed for Alternative 1 were also used in the noise assessment for Alternatives 2 and 3.

The results of the noise and vibration assessment for the SSX project indicate that noise impacts from Alternative 1 are expected to occur at noise sensitive receptor locations across the Fort Point Channel due to the removal of the USPS facility along Dorchester Avenue. The USPS facility acts as an effective noise barrier so that the noise from the existing train operations at South Station does not impact the receptors across the Fort Point Channel. With the removal of the USPS facility, there would be a direct sound propagation path across the Fort Point Channel. As a result, the 24-hour Ldn noise level would exceed the FTA moderate impact criteria. In addition, the peak-hour Leq noise level at the building at 245 Summer Street would also exceed the FTA's moderate impact criterion. For Alternative 2 and Alternative 3, the development along Dorchester Avenue and the air rights over South Station would entirely enclose the station area and, thereby, eliminate the noise impact at the building at 245 Summer Street and across the Fort Point Channel.

Because of the slow speed of the trains entering and leaving South Station, the vibration levels from the trains are not expected to exceed the FTA criterion for human annoyance. The vibration levels, however, would be perceptible along the platforms when standing next to the locomotives.

In any alternative, the trains at South Station would require midday layover at up to three proposed locations: Widett Circle, Beacon Park Yard, and Readville - Yard 2. At the Beacon Park Yard layover facility, the midday peak activity hour Leq noise level would exceed the FTA severe impact criterion at the residential receptors along Wadsworth Street and Pratt Street. At the Readville - Yard 2 layover facility, the midday peak activity hour Leq noise level would exceed the FTA moderate impact criterion at the nearby residential receptors along Wolcott Street and Riley Road. These impacts would require mitigation. There would be no noise impact from the train operations at the Widett Circle layover facility, because the nearest noise sensitive receptors along Albany Street are approximately 1,300 feet away.

Vibration levels from the track switches and crossovers at the Beacon Park Yard would exceed the FTA annoyance criterion of 72 VdB at residential receptors located within 130 feet of the switch. At Widett Circle and Readville – Yard 2, residential receptors are not located within 130 feet of the switches.

Although construction noise levels from the SSX project are not expected to exceed the FTA construction noise limits, they are expected to exceed the more stringent City of Boston construction noise limits. The building at 245 Summer Street and the headhouse building at existing South Station would be impacted by construction noise. Vibration levels generated by the construction equipment proposed for this project would not result in structural damage to nearby buildings, but could exceed the FTA human annoyance criterion.

3. Regulatory Context

The FTA has developed guidelines[3] that describe the methodology for preparing the noise and vibration analyses for transit projects. The FRA adheres to the methodology described in the FTA guidance manual for assessing noise and vibration impacts on FRA funded projects. The FTA guidance manual sets forth the basic concepts, methodology, impact criteria, and procedures for evaluating the extent and severity of the noise and vibration impacts from transit projects.

4. Methodology

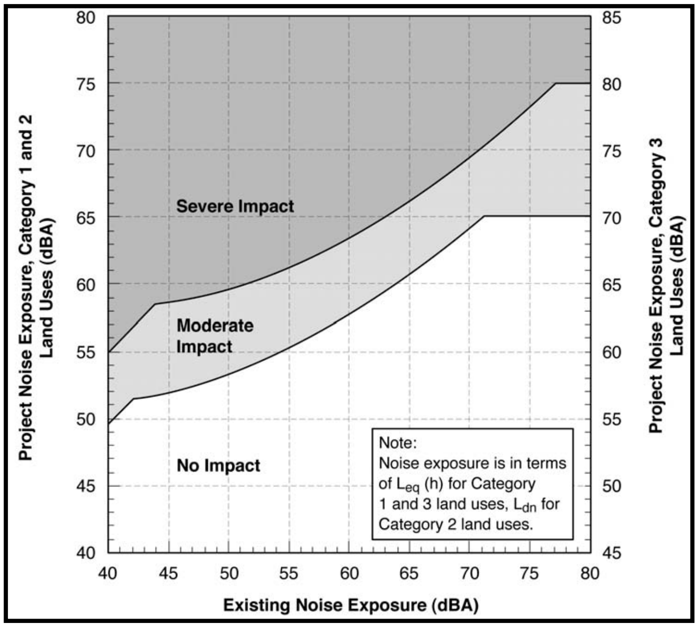
4.1 FTA Noise and Vibration Criteria

The criteria established by the FTA were used to evaluate impacts at noise-sensitive receptor locations adjacent to or near South Station and the layover facility sites. The following sections discuss the various noise and vibration evaluation criteria for the operation and construction of the South Station Expansion project.

4.1.1 Noise from Train Operations

For each identified noise-sensitive receptor location, noise levels under the future year 2035 Build Alternatives were compared with the FTA noise criteria to determine impact. The train operations at South Station would be the same for all three 2035 Build Alternatives (Alternative 1, 2, and 3). As a result, the train operations noise modeling analysis results for Alternative 1 were also used in the noise assessment for Alternatives 2 and 3. The FTA *Transit Noise and Vibration Impact Assessment* guidance manual sets forth the basic concepts, methods and procedures for evaluating the extent and severity of noise impacts from transit projects. The FTA guidelines assess noise impacts based on the selected land-use's sensitivity to noise. For example, the day-night noise level (or Ldn) is the noise metric used to assess project impacts at residential receptors while the hourly Leq noise level is used to assess impacts at non-residential and institutional receptors. The Leq represents a level of constant noise that has the same acoustic energy as the fluctuating noise level measured over a given time period such as an hour. The Ldn level represents the average noise level measured over a 24-hour period with a 10-dBA penalty added to the nighttime hours (10 p.m. to 7 a.m.) to account for people's increased sensitivity to noise while they are trying to sleep. The FTA does not consider most commercial businesses and industrial receptors sensitive to transit-related noise.

[3] Federal Transit Administration. *Transit Noise and Vibration Impact Assessment Report No. FTA-VA-90-1003-06. May* 2006.



Source: Federal Transit Administration, *Transit Noise and Vibration Impact Assessment*, Washington, D.C., May 2006.

Figure 1—FTA Noise Impact Criteria for Transit Projects

As shown in Figure 1, the FTA outdoor noise impact criteria are defined by two curves that allow increasing project noise levels as existing noise increases up to a point, beyond which impact is determined based on project noise alone. The FTA noise criteria are delineated into two categories: *moderate impact* and *severe impact*. The *moderate impact* threshold defines areas where the change in noise is noticeable but may not be sufficient to cause a strong, adverse community reaction. The *severe impact* threshold defines the noise limits above which a significant percentage of the population would be highly annoyed by new noise. Category 1 receptors (such as serene parks) are represented along the left axis and are described by the hourly Leq noise metric. Category 2 receptors (such as residences, hotels, and hospitals) are also represented along the left axis but are described by the 24-hour Ldn noise metric. Finally, Category 3 receptors (such as schools and churches) are represented along the right axis and are described by the hourly Leq noise metric. The FTA land-use categories and noise metrics are described in Table 1. The FTA noise limits, which are based on the existing background levels, are determined using empirical formulas and are shown graphically in Figure 1.

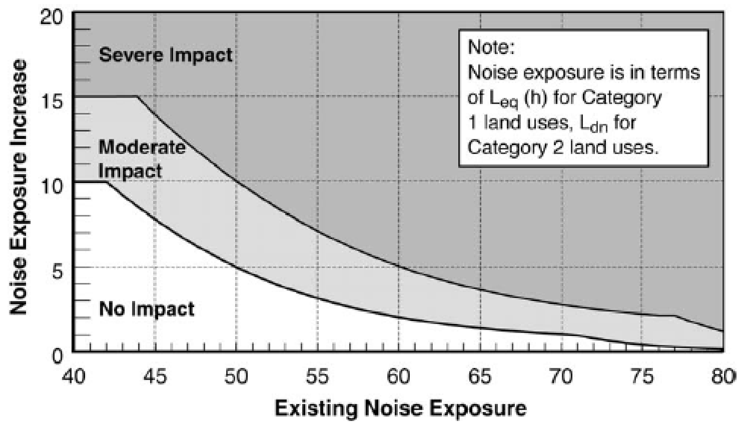
Table 1—FTA Outdoor Land-Use Categories and Noise Metrics

Land-Use Category[a]	Noise Level	Description
1	Leq(h)	Tracts of land set aside for serenity and quiet, such as outdoor amphitheaters, concert pavilions, and historic landmarks.
2	Ldn	Buildings used for sleeping include residences, hospitals, hotels and other areas where nighttime sensitivity to noise is of utmost importance.
3	Leq(h)	Institutional land-uses with primarily daytime and evening uses include schools, libraries, churches, museums, cemeteries, historical sites and parks, and certain recreational facilities used for study or meditation.

a Land-Use categories are based on sensitivity to noise intrusions.

Although the curves in Figure 1 are defined in terms of the project noise exposure and the existing noise exposure, it is the increase in the cumulative noise – when the project is added to the existing noise levels – that is the basis for the criteria.

Figure 2 shows the noise impact criteria for Category 1 and 2 land uses in terms of the allowable increase in the cumulative noise exposure.



Source: Federal Transit Administration, *Transit Noise and Vibration Impact Assessment*, Washington, D.C., May 2006.

Figure 2—Increase in Outdoor Cumulative Noise Levels Allowed by FTA Criteria

For example, the curves in Figure 2 indicate that the criterion for impact allows a noise exposure increase of 10 dBA if the existing noise exposure is 42 dBA or less, but only a 1 dBA increase when the existing noise level is 70 dBA.

4.1.2 Vibration from Train Operations

The FTA criteria were used to assess annoyance due to vibration and ground-borne noise from transit operations. The FTA vibration criteria for evaluating ground-borne vibration and noise impacts from train operations at nearby sensitive receptors are shown in Table 2. These vibration criteria are related to ground-borne vibration levels that are expected to result in human annoyance, and are based on root mean square (or RMS) velocity levels expressed in decibels (or VdB) relative to one micro-inch per second (μips). The FTA's experience with community response to ground-borne vibration indicates that when there are only a few train events per day, it would take higher vibration levels to evoke the same community response that would be expected from more frequent events. This is accounted for in the FTA criteria by distinguishing between projects with frequent (more than 70 train events per day), occasional (between 30 and 70 train events per day), and infrequent events (less than 30 train events per day). The vibration criteria levels shown in Table 2 are defined in terms of human annoyance for different land-use categories such as high sensitivity (Category 1), residential (Category 2), and institutional (Category 3). In general, the threshold of human perceptibility of vibration is 65 VdB.

Table 2—FTA Exterior Ground Borne Vibration and Interior Noise Impact Criteria for Annoyance

Land Use Category	Ground-Borne Vibration Levels (VdB)[a] (Exterior)			Ground-Borne Noise Levels (dBA)[b] (Interior)		
Description	Frequent Events[c]	Occasional Events[d]	Infrequent Events[e]	Frequent Events[c]	Occasional Event[d]	Infrequent Event[e]
Category 1: Buildings where low vibration is essential for interior operations.	65	65	65	N/A[f]	N/A[f]	N/A[f]
Category 2: Residences and buildings where people normally sleep.	72	75	80	35	38	43
Category 3: Institutional buildings with primarily daytime use.	75	78	83	40	43	48

a RMS vibration velocity levels are reported in decibels (or VdB) referenced to 1 micro inch per second (μips).
b Ground-Borne noise levels are reported in A-weighted decibels (dBA) referenced to 20 micro Pascals.
c "Frequent Events" is defined as more than 70 vibration events per day.
d "Occasional Events" is defined as between 30 and 70 vibration events per day.
e "Infrequent Events" is defined as less than 30 vibration events per day.
f N/A means "not applicable". Vibration-sensitive equipment is not sensitive to ground-borne noise.

The vibration levels shown in Table 2 are well below the onset of structural damage to buildings of 100 VdB. It is extremely rare for vibration from transit operations to cause any sort of building damage, even minor cosmetic damage. The potential for damage from vibratory or impact devices, however, would be addressed as part of the construction assessment.

The building located at 245 Summer Street, adjacent to the project area, has indicated that their computers located in the basement of the building are extremely sensitive to vibration. The FTA criterion for buildings with vibration sensitive equipment is 65 VdB.

While vibration criteria are generally used to assess annoyance from transit sources at the exterior facade of receptors, ground-borne noise, or the rumbling sound due to vibrating room surfaces, is typically assessed indoors. In general, the relationship between vibration and ground-borne noise depends on the dominant frequency of the vibration and the acoustical absorption characteristics of the receiving room. According to the FTA guidelines, the dominant vibration frequency from trains passing along typical ground and soil conditions generally occurs in the 30-60 Hz range.

4.1.3 Construction Noise and Vibration

FTA Guidelines

During the preliminary environmental permitting phase of a project when construction details are limited, the FTA suggests evaluating proposed construction scenarios against the one-hour Leq thresholds shown in Table 3. These criteria are compared to noise levels from the two loudest pieces of equipment that, under worst-case conditions, operate continuously for one hour. The FTA construction noise limits are reported for the peak one-hour period in A-weighted decibels (or dBA). Construction noise limits are established for both daytime (7 a.m.–10 p.m.) and nighttime (10 p.m.-7 a.m.) activities. The maximum noise limits represent noise levels from the two loudest pieces of equipment operating at full power over a period of one-hour.

Table 3—Recommended FTA Construction Noise Limits (in dBA)

Land-Use Category	Construction Period	
	Daytime	Nighttime
Residential	90	80
Commercial	100	100
Industrial	100	100

The primary concern regarding construction vibration relates to potential damage effects to buildings. Guideline vibration damage criteria are shown in Table 4 for various structural categories. Table 4 shows the construction vibration damage criteria in both peak particle velocity (PPV) in inches/second, and in root-mean-square (RMS) vibration velocity in decibels (VdB). These limits are criteria that should be used during the environmental impact assessment phase to identify potential problem locations that must be addressed during final design.

Table 4—Construction Vibration Damage Criteria for Buildings

Building Category	PPV (inches/second)	VdB (vibration velocity in decibels)
Reinforced-concrete, steel or timber	0.5	102
Engineered concrete and masonry	0.3	98
Non-engineered timber and masonry buildings	0.2	94
Buildings extremely susceptible to vibration damage	0.12	90

City of Boston

In addition to the FTA criteria, the City of Boston Construction Noise Limits were also evaluated to determine impact during construction. In general, local noise ordinances do not set limits on noise from transit operations but rather on construction and other nuisance noises. Additionally, construction activities to the maximum extent possible are limited almost everywhere to the daytime hours when noise is less intrusive.

However, the construction noise limits for the City of Boston are much more conservative than the FTA construction noise guidelines described above. In addition, they require a more detailed construction noise assessment to determine impact.

The City of Boston's Regulations[4] for the control of noise emitted from construction sites indicates that it is unlawful to operate any construction device on any construction site if the operation of such devices emits noise, measured at the lot line of any affected property, in excess of the levels shown in Table 5.

[4] Boston Redevelopment Authority. *City of Boston Noise Ordinance – Title 7, Section 50, Regulations for the Control of Noise in the City of Boston; Regulation 3: Restrictions on Noise Emitted from Construction Sites.* City of Boston Zoning Code. January 1977. www.bostonredevelopmentauthority.org/zoning.

Table 5—City of Boston Construction Noise Limits

Lot Use of Affected Property	L10 Level	Maximum Noise Level
Residential or Institutional	75 dBA	86 dBA
Business or Recreational	80 dBA	--
Industrial	85 dBA	--

4.1.4 Noise and Vibration Measurements

A noise-monitoring program was conducted to: (1) establish the existing ambient background noise levels within the project area, and (2) develop the project criteria noise limits using the FTA guidelines. Noise measurements were obtained at noise-sensitive receptor locations near South Station and at the proposed layover site locations. Using base maps of the surrounding areas, and information obtained during site visits, representative measurement locations were selected. Noise measurements were obtained at several locations within the South Station platform area and four locations were selected to be representative of the different types of residential and other noise-sensitive land uses around South Station. Noise measurements were also taken at the three proposed layover site locations. The results of the noise-monitoring program were used to establish the existing background noise environment and to develop the allowable project noise criteria limits using the FTA guidelines.

Vibration measurements were also obtained at four locations (including the building at 245 Summer Street adjacent to South Station) to determine the existing vibration levels from the train operations at South Station, as well at the three proposed layover locations sites.

4.1.5 Impact Assessment

The noise and vibration analysis used the prediction methodology contained in the FTA guidance manual. The modeling assumptions and methodology are summarized for noise and vibration separately in the following subsections.

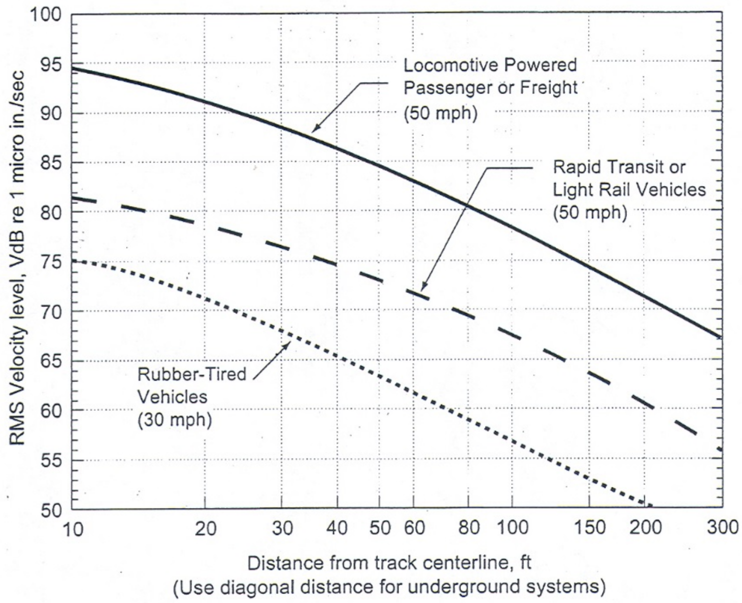
Noise Modeling Analysis

The FTA noise prediction guidelines contain mathematical algorithms that allow the computation of project generated noise levels at selected receptor locations. The FTA noise model (spreadsheet format) requires inputs such as maximum noise levels at 50 feet for each type of noise source (e.g., locomotive engine idle, train movement, wheel squeal, etc.) that are expected to occur at South Station.

Inputs such as the number of train operations, trainset sizes, and train speed were used to determine project noise levels at identified sensitive receptors. Other inputs such as track type (i.e., jointed, or continuously welded), the presence of an intervening noise barriers or buildings, and ground attenuation effects were also included in the noise modeling assessment.

Vibration Modeling Analysis

As with noise, the FTA guideline was also used to predict vibration levels from transit operations. The FTA vibration model combines various algorithms with empirically developed ground surface curves to estimate transit vibration levels along average soil conditions. As shown in Figure 3, the FTA surface vibration curves were used to predict ground-borne vibration and ground-borne noise levels from transit operations at receptor locations near South Station. The model then computes RMS velocity levels as well as converted ground-borne noise levels at each identified receptor location for single-event train operations. These computed levels were then compared with the FTA ground-borne vibration impact criteria to determine the onset of impact. As shown in Figure 3, vibration curves are specified for both locomotives and lighter railcars.



Source: Federal Transit Administration, *Transit Noise and Vibration Impact Assessment*, Washington, D.C., May 2006.

Figure 3—FTA Generalized Ground Surface Vibration Curves

Project Impact Assessment

The predicted noise and vibration levels from the proposed SSX project were compared to the FTA criteria to determine impact. At locations where the project noise and vibration levels were predicted to exceed the FTA and other applicable criteria, the feasibility of abatement measures listed in the FTA guidelines were evaluated for mitigating impacts at noise- and vibration-sensitive receptors.

Construction Noise Impacts

A preliminary construction noise analysis was performed in accordance with the calculation procedures described in the FTA guidance manual. Using information regarding the type of construction equipment that may be required for the project, and the construction equipment reference noise levels from the FTA guidance manual, estimates of predicted construction noise levels were determined at representative receptor locations to assess impacts.

In areas where construction noise impacts were predicted to occur, appropriate noise mitigation measures were recommended. These noise mitigation measures included noise barriers, and enclosures for mechanical equipment operating at the construction site.

Construction Vibration Impacts

A qualitative construction vibration analysis was also performed in accordance with the methodology described in the FTA guidance manual. The vibration analysis evaluated construction vibration levels relative to annoyance to building occupants and the potential to cause building damage.

To evaluate construction vibration impacts to buildings, the peak particle velocity (ppv) in inches/second is the metric of interest. The peak particle velocity is defined as the maximum instantaneous positive or negative peak of the vibration event. Although peak particle velocity is appropriate for evaluating the potential of building damage, it is not suitable for evaluating human response to vibration. Because it takes some time for the human body to respond to vibration, the average RMS vibration level expressed in VdB is used in the FTA guidance manual to evaluate vibration impacts in terms of annoyance to humans.

Vibration from construction activity is caused by general equipment operations, and is usually highest during pile driving, blasting, and construction related demolition activities. Typical vibration levels from construction activities do not have the potential to cause structural damage to buildings. Construction activities, such as pile driving, if performed within 50 to 100 feet of a structure, can produce vibration levels that may have the potential to cause damage.

5. Existing Conditions

5.1 South Station Site

The South Station site occupies approximately 49 acres located near Chinatown, the Fort Point Channel, and the South Boston Waterfront/Innovation District. The site includes the following: South Station Rail/Transit Terminal and South Station Bus Terminal, the USPS General Mail Facility/South Postal Annex, including the portion of Dorchester Avenue fronting the site and running parallel to the Fort Point Channel. The South Station Rail Terminal area currently consists of 13 tracks, eight platforms and a system of trackwork (also referred to as interlockings) that allows Amtrak and the MBTA trains to serve the station from the NEC and Framingham/Worcester Line from the south and west and the MBTA's Fairmount Line and Old Colony Railroad from the south. The site extends along a portion of the NEC Main Line to the west, extending past Cove Interlocking, and along a portion of the MBTA's Fairmount Line/Old Colony Railroad to the south, extending just past Broad Interlocking. The site also includes a small park, the Harborwalk area, and a portion of the Fort Point Channel located at the southern end of the site.

5.1.1 Noise Measurements

A noise monitoring program was conducted in February 2013 to establish the existing noise levels within the project area, and to develop the noise impact criteria for the project using the procedures described in the FTA guidelines. Noise measurements were obtained at representative noise-sensitive receptor locations in the areas surrounding South Station. In addition, noise measurements were also obtained inside the station area along the platforms to determine the noise levels along the interior perimeter of the Station and to obtain representative noise levels from idling locomotives. Noise measurements were obtained at a total of eight locations. Four locations are within South Station, and four locations are outside the station area at the nearest noise-sensitive receptors. The noise measurement locations are shown in Figure 4.

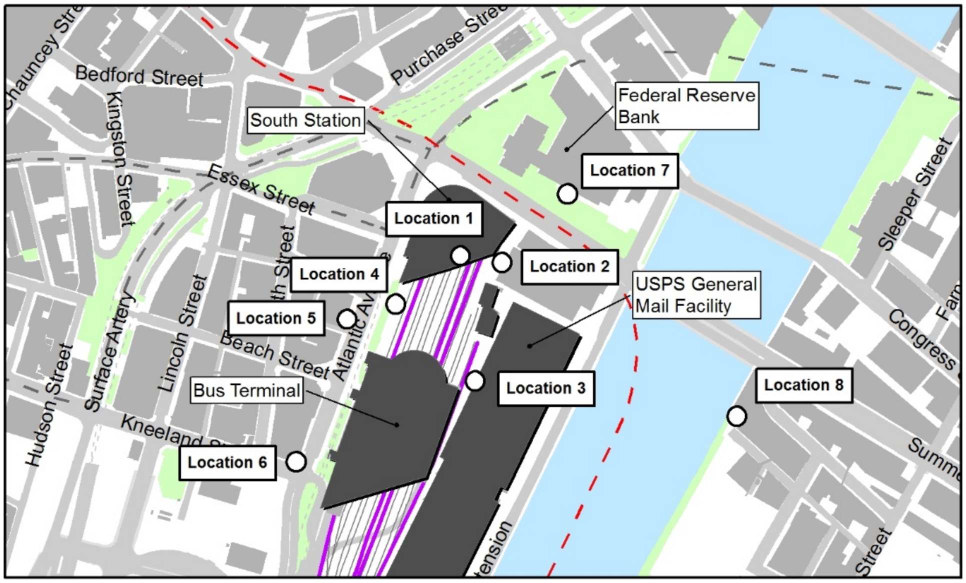


Figure 4—Noise Measurement Locations at South Station

The noise monitoring program consisted of measuring peak-hour Leq noise levels at non-residential receptors. In areas where there could be residential receptors, hourly Leq levels were measured during peak-hour, midday, and nighttime periods. These hourly noise measurements were then used in calculate an Ldn noise level using the methodology described in the FTA guidance manual. The sound level meter used on this project was a CEL Model 593 meter that is in compliance with the American National Standards Institute requirements for Type I accuracy.

Table 6 lists the noise measurement locations and shows the noise measurement results.

Noise measurement Location 1 is outside the South Station headhouse in the center of the area where the trains come into the station. The measured peak-hour Leq noise level at this location is 72.3 dBA. The primary source of noise at this location is from the idling electric locomotives from the Amtrak trains that enter the station locomotive first. During the peak-hour noise measurement period, Amtrak trains with electric locomotives were idling on Tracks 7 and 8 for part of the hour. Tracks 7 and 8 are located near measurement Location 1. A typical noise level from an idling locomotive is 80 dBA at a distance of 50 feet. When the Amtrak trains are not idling in the station, other noise sources include: wheel/rail noise from the passenger railcars entering and leaving the station; idling noise from the diesel locomotives located at the far south end of the station away from the headhouse; passengers walking and talking as the go to and from their trains; rolling luggage bags; and the station public address system.

Noise measurement Location 2 is at the building at 245 Summer Street adjacent to South Station. The measured peak-hour Leq noise level at this location is 71.3 dBA. The primary source of noise at this location is from the idling electric locomotives from the Amtrak trains that enter the station locomotive first. The measured Leq noise level at Location 2 is slightly lower than the Leq noise level measured at Location 1 because of the increased distance from the idling locomotives on Tracks 7 and 8. When the Amtrak trains are not idling in the station, other noise sources include: wheel/rail noise from the passenger railcars entering and leaving the station; idling noise from the diesel locomotives located at the far south end of the station away from the headhouse; passengers walking and talking as they go to and from their trains; rolling luggage bags; and the station public address system.

Table 6—Existing Measured Noise Levels at the South Station Area

Loc. No.	Description	Peak-Hour Leq	Midday Leq	Nighttime Leq	Ldn Level
1	South Station headhouse	72.3 dBA	---	---	---
2	245 Summer Street	71.3 dBA	---	---	---
3	East Side of South Station – Track 13	82.0 dBA	---	---	---
4	West Side of South Station – Track 1	69.1 dBA	---	---	---
5	Atlantic Avenue at East Street	67.8 dBA	67.0 dBA	64.4 dBA	69.3 dBA
6	Atlantic Avenue at Kneeland Street	73.0 dBA	71.0 dBA	65.0 dBA	71.2 dBA
7	Federal Reserve Building	64.6 dBA	---	---	---
8	Across Fort Point Channel at Necco Street	56.4 dBA	57.9 dBA	54.0 dBA	59.2 dBA

Note: --- indicates that midday and nighttime hourly Leq noise measurements were not obtained because there are no residential receptors at this location. The 24-hour Ldn noise level is determined from the measured peak-hour, midday, and nighttime hourly Leq noise levels. The Ldn noise level is only required for residential receptors or receptors where people normally sleep such as hospitals and hotels.

Noise measurement Location 3 is on the east side of South Station along Track 13 near the USPS facility. The measured peak-hour Leq noise level at this location is 82.0 dBA. The primary source of noise at this location is from the idling diesel locomotives from the MBTA trains that enter the station passenger railcars first. All of the MBTA commuter rail trains have their diesel locomotives at the south end of the station away from the headhouse. Since noise measurement Location 3 is much closer to these idling diesel locomotives, and since there are idling diesel locomotives on almost all of the tracks during peak-hours, the measured peak-hour noise level is higher than the levels measured at the South Station headhouse.

Noise measurement Location 4 is on the west side of South Station along track 1, but closer to the headhouse than measurement Location 3. The measured peak-hour Leq noise level at this location is 69.1 dBA. The primary source of noise at this location is from the idling electric locomotives from the Amtrak trains that enter the station locomotive first. Since this location is farther from the idling Amtrak locomotives on Tracks 7 and 8, the measured peak-hour noise level is lower than the noise levels measured at Locations 1 and 2. When the Amtrak trains are not idling in the station, other noise sources include: wheel/rail noise from the passenger railcars entering and leaving the station; idling noise from the diesel locomotives located at the far south end of the station away from the headhouse; passengers walking and talking as they go to and from their trains; rolling luggage bags; the station public address system; and the local street traffic on Atlantic Avenue.

Noise measurement Location 5 is outside of South Station along Atlantic Avenue near East Street. The measured peak-hour Leq noise level at this location is 67.8 dBA. The primary noise source at this location is the train activity at South Station, and the local street traffic on Atlantic Avenue. The primary noise source from the train activity at South Station is from the idling locomotives. Because of the current and future potential for residents to live in buildings along Atlantic Avenue, hourly Leq noise levels were also obtained during midday (67.0 dBA), and nighttime (64.4 dBA) hours. Using the methodology described in the FTA guidance manual, a 24-hour Ldn noise level was calculated using the noise measurements from these three hourly periods. This noise measurement procedure was used because leaving the sound level meter unattended on the sidewalk for a 24-hour period was impractical for security reasons. The Ldn noise level at measurement Location 5 is 69.3 dBA.

Noise measurement Location 6 is outside of South Station along Atlantic Avenue near Kneeland Street. The measured peak-hour Leq noise level at this location is 73.0 dBA. The primary noise source at this location is the diesel locomotive idling on Track 1. Noise from idling diesel locomotives on the other tracks also contributed to the higher Leq noise level measured at this location relative to the measured Leq noise level at measurement Location 5. In addition to the noise from the idling locomotives, there was also the noise from the local street traffic on Atlantic Avenue and Kneeland Street. Because of the current and future potential for residents to live in buildings on this end of Atlantic Avenue, hourly Leq noise levels were also obtained during midday (71.0 dBA), and nighttime (65.0 dBA) hours. Using the methodology described in the FTA guidance manual, a 24-hour Ldn noise level was calculated using the noise measurements from these three hourly periods. The Ldn noise level at measurement Location 6 is 71.2 dBA.

Noise measurement Location 7 is at the Federal Reserve Building on Summer Street across from South Station. The measured peak-hour Leq noise level at this location is 64.6 dBA. The primary noise source at this location is the local street traffic on Summer Street. South Station and the building at 245 Summer Street effectively shield the Federal Reserve Building from any train noise from South Station.

Noise measurement Location 8 is across the Fort Point Channel at Necco Street. The measured peak-hour Leq noise level at this location is 56.4 dBA. The primary noise source at this location is the local street traffic on Summer Street, especially as it crosses over the Summer Street Bridge, and noise from the USPS facility adjacent to South Station. The USPS facility effectively shields this area from any train noise from South Station. Because of the current and future potential for residents to live in the area across the Fort Point Channel, hourly Leq noise levels were also measured during a midday (57.9 dBA), and nighttime (54.0 dBA) hour. The nighttime hourly Leq noise measurement was obtained around midnight and is not representative of the higher volume of nighttime truck activity that occurs between 4 and 5 a.m. at the USPS facility. The midnight hourly Leq noise measurement was used in determining the 24-hour Ldn noise level because it is more representative of the overall nighttime noise levels between 10 p.m. and 7 a.m. Using the methodology described in the FTA guidance manual, a 24-hour Ldn noise level was calculated using the noise measurements from these three hourly periods. The Ldn noise level at measurement Location 8 is 59.2 dBA.

5.1.2 Vibration Measurements

In addition to the noise measurements, vibration measurements were also obtained at South Station. Vibration measurements were obtained at Locations 1 through 4 shown in Figure 4. However, because of the slow speed of the trains entering and leaving South Station, typical vibration levels from the trains in the areas surrounding South Station were below the FTA impact criterion of 72 VdB for human annoyance. Even vibration levels obtained inside the station area near the headhouse were below the FTA impact criterion of 72 VdB for human annoyance. Typical vibration levels along the platforms at South Station are 65 VdB at a distance of 20 feet from the moving passenger railcars, and 70 VdB at a distance of 50 feet from a moving diesel locomotive.

Because of concerns regarding vibration-sensitive computer equipment inside the basement area of the building at 245 Summer Street adjacent to South Station, a more detailed indoor and outdoor vibration measurement program was conducted for this facility using more sensitive vibration-monitoring equipment for measuring the indoor vibration levels. Vibration levels measured outside the building from the Amtrak electric trains that enter South Station locomotive first were below 60 VdB at a distance of 75 feet from the closest tracks on which the Amtrak electric locomotives operated. This is below the FTA criterion of 65 VdB for buildings with vibration-sensitive equipment. Vibration measurements obtained inside the basement area of 245 Summer Street, adjacent to the vibration sensitive computer equipment, indicated that the vibration was not due to the trains, but rather the mechanical equipment located inside the basement area of the building.

Based on these results, no additional vibration measurements were obtained outside the South Station area. Because of the distance from the locomotives to other receptor locations outside the South Station area, the vibration levels were below the measurement capability of the instrumentation (50 VdB).

5.2 Layover Facility Sites

In addition to the noise measurements at South Station, noise measurements were also obtained at the three proposed layover facilities sites associated with the South Station Expansion Project: Widett Circle, Beacon Park Rail Yard, and Readville - Yard 2. These layover facilities would be used to store trains during midday between the AM and PM peak-hour periods at South Station. The results of the noise measurements obtained at the proposed layover facilities are described below and shown in Table 7.

5.2.1 Widett Circle

Widett Circle totals approximately 29.4 acres and is comprised of two parcels located in the South Boston neighborhood of Boston: Cold Storage and Widett Circle. The industrial-zoned parcel is located on the MBTA Fairmount Line, approximately one track-mile from South Station. It is situated within Amtrak's loop tracks and adjacent to the MBTA's Fairmount Line and MBTA's South Side Service and Inspection facility.

The Widett Circle layover facility would be located in the area between the Southampton Rail Yard facility and Interstate Route 93 (I-93). The area is currently used as a major warehouse facility with a high volume of truck activity throughout the day. The primary sources of noise at Widett Circle are the trucks operating at the facility, trains at the Southampton Rail Yard, and traffic noise from I-93. The nearest residential receptors are located along Albany Street south of the Widett Circle layover facility and across I-93. The noise measurement location near Widett Circle (Albany Street) is shown in Figure 5. Hourly Leq noise measurements on Albany Street were obtained during peak-hour (67.0 dBA), midday (66.6 dBA), and nighttime (63.1 dBA) periods. The measured noise levels at this location are due to local street traffic on Albany Street and the traffic noise on I-93. Using the methodology described in the FTA guidance manual, a 24-hour Ldn noise level was calculated using the noise measurements from these three hourly periods. The Ldn noise level on Albany Street across from the proposed Widett Circle layover facility is 68.2 dBA.

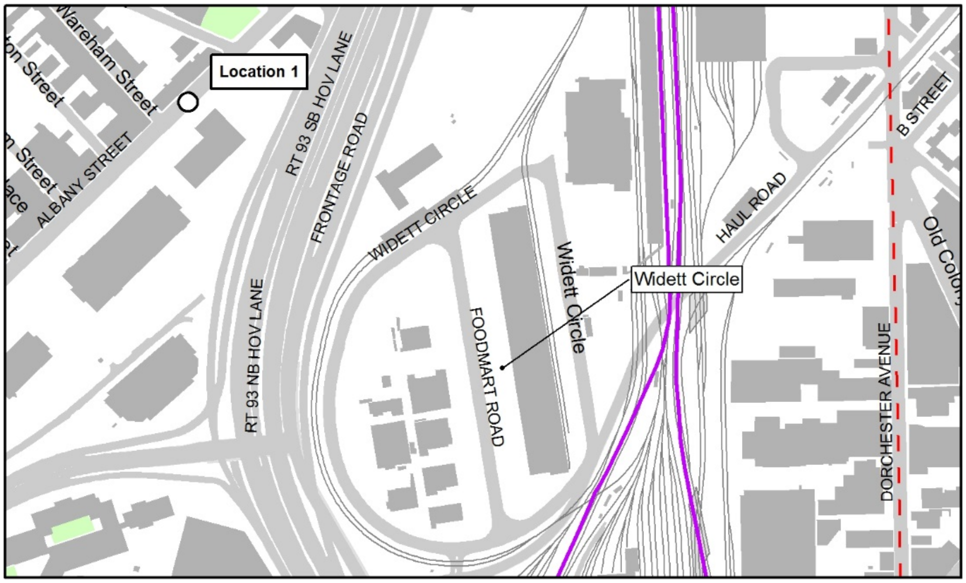


Figure 5—Noise Measurement Locations at Widett Circle Layover Facility

Table 7—Noise Measurement Results at the Proposed Layover Facilities

Location	Peak-Hour Leq	Midday Leq	Nighttime Leq	Ldn Level
Widett Circle at Albany Street	67.0 dBA	66.6 dBA	63.1 dBA	68.2 dBA
Beacon Park Rail Yard – 20 Wadsworth Street[a]	---	78.0 dBA	---	81.4 dBA
Readville – Yard 2 – 24 Wolcott Street[a]	---	62.0 dBA	---	57.9 dBA

a Indicates that 24-hour noise measurements were obtained at these residential receptor locations.

5.2.2 Beacon Park Yard

Beacon Park Yard is located along Cambridge Street in the Allston neighborhood of Boston. The site is located on the MBTA Framingham/Worcester Line approximately 3.8 track-miles from South Station. It is an industrial-zoned site located between the Massachusetts Turnpike Interstate Route 90 (I-90) Allston Toll Plaza and the MBTA Framingham/Worcester Line. The approximately 30-acre site has served for many years as a major freight rail yard and intermodal terminal in Boston for CSX Transportation, Inc. (CSXT).

Twenty-four hour noise measurements were obtained in the backyard of the residence at 20 Wadsworth Street. The noise measurement location at Beacon Park Yard is shown in Figure 6. The residents along Wadsworth Street and Pratt Street are adjacent to the CSX Rail Yard. In addition, the Boston University athletic facilities along Ashford Street are also adjacent to this area. The measured Ldn noise level at the residences along Wadsworth Street is 81.4 dBA. The primary source of noise at this location is from the MBTA commuter rail trains that operate on the tracks directly adjacent to these residences. The measured hourly Leq noise levels range from 75 to 80 dBA during the hours of commuter rail train operations.

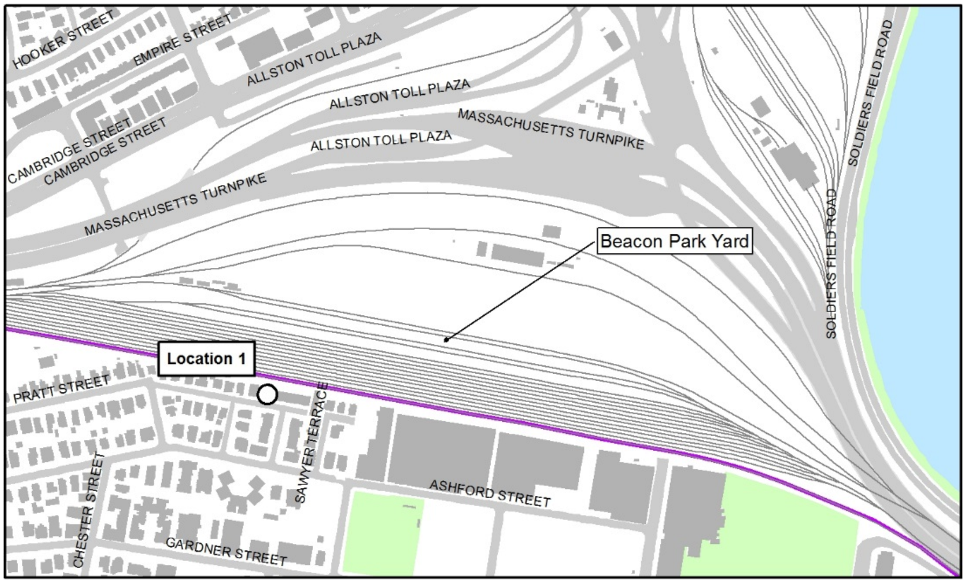


Figure 6—Noise Measurement Location at the Beacon Park Yard Layover Facility

Although vibration measurements were not obtained at this location, based on the FTA vibration curves in Figure 3, the existing vibration levels from the passing commuter rail trains (traveling at approximately 50 mph) are expected to be 88 VdB at the residential receptors along Wadsworth Street and Pratt Street because of their proximity to the commuter rail corridor. This level exceeds the FTA annoyance criterion of 72 VdB for residential receptors.

5.2.3 Readville – Yard 2

The MBTA's Readville - Yard 2 is located in the Readville section of Hyde Park in Boston in the northeast quadrant of the intersection of the NEC and the MBTA Fairmount Line, approximately 8.8 track-miles south of South Station. Readville - Yard 2 is a maintenance repair facility and the largest layover yard used by the MBTA for its south side service. The layover yard has a total of 12 tracks. The MBTA currently uses Readville – Yard 2 for midday layover storage of 10 trainsets[5] of variable lengths.

Twenty-four hour noise measurements were obtained in the backyard of the residence at 24 Wolcott Street. The noise measurement location at Readville – Yard 2 is shown in Figure 7. The residents along Wolcott Street are adjacent to the existing Readville Rail Yard. The measured Ldn noise level at the residences along Wolcott Street is 57.9 dBA. The highest hourly Leq noise levels were measured during mid-afternoon and ranged from 55 to 62 dBA. These noise levels were from the midday MBTA train operations at the Readville rail yard.

[5] A trainset describes the physical makeup of a combination of locomotives and coaches coupled together and operating as one unit.

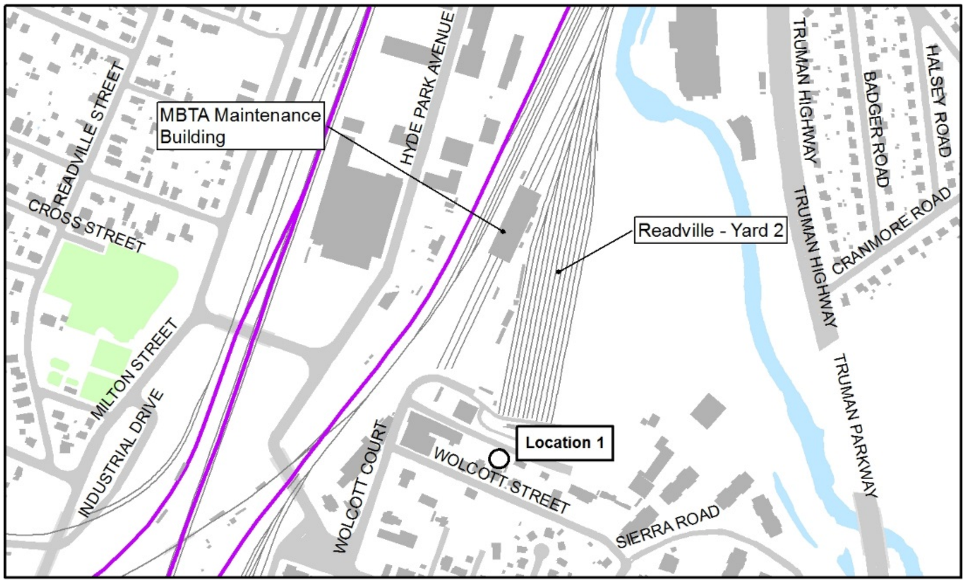


Figure 7—Noise Measurement Location at Readville – Yard 2 Layover Facility

6. Project Impacts

For the SSX project, MassDOT considered alternative concept designs on the track configuration, station concept, layover facility sites, and joint/private development elements of the project at that South Station site. The concepts developed for the *track configuration, station design* and *layover facility sites* are the same in each Build Alternative and would result in no variations in environmental impacts across each alternative. Differences in the DEIR project alternatives at the South Station site apply only to the joint/private development alternatives. Track configuration alternatives would occupy the same general area and would not differ relative to environmental considerations. Therefore, the noise and vibration impact evaluations presented in this section address the DEIR Build Alternatives at the South Station site and at the three proposed layover sites.

6.1 Noise Impacts

For each identified noise-sensitive receptor location, noise levels for the 2035 Build Alternatives were compared with the FTA noise criteria to determine impact. The train operations at South Station would be the same for all three 2035 Build Alternatives (Alternatives 1, 2, and 3). As a result, the train operations noise modeling analysis results for Alternative 1 were also used in the noise assessment for Alternatives 2 and 3.

Noise impacts were determined using the methodology described in the FTA guidance manual. Based on the results of the noise measurements described in Section 5 of this technical report, FTA impact criteria were established for moderate and severe impact conditions at noise-sensitive receptors. Noise-sensitive receptors primarily include residences and buildings where people normally sleep such as hospitals and hotels. Other noise-sensitive receptors include schools, libraries, and office buildings where quiet is essential for a productive work environment. Most other commercial, retail, and industrial land uses are not considered noise-sensitive. This would include the South Station headhouse.

For this study, the nearest noise-sensitive receptors to South Station include the building at 245 Summer Street, the Federal Reserve Building, receptors along Atlantic Avenue at East Street near the north end of the station, receptors along Atlantic Avenue at Kneeland Street near the south end of the station, and receptors across the Fort Point Channel at Necco Street.

Table 8 presents the FTA criteria for moderate and severe impact based on the peak-hour Leq noise level measured at each of the noise-sensitive non-residential receptors using the curves shown in Figure 2. These curves were used to determine the FTA allowable increase in noise level at each location for the SSX project. The curves shown in Figure 2 indicate that the FTA moderate and severe impact levels change based on the existing measured noise levels.

Table 8—FTA Impact Criteria Based on the Measured Peak Hour Leq Levels at Non-residential Receptors

Loc. No.	Description	Measured Peak-Hour Leq Level	Moderate Impact Criterion	Severe Impact Criterion
2	245 Summer Street	71.3 dBA	+ 1.0 dBA	+2.5 dBA
5	Atlantic Avenue at East Street	67.8 dBA	+1.2 dBA	+3.0 dBA
6	Atlantic Avenue at Kneeland Street	73.0 dBA	+0.7 dBA	+2.2 dBA
7	Federal Reserve Building	64.6 dBA	+1.5 dBA	+4.0 dBA
8	Across Fort Point Channel at Necco Street	56.4 dBA	+2.5 dBA	+6.5 dBA

Table 9 presents the FTA criteria for moderate and severe impact based on the Ldn noise level at each of the noise-sensitive residential receptors using the curves shown in Figure 2. These curves were used to determine the FTA allowable increase in the noise levels from the SSX project.

Table 9—FTA Impact Criteria Based on the Measured 24-hour Ldn Level at Current and Potential Residential Receptors

Loc. No.	Description	Measured Ldn Level	Moderate Impact Criterion	Severe Impact Criterion
5	Atlantic Avenue at East Street	69.3 dBA	+1.0 dBA	+3.0 dBA
6	Atlantic Avenue at Kneeland Street	71.2 dBA	+1.0 dBA	+2.5 dBA
8	Across Fort Point Channel at Necco Street	59.2 dBA	+2.5 dBA	+5.5 dBA

Locations 5, 6, and 8 are found in both Table 8 and Table 9 because these areas include both residential and non-residential receptors. Because different noise metrics are used to determine impact for these receptors (the 24-hour Ldn level for residential receptors, and the peak-hour Leq level for non-residential receptors), the FTA impact criteria are described in both tables.

Measurements at Locations 1, 3, and 4 were obtained inside the station area along the platforms and are not representative of sensitive receptor locations, so they were not included in Table 8 or Table 9. Most passengers on the platforms going to and from the trains are exposed to the noise from the idling locomotives for only a very short period of time. Noise measurements were obtained at these locations (closer to the idling locomotives) to get a better understanding of the noise levels generated by the electric (Amtrak) and diesel (MBTA) locomotives within the station area.

Using the noise modeling equations from the FTA guidance manual, noise levels specific to train operations for 2013 Existing Conditions and 2035 Build condition were used to determine the change in noise levels due to the increase in train operations at South Station. Using information that included the train operations by type (diesel locomotive powered or electric locomotive powered), time of day, the number of passenger railcars and type of locomotive for each trainset, and the location by track number for each train operation, the peak-hour (5 p.m to 6 p.m) and 24-hour Ldn noise levels were calculated at each of the nearest noise-sensitive receptors. By comparing the predicted noise levels from 2013 Existing Conditions with the predicted noise levels from 2035 Alternative 1, the change in noise level due to the change in the train operations at South Station was determined, as detailed in the following sections. This change in noise level was then compared to the FTA criteria in Table 8 to determine impact.

Train operations data for 2013 Existing Conditions and for the 2035 Build Alternatives were developed for the project. This information was further processed to get the data into the necessary format for use in the FTA noise model. Because of the detailed train operations data developed for the project, noise levels were calculated based on the train operations on each of the tracks. These calculated noise levels were then extrapolated to each of the noise-sensitive receptors (distance attenuation), and then logarithmically added to obtain the overall peak-hour Leq and 24-hour Ldn noise level at each receptor. The noise modeling analysis included the wheel/rail noise from the moving trains, and the idling noise from the locomotives. All Amtrak electric powered trains were assumed to enter the station locomotive first with the idling electric locomotives at the north end of the station near the headhouse. All MBTA diesel powered trains were assumed to enter the station passenger railcars first with the idling locomotives at the south end of the station away from the headhouse.

As observed during the noise measurements, the noise from the idling locomotives was the primary noise source at South Station. There were always at least one or more locomotives idling at South Station throughout the day. The noise from the idling locomotives was at least 20 dBA above the wheel/rail noise generated by the moving trains.

6.1.1 Alternative 1 - Transportation Improvements Only

South Station Site

Alternative 1 assumes that South Station would be expanded onto the adjacent 14-acre USPS property. MassDOT would acquire and demolish the USPS General Mail Facility/South Postal Annex. Capacity improvements would include construction of seven new tracks and four platforms (including widening of one existing platform), for a total of 20 tracks and 11 platforms. Tower 1 Interlocking, as well as four approach interlockings, would be reconstructed and/or reconfigured. With Alternative 1, no provision would be made for future private development as part of the SSX project.

Dorchester Avenue would be restored for public and station access. Restoration of Dorchester Avenue would reconnect Dorchester Avenue to Summer Street as a public way. It would include landscaping and improved pedestrian and cycling connections and facilities (including adjacent sidewalks and crosswalks). Restoration also would include construction of an extension of the Harborwalk along reopened Dorchester Avenue. Alternative 1 would include the construction of additional layover facilities at one or more locations.

Based on 2013 existing and proposed 2035 train operations data, the number of train operations from 2013 Existing Conditions (449 trains per day including both revenue and non-revenue service) versus the number of train operations for 2035 Alternative (554 trains per day including both revenue and non-revenue service), would result in an increase of 105 trains per day. During the peak-hour (5 p.m. to 6 p.m.), the number of train operations from 2013 Existing Conditions (17 inbound trains and 24 outbound trains) versus the number of train operations for 2035 Alternative 1 (22 inbound trains and 26 outbound trains), would result in an increase of five inbound and two outbound trains per day. However, these train operations would now be distributed over 20 tracks instead of the existing 13 tracks at South Station.

For non-residential receptors, Table 10 summarizes the results of the calculated peak-hour Leq noise levels from the noise modeling analysis due to train operations for 2013 Existing Conditions and 2035 Alternative 1. For residential receptors, Table 11summarizes the results of the calculated 24-hour Ldn noise levels from the noise modeling analysis due to train operations for 2013 Existing Conditions and 2035 Alternative.

As a result of the detailed train operations data for 2013 Existing Conditions and 2035 Alternative 1, the noise analysis results shown in Table 10 (for the peak-hour Leq noise levels) and Table 11 (for the 24-hour Ldn noise levels) used the calculated noise levels from the noise model analysis to determine the change in noise levels because they more accurately reflect the change in noise level due to the train operations. Although the existing measured noise levels were used to determine the FTA moderate and severe impact criteria, the measured noise levels at the noise-sensitive receptors include both the noise from the trains and other non-train related noise sources such as local street traffic on Atlantic Avenue and Summer Street. As a result, comparing the 2013 existing measured noise levels with the 2035 predicted noise levels from the train operations data for the Build alternatives would not represent an accurate assessment of the noise levels due to the changes in train operations at South Station.

Table 10—Results of the Noise Modeling Analysis for the Peak-hour Leq Noise Level at Non-Residential Receptors

Loc. No.	Description	2013 Calculated Peak-Hour Leq Level	2035 Calculated Peak-Hour Leq Level	Change in Peak-Hour Leq Level	Impact Assessment
2	245 Summer Street	69.4 dBA	71.1 dBA	+1.7 dBA	Moderate Impact
5	Atlantic Avenue at East Street	63.6 dBA	64.4 dBA	+0.8 dBA	No Impact
6	Atlantic Avenue at Kneeland Street	71.7 dBA	68.5 dBA	-3.2 dBA	No Impact
7	Federal Reserve Building	59.2 dBA	61.9 dBA	+2.7 dBA	No Impact
8	Across Fort Point Channel at Necco Street	57.3 dBA	59.8 dBA	+2.5 dBA	No Impact

Table 11—Results of the Noise Modeling Analysis for the Peak-hour Ldn Noise Level at Current and Potential Residential Receptors

Loc. No.	Description	2013 Calculated Ldn Level	2035 Calculated Ldn Level	Change in Ldn Level	Impact Assessment
5	Atlantic Avenue at East Street	64.5 dBA	64.0 dBA	-0.5 dBA	No Impact
6	Atlantic Avenue at Kneeland Street	69.8 dBA	70.5 dBA	+0.7 dBA	No Impact
8	Across Fort Point Channel at Necco Street	56.7 dBA	58.6 dBA	+1.9 dBA	Moderate Impact

At 245 Summer Street, the peak-hour Leq noise level from the train operations is expected to increase from 69.4 dBA to 71.1 dBA. This increase in peak-hour noise level is due to the increase in the idle time of the Amtrak electric locomotives at the north end of the station near the building. Based on the impact criteria for this location shown in Table 8, this increase of 1.7 dBA would result in a moderate noise impact at this location.

At the Atlantic Avenue/East Street location, the peak-hour (5 p.m. to 6 p.m.) Leq noise level from the train operations is expected to increase from 63.6 dBA to 64.4 dBA. This increase in peak-hour noise level is due to the increase in the idling time of the Amtrak electric locomotives located at the north end of the station near the headhouse. However, based on the impact criteria for this location shown in Table 8, this increase of 0.8 dBA would not result in an impact condition at this location.

At the Atlantic Avenue/East Street location, the Ldn noise level from the train operations is expected to decrease from 64.5 dBA to 64.0 dBA. This decrease in the Ldn noise level is due to the distribution of the Amtrak electric locomotives on additional tracks that are located farther from Atlantic Avenue. Based on the impact criteria for this location shown in Table 9 for the Ldn level, this decrease of 0.5 dBA in Ldn level would not result in an impact condition at this location.

At the Atlantic Avenue/Kneeland Street location, the peak-hour Leq noise level from the train operations is expected to decrease from 71.7 dBA to 68.5 dBA. This decrease of 3.2 dBA in peak-hour noise level is due to the broader distribution of the MBTA diesel locomotives in the expanded terminal area. Although more trains would operate at South Station during the peak hour under the future Build Alternatives, the distribution of trains within the terminal would locate trains further from the Atlantic Avenue sensitive receptors. Because there is a decrease in the peak-hour Leq noise level, a noise impact condition is not expected to occur.

At the Atlantic Avenue/Kneeland Street location, the Ldn noise level from the train operations is expected to increase from 69.8 dBA to 70.5 dBA. This increase in the Ldn noise level is due to the increase in the number of MBTA diesel locomotives idling at the station throughout the day. Based on the impact criteria for this location shown in Table 9, this increase of 0.7 dBA in Ldn level would not result in an impact condition at this location.

At the Federal Reserve Building on Summer Street across from South Station, the predicted peak-hour Leq noise level from the train operations is expected to increase from 59.2 dBA to 61.9 dBA. However, this location is partially shielded by the South Station headhouse and the building at 245 Summer Street. As a result of the shielding effect of these buildings, the predicted peak-hour Leq noise levels from the train operations at South Station for both 2013 and 2035 are expected to be approximately 5 dBA lower. As a result of this shielding effect, the noise levels at the Federal Reserve Building are expected to be at least 5 dBA lower (54.2 and 56.9 dBA respectively) than the noise levels shown in Table 10. The measured peak-hour Leq noise level at the Federal Reserve Building (64.6 dBA) is primarily due to the local traffic on Summer Street. At this location, the noise from the train operations at South Station is essentially inaudible above the traffic noise. As a result, the FTA noise impact criteria from the curves in Figure 1 were used to assess the noise impact at the Federal Reserve Building. For a measured peak-hour Leq noise level of 64.6 dBA, the FTA moderate noise impact criterion from Figure1 for the predicted peak-hour Leq noise level from the train operations at South Station is 66 dBA. Since this level is below the predicted peak-hour Leq noise level for 2035 Alternative 1 of 56.9 dBA, this peak-hour Leq noise level would not result in a noise impact at the Federal Reserve Building.

Across Fort Point Channel at Necco Street, the predicted peak-hour Leq noise level from the 2035 train operations at South Station is expected to be 59.8 dBA. For 2013 Existing Conditions, the USPS facility forms an effective noise barrier that shields this location from the train noise at South Station. With the removal of the USPS facility, there is no shielding effect at this location. Because of the shielding effect from the USPS facility, the train noise from South Station is inaudible at this location. As a result, the FTA noise impact criteria from the curves in Figure 1 were used to assess the noise impact across the Fort Point Channel. For a measured peak-hour Leq noise level of 56.4 dBA, the FTA moderate noise impact criterion from Figure 1 is 61 dBA for the predicted peak-hour Leq noise level from the train operations at South Station. Since the predicted peak-hour Leq noise level from the train operations for 2035 Alternative 1 is 59.8 dBA, and is below the FTA moderate impact criterion of 61 dBA, a noise impact is not expected to occur across the Fort Point Channel.

The predicted Ldn noise level at this location across the Fort Point Channel from the 2035 train operations at South Station is expected to be 58.6 dBA. As described above, the FTA noise impact criteria from the curves in Figure 1was used to assess the noise impact across the Fort Point Channel. For a measured 24-hour Ldn noise level of 59.2 dBA, the FTA moderate noise impact criterion from Figure 1 is 57 dBA for the predicted Ldn noise level from the train operations at South Station. The predicted Ldn noise level from the train operations for 2035 Alternative 1 is 58.6 dBA. Since this Ldn noise level is above the FTA moderate impact criterion of 57 dBA, the train operations at South Station would result in a moderate noise impact across the Fort Point Channel.

Layover Facility Sites

As part of the SSX project, a number of MBTA trains would layover at one or more locations during the midday hours between the morning and evening peak-hour operating periods at South Station. The three proposed layover facility locations under consideration are Widett Circle, Beacon Park Yard, and Readville - Yard 2. Based on the midday noise levels measured at each of these locations, the curves in Figure 2 were used to determine the FTA moderate and severe impact criteria at the nearest sensitive receptor at each of the layover facilities. The FTA impact criteria for moderate and severe impact at each of the layover facilities are shown in Table 12. The results of the noise impact assessment at the layover facilities are shown in Table 13.

Table 12—FTA Impact Criteria at Layover Facilities Based on Measured Midday L_{eq} Levels

Layover Facility	Measured Midday Hourly Leq Level	FTA Moderate Impact	FTA Severe Impact
Widett Circle	66.6 dBA	+1.5 dBA	+3.0 dBA
Beacon Park Yard	78.0 dBA	+0.2 dBA	+2.0 dBA
Readville - Yard 2	62.0 dBA	+2.0 dBA	+4.0 dBA

Widett Circle

The proposed Widett Circle layover facility would have the capacity to store up to 30 trainsets during the midday layover period. The nearest noise-sensitive receptors are along Albany Street across I-93. This area is approximately 1,300 feet from the acoustic center of the Widett Circle layover facility. For the noise assessment for the layover facility, and in order to assess the most impactful scenario, it was assumed that all 30 trains arrive at (or leave) the layover facility during the same midday hour. The calculated midday hourly Leq noise level from the train activity at the Widett Circle layover facility is 55.3 dBA at the nearest noise-sensitive receptor. Adding the noise level from the layover facility (55.3 dBA) to the measured midday noise level on Albany Street (66.6 dBA) results in an overall noise level of 66.9 dBA. As a result, the increase in the midday Leq noise level at the nearest noise-sensitive receptor is 0.3 dBA. Since this increase in noise level is below the FTA criteria shown in Table 12, noise impacts are not expected from the midday train activity at the Widett Circle layover facility.

Beacon Park Yard

The proposed Beacon Park Yard layover facility would have the capacity to store up to 20 trainsets during the midday layover period. The nearest noise-sensitive receptors are the residences along Wadsworth Street adjacent to the layover facility. For the noise assessment for the layover facility, and in order to assess the most impactful scenario, it was assumed that all 20 trains arrive at (or leave) the layover facility during the same midday hour. The calculated midday hourly Leq noise level from the train activity at the Beacon Park Yard layover facility is 76.4 dBA at the nearest noise-sensitive receptor. Adding the noise level from the layover facility (76.4 dBA) to the measured midday noise level at the residences along Wadsworth Street (78.0 dBA) results in an overall noise level of 80.3 dBA. As a result, the increase in the midday Leq noise level at the nearest noise-sensitive receptors is 2.3 dBA. From the FTA impact criteria shown in Table 12, this increase of 2.3 dBA would result in a severe noise impact for the residences along Wadsworth Street.

Readville - Yard 2

The Readville - Yard 2 is already used by the MBTA as a layover facility. The existing layover facility currently stores up to 10 trainsets. As part of the SSX project, this layover facility would be expanded to store up to an additional 8 trainsets. The nearest noise-sensitive receptors are the residences along Wolcott Street adjacent to the layover facility. For the noise assessment for the layover facility, and in order to assess the most impactful scenario, it was assumed that all 8 additional trains arrive at (or leave) the layover facility during the same midday hour. The calculated midday hourly Leq noise level from the additional train activity at the Readville - Yard 2 layover facility is 62.0 dBA at the nearest noise-sensitive receptors. Adding the noise level from the layover facility (62.0 dBA) to the measured midday Leq noise level at the residences along Wolcott Street (62.0 dBA), results in an overall noise level of 65.0 dBA. As a result, the increase in the midday Leq noise level at the nearest noise-sensitive receptors is 3.0 dBA. From the FTA impact criteria shown in Table 12, this increase of 3.0 dBA would result in a moderate noise impact for the residences along Wolcott Street.

Table 13—Results of the Noise Modeling Analysis for the Layover Facilities

Layover Facility	Measured Midday Hourly Leq Level	Predicted 2035 Midday Hourly Leq Level	Change in Midday Hourly Leq Level	Impact Assessment
Widett Circle	66.6 dBA	66.9 dBA	+0.3 dBA	No Impact
Beacon Park Yard	78.0 dBA	80.3 dBA	+2.3 dBA	Severe Impact
Readville - Yard 2	62.0 dBA	65.0 dBA	+3.0 dBA	Moderate Impact

6.1.2 Alternative 2 - Joint/Private Development Minimum Build and Alternative 3 - Joint/Private Development Maximum Build

Alternative 2 – Joint/Private Development Minimum Build and Alternative 3 – Joint/Private Development Maximum Build would include the elements of Alternative 1, as well as provisions for future private development by incorporating appropriate structural foundations into the overall station and track design. Alternatives 2 and 3 also would include construction of additional layover facilities at one or more locations, as was analyzed in Alternatives 1.

For both 2035 Alternatives 2 and 3, the train operations at South Station would be identical to the Transportation Improvements Only Alternative. The area along Dorchester Avenue would be developed with a combination of residential, hotel, office space, and commercial space. This development would effectively shield the area across the Fort Point Channel from the train noise from South Station. In addition, other Joint/Private Development at South Station would include the development of the air rights over the entire tracks and platform area at South Station. As a result, the area of South Station where the trains operate would be enclosed, thus eliminating any potential noise impact in the areas surrounding the station. The noise generated by the trains inside the station would be contained within this enclosed area. Only the area south of the station where the trains enter and depart from South Station would be open, allowing any noise to escape from this enclosed area. Therefore, under Alternatives 2 and

3, there would be no noise impact from the train operations associated with the South Station Expansion project.

For 2035 Alternatives 2 and 3, however, the noise levels inside the station area (tracks and platforms), would increase by 3 to 5 dBA depending on the reverberation characteristics of the enclosed space. The higher noise levels could affect the speech intelligibility of the public address system on the platforms. The use of sound absorption materials on the interior walls and ceiling surfaces, and the number and location of the PA speakers could be used to improve speech intelligibility. The issue of speech intelligibility would be addressed during the design phase of the station enclosure.

6.2 Vibration Impacts

As a result of the slow speed of the trains (approximately 10 mph) entering and leaving South Station, the vibration levels generated by the trains would be below the FTA human annoyance criteria of 72 VdB for residential receptors, and 75 VdB for non-residential receptors. These FTA vibration impact levels are from Table 2 for frequent train events. These vibration levels are well below the impact criterion for the onset of structural damage to buildings (100 VdB). Using the FTA vibration curves in Figure 3 for locomotives and railcars, and adjusting these curves for train speed (10 mph), results in an impact distance for residential receptors of three feet from the railcars, and 40 feet from the locomotives. This means that a residential receptor (i.e. home) would have to be located within three feet of a railcar or 40 feet of a locomotive to receive a vibration level of 72 VdB or higher. For non-residential receptors, the impact distance would be 25 feet for a locomotive. Since there are no sensitive receptors located within these impact distances at South Station, vibration impacts are not expected from the South Station Expansion project. In addition, because of the low vibration levels generated by the trains, the train activity at South Station is not expected to result in any ground-borne noise inside the buildings.

For the building at 245 Summer Street, where vibration sensitive computer equipment is located in the basement of the building, the FTA criterion of 65 VdB (from

Table 2 for Category 1 receptors) was used to assess the potential for impact. For a vibration level of 65 VdB, the impact distances are 15 feet for railcars, and 80 feet for locomotives. Since the building at 245 Summer Street is located more than 80 feet from the nearest track, and because the trains would almost be at a stop, the vibration levels would be even lower. As a result, the vibration levels from the train activity at South Station are not expected to result in a vibration impact at this building.

At the three proposed layover facilities, residential receptors are not located within the impact distance of 40 feet from a locomotive operating in the layover facility. At Widett Circle, the nearest residential receptors along Albany Street are located approximately 1,300 feet from the acoustic center of the layover facility. At Beacon Park Yard, the nearest residential receptors along Wadsworth Street are located approximately 50 feet from the nearest track within the layover facility. Any vibration generated by the trains operating in the layover facility would be significantly lower than the vibration levels generated by the commuter rail trains traveling at 50 mph along the rail line adjacent to these residences. At the Readville - Yard 2, the nearest residential receptors along Wolcott Street are located approximately 200 feet from the nearest locomotives at the layover facility.

For locomotives traveling over switches and crossovers in the layover facility, vibration levels could increase by up to 10 VdB due to the impact of the locomotive wheels with the breaks in the tracks. As a result of this increase in vibration level, a residential receptor located within 130 feet of a switch or crossover could receive a vibration level that would exceed the FTA annoyance criterion of 72 VdB for residential receptors. At Beacon Park Yard, the nearest layover track is approximately 50 feet from the residential receptors along Wadsworth Street. This could result in a vibration impact depending on the location of the switch and the distance to the residential receptors. The residences along Wadsworth Street and Pratt Street are currently impacted by the vibration levels from the MBTA commuter rail trains that operate along the mainline track that is only 30 feet from these residential receptors. Vibration levels from trains passing by traveling at approximately 50 mph would generate a vibration level of approximately 88 VdB at these residential receptors. Because of the existing vibration levels along Wadsworth Street and Pratt Street, there would be no increase in the vibration levels from the train operations in the layover facility.

The vibration levels generated by the train activity at the layover facilities at Widett Circle and Readville – Yard 2, however, are not expected to result in an impact at the nearest residential receptors. At these two locations, no residential receptors are located within 40 feet of a locomotive, or 130 feet of a switch or crossover.

6.3 Construction Noise and Vibration Impacts

Typical construction equipment that would be used during the demolition of the USPS facility and the construction of the South Station Expansion project could include excavators, front-end loaders, bulldozers, cranes, jack hammers, mounted impact hammers, and trucks. The FTA construction noise impact assessment is based on the combined noise level from the two loudest pieces of equipment that, under worse-case conditions, would be operating continuously at full power for one hour. The two loudest pieces of equipment would be a mounted impact hammer (90 dBA at 50 feet) and an excavator (85 dBA at 50 feet). The combined Leq noise level from these two pieces of equipment is 91 dBA at a distance of 50 feet. For residential receptors, the FTA hourly Leq construction noise limit is 90 dBA. For commercial receptors, the FTA hourly Leq construction noise limit is 100 dBA. Using a sound attenuation factor of 6 dB per doubling of distance for a point source, and extrapolating the combined construction equipment noise level of 91 dBA at 50 feet, results in a noise level of 90 dBA (for a residential receptor) at a distance of 55 feet from the construction activity, and a noise level of 100 dBA (for a commercial receptor) at a distance of 15 feet from the construction activity. Since there are no residential receptors within 55 feet of the construction activity, or commercial receptors within 15 feet of the construction activity, construction noise levels from the South Station Expansion project are not expected to exceed the FTA construction noise limits.

The City of Boston L10 construction noise limits (the noise level exceeded 10% of the time) are 75 dBA for residential receptors, and 80 dBA for commercial and business receptors. The project combined Leq noise level from the two noisiest pieces of equipment operating continuously at full power for one hour during construction at the South Station site is 91 dBA at 50 feet. Since the construction equipment would be operating continuously for one hour, the Leq and the L10 noise levels are the same. Using a distance attenuation factor of 6 dB per doubling of distance for a point source, a residential receptor located within 300 feet of such construction activity would exceed the 75 dBA L10 noise limit, while a commercial/business receptor located within 200 feet of the construction activity would exceed the 80 dBA L10 construction noise limit. Most of the demolition and construction activity would occur along the east side of South Station along Dorchester Avenue. At this location, there are no residential receptors within 300 feet of the construction activity. The building at 245 Summer Street and the South Station headhouse are both located within 200 feet of the construction activity, however, and would be impacted by construction noise.

Vibration levels generated by the construction equipment proposed for this project would not result in any structural damage to nearby buildings. Vibration levels from the typical construction equipment used on this project would range from 80 VdB for a jackhammer at a distance of 25 feet to 87 VdB for a mounted impact hammer at a distance of 25 feet. These vibration levels are well below the building damage threshold of 100 VdB. These vibration levels would exceed the FTA human annoyance criterion of 75

VdB, however, as well as the FTA criterion of 65 VdB for buildings with vibration sensitive equipment such as the building at 245 Summer Street. At the three layover facilities, because there are no buildings located within 25 feet of the construction activity, vibration levels during construction would be below 87 VdB.

In addition, the use of impact pile drivers that generate higher vibration levels (104 to 110 VdB at a distance of 25 feet from the pile driver) should be avoided. A pile driver with a vibration level of 110 VdB at a distance of 25 feet would result in a vibration level of 100 VdB (the threshold for building damage) at a distance of 65 feet. Therefore, any building within 65 feet of an impact pile driver could be subjected to potential damage.

7. Proposed Mitigation

The results of the noise assessment at South Station indicate that for Alternative 1, the noise levels at several receptors are expected to exceed the FTA moderate impact criteria. These receptors include the building at 245 Summer Street and the area across Fort Point Channel. A noise barrier along between the length of the easternmost track and Dorchester Avenue would reduce the noise levels from South Station at sensitive-receptors across Fort Point Channel. The height of the noise barrier should extend approximately 3 feet above the height of the locomotive to reduce the noise levels from the idling locomotives by approximately 10 dBA. When the private development along Dorchester Avenue (Alternatives 2 and 3) is completed, however, the station area would be enclosed, and the noise barrier would no longer be necessary. A noise barrier between the building at 245 Summer Street and South Station would reduce the noise levels at this building. Although these noise barriers would reduce the noise levels from the South Station Expansion project, other issues such as structural considerations, and the feasibility and reasonableness of constructing the noise barriers should also be addressed during final design.

At the Beacon Park Yard site, a noise barrier could be installed along the MBTA's Framingham/Worcester Line, which is at the south side of the site, adjacent to the residential receptors. The chain link fence currently installed at this location only provides security to keep people away from the tracks. This noise barrier would reduce the noise levels from the layover facility at the residential receptors along Wadsworth Street and Pratt Street. In addition, this noise barrier also would reduce the noise levels from the existing MBTA commuter rail trains operating in this corridor. This noise barrier would extend the length of Wadsworth Street and Pratt Street between the two industrial buildings at either end of this area.

At the Readville - Yard 2 site, a noise barrier on top of a berm exists between the layover facility and the residences located along Wolcott Street. This noise barrier would be extended to include the layover facility expansion area and the apartment buildings along Riley Road. This noise barrier would reduce the noise levels from the layover facility at the residential receptors along Wolcott Street and Riley Road.

To reduce the vibration impacts from the track switches and crossovers at the Beacon Park Yard, the switches should not be located within 130 feet of any residential receptor. If it is not possible to relocate the switches, then ballast mats would be installed under the switches.

The demolition and construction activity associated with the South Station Expansion project would impact 245 Summer Street and the South Station headhouse. As a result, noise barriers would be required to mitigate the construction noise levels at these receptors. As with other major construction projects in the City of Boston, the contractor would be required to submit a Construction Noise Control Plan to indicate the methods to mitigate construction noise levels, and to provide noise monitoring during construction to determine compliance with the FTA and the City of Boston construction noise limits. The

Noise Control Plan would include a detailed construction noise assessment based on the contractor's actual proposed construction program. Detailed construction noise calculations would be provided for each phase of construction (site preparation, demolition, excavation, concrete pouring, track laying, etc.). For each phase of construction, a detailed list of construction equipment including the type and location of each piece of equipment, the location of each construction activity, and whether the construction activity would occur during the daytime, evening, or nighttime hours. Reference construction equipment source noise levels (Lmax at 50 feet) from the FTA guidance manual for each piece of equipment would be used in the construction noise assessment. Construction noise levels for each phase of construction would be calculated at each of the closest sensitive receptors. If the construction noise levels are predicted to exceed the FTA or City of Boston construction noise limits, then appropriate noise mitigation measures such as noise barriers would be evaluated to determine the appropriate location, height, and length of the noise barrier to provide effective mitigation. Noise monitoring would be conducted during construction to determine compliance with the FTA and City of Boston construction noise limits. In addition, because of the vibration sensitive equipment in the basement of the building at 245 Summer Street, vibration measurements should be obtained inside the building to ensure that the vibration levels do not exceed equipment specifications.

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