



TIER 1 FINAL ENVIRONMENTAL IMPACT STATEMENT
VOLUME 1 (PREFERRED ALTERNATIVE)



7.12 Noise and Vibration

7.12 NOISE AND VIBRATION

7.12.1 Introduction

This chapter analyzes and identifies counties associated with the Preferred Alternative where moderate or severe noise and vibration impacts are predicted to occur. This chapter also includes analysis of the existing Northeast Corridor (NEC) and No Action Alternative for comparative purposes. The analysis reflects the use of readily available information and does not include any field investigations to confirm the existing land use or to conduct site-specific noise measurements. Volume 2, Appendix E.12, provides the effects-assessment methodology developed by the Federal Railroad Administration (FRA) to assess noise and vibration effects for NEC FUTURE.

Noise—typically defined as unwanted or undesirable sound—is generated by railway-related sources such as vehicle engines, wheel-rail interaction, and audible warning devices, including train horns, which may cause annoyance at nearby sensitive receptors. In the case of high-speed rail, aerodynamic noise can be generated when train speeds start to exceed 160 miles per hour (mph).

Vibration—defined as oscillatory motion—is generated by wheel-rail interaction from railway operations. Such vibration is transmitted through the track structure into the ground and may be perceptible and disturb people or sensitive activities in nearby buildings.

Volume 2, Appendix E.12, includes a full discussion of the resource and effect-assessment methodology. The FRA defined the Affected Environment as a 5,000-foot-wide swath centered along the Representative Route. For the Representative Route of the Preferred Alternative, the FRA performed, and presents in this section, a quantitative noise assessment for Day-Night Sound Levels, Ldn (dBA),¹ and a quantitative vibration assessment for Vibration Velocity Level² (VdB). For the assessment of the Preferred Alternative, the FRA included noise and vibration evaluations and effects associated with communities in Connecticut and Massachusetts for the Hartford/Springfield Line, which is included in the Preferred Alternative.

7.12.2 Resource Overview

Land uses sensitive to noise and vibration within the Affected Environment include residential, institutional, and park lands. Within the Study Area, the areas of greatest concern for noise and vibration effects include densely populated areas, particularly those that are not currently within existing rail or highway corridors and therefore have lower existing noise and vibration levels. These areas include dense urban areas with residential and institutional land use in Baltimore, Philadelphia, northern New Jersey, New York City, and Providence, as well as suburban areas in

¹ Ldn, or Day-Night Sound Level, is expressed in A-weighted decibels (dBA) and represents an average noise level evaluated over 24 hours in which a 10 dBA "penalty" is added to the hourly equivalent noise level for each of the nine nighttime hours (10 PM to 7 AM) to account for both increased human sensitivity to nighttime noise during quiet activities (such as sleeping) and the reduction in ambient noise levels during the nighttime hours.

² Vibration velocity level refers to the vibration magnitude as a mathematically averaged level, or Root Mean Square (RMS) level, which represents how much the ground is moving due to the rail vibration. The RMS vibration velocity level is used to describe rail vibration because it has been shown to correlate well to human response to environmental vibration. Vibration velocity is expressed in vibration decibels (VdB) relative to one micro-inch per second (VdB re: 1 micro-inch/second).

New Castle, DE, Westchester County, NY, and communities in Connecticut. Areas with concentrations of other sensitive land use, such as parks, wildlife refuges and cultural/historic resources, are also of concern.

Key findings for the analysis of the effects of the NEC FUTURE Preferred Alternative on noise and vibration are listed below:

- ▶ **Benefits:** The Preferred Alternative minimizes the potential for noise and vibration impacts by using existing rail corridors along the majority of the Representative Route. It also eliminates projected noise and vibration impacts in several counties in New York, Connecticut, and Massachusetts that were previously part of the Representative Routes of the Action Alternatives as described in Volume 2.
- ▶ **Impacts:** The estimated population affected by the Preferred Alternative is projected to be 148,510 (severe impacts), 203,400 (moderate impacts), and 47,530 (vibration impacts). The approximate total population count is 4,713,911 within the 5,000-foot-wide swath defined as the Affected Environment for noise and vibration. This Affected Environment was kept sufficiently wide to consider a conservative area within which noise and vibration impacts may occur as a result of project operations and to encompass and account for potential noise sources including infrastructure improvements, ancillary facilities, or service changes that may develop as the project continues. Based on the 5,000-foot-wide swath total population count, the estimated percentage of the population affected by the Preferred Alternative is projected to be 3 percent (severe impacts), 4 percent (moderate impacts), and 1 percent (vibration impacts).

7.12.3 Affected Environment

Volume 2, Section 7.12.3, discusses existing transportation-related noise and vibration sources within the Affected Environment, and applicable FRA methodology on land uses. Table 7.12-1 indicates the land uses identified for the Preferred Alternative.

The FRA evaluated the existing noise and vibration levels for the Preferred Alternative. The FRA used a distance of 100 feet—a standard reference for railway noise and vibration in the United States—as a reference distance to estimate existing noise and vibration levels for the Preferred Alternative along the existing NEC and Hartford/Springfield Line. Volume 2, Appendix E.12, contains a more detailed description of the noise and vibration within the Affected Environment, including existing noise and vibration levels 50 feet–800 feet from the Preferred Alternative. Volume 2, Appendix E.12, also contains information on noise metrics.

Table 7.12-2 provides the ranges for existing noise and vibration levels by state and county. This represents conditions at sensitive receptors closest to the Preferred Alternative. The existing noise levels are fairly high, with noise exposure levels (Ldn) that are typically in the range of 55–75 dBA. To put these levels into perspective, the Department of Housing and Urban Development defines an Ldn of 65 dBA as the onset of a normally unacceptable housing environment, and the Federal Aviation Administration considers residential land uses not compatible with noise environments where Ldn is greater than 65 dBA.

Table 7.12-1: Affected Environment: Noise and Vibration – Land Use

Geography	County	Noise- and Vibration-Sensitive Land Use
D.C.		Residences, schools, religious facilities, and parks
MD	Prince George's	Residences, schools, religious facilities, and parks
	Anne Arundel	Residences, religious facilities, and parks
	Baltimore	Residences, schools, religious facilities, cemeteries, hospital, and parks
	Harford	Residences, schools, religious facilities, and parks
	Cecil	Residences, schools, religious facilities, and parks
DE	New Castle	Residences, schools, religious facilities, health care center, prison, and parks
PA	Delaware	Residences, schools, religious facilities, and parks
	Philadelphia	Residences, schools, religious facilities, cemetery, hospital, prison, and parks
	Bucks	Residences, schools, religious facilities, cemeteries, and parks
NJ	Mercer	Residences, schools, religious facilities, and parks
	Middlesex	Residences, schools, religious facilities, and parks
	Union	Residences, schools, religious facilities, cemeteries, and parks
	Essex	Residences, schools, religious facilities, cemeteries, and parks
	Hudson	Residences, schools, religious facilities, and parks
NY	New York	Residences, schools, religious facilities, hospitals, hotels, and parks
	Kings	Residences
	Queens	Residences, schools, religious facilities, cemeteries, and parks
	Bronx	Residences, schools, religious facilities, hospital, hotel, and parks
	Westchester	Residences, schools, religious facilities, cemeteries, library, prison, and parks
CT	Fairfield	Residences, schools, religious facilities, hotels, cemeteries, hospitals, and parks
	New Haven	Residences, schools, religious facilities, hospitals, cemeteries, hotel, libraries, performing arts center, and parks
	Hartford	Residences, schools, religious facilities, cemeteries, hospitals, libraries and parks
	Middlesex	Residences, schools, religious facilities, and parks
	New London	Residences, schools, religious facilities, hospitals, hotels, and parks
RI	Washington	Residences, schools, religious facilities, medical facilities, cemeteries, and parks
	Kent	Residences, school, religious facility, library, and hotels
	Providence	Residences, schools, religious facilities, hospitals, hotel, prison, cemetery, library, parks, and the Rhode Island State House
MA	Bristol	Residences, schools, and religious facilities
	Norfolk	Residences, schools, religious facilities, cemeteries, and parks
	Suffolk	Residences, schools, religious facilities, hospitals, and parks
	Hampden	Residences, school, religious facilities and libraries

Source: NEC FUTURE team, 2016

Table 7.12-2: Affected Environment: Noise and Vibration – Existing Levels

Geography	County	Noise Exposure (Ldn) at 100 ft. from Representative Route (dBA)	Max. Vibration Velocity Level at 100 ft. from Representative Route (VdB)	
D.C.	District of Columbia	68	87	
MD	Prince George's	72	87	
	Anne Arundel	72	87	
	Baltimore Co.	72–75	87	
	Baltimore City	60–71	50–87	
	Harford	71–75	87	
	Cecil	74–75	87	
DE	New Castle	66–74	87	
PA	Delaware	66–70	87	
	Philadelphia	60–69	87	
	Bucks	71–72	87	
NJ	Mercer	68–73	87	
	Middlesex	69–74	87	
	Union	75	87	
	Essex	70–71	87	
	Hudson	60–75	87	
NY	New York	60–73	77–87	
	Kings*	—	—	
	Queens	60–68	77–87	
	Bronx	65–68	77–87	
	Westchester	70–71	87	
CT	Fairfield	65–71	87	
	New Haven	To Boston	55–70	87
		To Springfield**	64–74	87
	Hartford**	64–74	77–87	
	Middlesex	68	87	
	New London	50–75	50–87	
RI	Washington	50–69	50–87	
	Kent	69–71	87	
	Providence	60–71	87	
MA	Bristol	68	87	
	Norfolk	67–68	87	
	Suffolk	60–68	87	
	Hampden**	66–73	87	

Source: NEC FUTURE team, 2016

* The existing NEC does not go through Kings County.

** These counties include the existing Hartford/Springfield Line to Springfield, MA.

For vibration, values in Table 7.12-2 indicate existing maximum levels of 87 VdB, which is above the FRA/Federal Transit Administration (FTA) criteria of 72–75 VdB for residential land use based on the current train volumes.

7.12.4 Environmental Consequences

This analysis focused on identifying the population within the projected noise and vibration impact zones for the existing NEC, No Action Alternative, and Preferred Alternative. Areas of severe and moderate noise impact and areas of vibration impact were determined based on the estimated existing and future noise and vibration levels using applicable FRA/FTA prediction methods and criteria. The populations with potential impacts were then identified based on census tract data for the impact areas. The following sections discuss the key findings of the Environmental Consequences analysis.

7.12.4.1 No Action Alternative

The FRA did not evaluate the noise and vibration levels for the No Action Alternative in the Tier 1 Draft EIS because the operations along the existing NEC are not expected to change with the exception of a few minor differences in train equipment; therefore, no new noise and vibration impacts are expected to occur. However, there are predicted changes from the existing condition along the Hartford/Springfield Line in the No Action Alternative. As such, the FRA evaluated the noise and vibration impacts of operations under the No Action Alternative for the Hartford/Springfield Line for the Tier 1 Final EIS.

Table 7.12-3 provides ranges by state and county for the No Action Alternative noise levels along the existing Hartford/Springfield Line. Under the No Action Alternative, there is an approximate 40–50 percent increase in noise from existing conditions, a result of the increase in operations. However, maximum vibration levels are expected to be the same because the train types that are the source of the vibration levels are not changing. Noise levels (Ldn) associated with operations under the No Action Alternative are typically in the range of 65–76 dBA. Table 7.12-4 lists by state and county the estimated populations affected by this noise; these populations live within the projected FRA/FTA severe and moderate noise impact zones along the Hartford/Springfield Line.

For vibration, values in Table 7.12-3 indicate existing maximum levels of 87 VdB, which is above the FRA/FTA criteria of 72–75 VdB for residential land use based on the current train volumes. However, there are no projected vibration impact zones for the No Action Alternative since there is no change in maximum vibration level from existing conditions along the Hartford/Springfield Line.

Table 7.12-3: Environmental Consequences: Noise and Vibration – No Action Alternative

State	County	Results at 100 ft. from Representative Route			
		Noise Exposure Ldn (dBA)	Change in Noise Exposure Ldn (dBA)	Maximum Vibration Level (VdB)	Change in Maximum Vibration Level (VdB)
CT	Hartford	65–75	0–2	87	0
	New Haven	65–76	1–2	87	0
MA	Hampden	66–75	0–2	87	0

Source: NEC FUTURE team, 2016

Dark gray shading = Areas with noise or vibration impact; Bold type font = Areas with severe noise impact

**Table 7.12-4: Environmental Consequences: Noise Residential Impacts – No Action
Alternative (Hartford/Springfield Line)**

State	County	Estimated Population within Severe Noise Impact Zones	Estimated Population within Moderate Noise Impact Zones
CT	Hartford	760	4,840
	New Haven	860	4,200
MA	Hampden	0	630
TOTAL		1,620	9,670

Source: NEC FUTURE team, 2016

7.12.4.2 Preferred Alternative

Chapter 4 provides more information about the service levels and the Representative Route of the Preferred Alternative. Table 7.12-5 summarizes by state and county the future noise and vibration conditions in terms of the estimated future levels and changes in noise levels (from existing to future conditions) for the Representative Route. Noise levels (Ldn) associated with operations under the Preferred Alternative are typically in the range of 65–82 dBA. The counties with the greatest changes in noise exposure (from existing to conditions under the Preferred Alternative) are Harford and Cecil Counties, MD; New London, CT; and Washington, RI. Kings County, NY, includes only a small portion of a new tunnel section in the Preferred Alternative and is the only county without noise impact under the Preferred Alternative.

Along the Representative Route of the Preferred Alternative, noise levels are generally highest in Maryland, Delaware, New York, and New Jersey, and lowest in Washington, D.C., Rhode Island, and Massachusetts.

Table 7.12-5 presents data indicating maximum vibration levels associated with the Preferred Alternative to be in the range of 67–87 VdB.

Table 7.12-6 lists by state and county the estimated populations within the projected FRA/FTA severe and moderate noise impact and vibration impact zones. There are no projected vibration impact zones along the existing Hartford/Springfield Line under the Preferred Alternative since there is no change in maximum vibration level from existing conditions.

In addition to residential population, other sensitive land uses could be affected by increases in noise and vibration. As shown in Table 7.1-5, all counties included in the Preferred Alternative, with the exception of Kings County, NY, are predicted to have moderate or severe noise impacts. Increased noise levels could result in indirect effects on parklands (Chapter 7.4), ecological resources, including ecologically sensitive habitats, threatened and endangered species, and essential fish habitat (Chapter 7.6) and cultural resources (Chapter 7.9) identified within those same counties. Similarly, increased vibration levels could also result in indirect effects to those same resources for counties identified as having vibration impacts. See Table 7.1-5 for counties identified as having vibration effects.

Table 7.12-5: Environmental Consequences: Noise and Vibration – Preferred Alternative

Geography	County		Results at 100 ft. from Representative Route			
			Noise Exposure Ldn (dBA)	Change in Noise Exposure Ldn (dBA)	Maximum Vibration Level (VdB)	Change in Maximum Vibration Level (VdB)
D.C.	District of Columbia		71–72	3	87	0
MD	Prince George's		75–76	3 to 4	87	0
	Anne Arundel		75–76	3 to 4	87	0
	Baltimore Co.		76–80	2 to 14	70–87	1 to 9
	Baltimore City		65–73	-3 to 3	87	0 to 37
	Harford		72–80	4 to 26	70–87	9 to 30
	Cecil		76–80	3 to 30	70–87	1 to 30
DE	New Castle		68–82	2 to 16	77–87	0 to 30
PA	Delaware		70–78	4 to 11	79–87	8 to 8
	Philadelphia		66–74	-2 to 6	77–87	8 to 8
	Bucks		75–75	3 to 4	87	0
NJ	Mercer		71–76	2 to 3	87	0
	Middlesex		68–76	-2 to 14	85–87	30 to 37
	Union		69–77	-6 to 2	87	0
	Essex		66–73	-4 to 2	87	0
	Hudson		75–79	0 to 4	87	0
NY	New York		79–79	0 to 6	77–87	0 to 37
	Kings*		0	0	87	37
	Queens		66–74	3 to 9	77–87	0 to 37
	Bronx		67–75	2 to 7	77–87	0
	Westchester		72–79	2 to 12	77–87	16 to 26
CT	Fairfield		68–78	1 to 12	77–87	16 to 26
	New Haven	To Boston	69–75	5 to 7	87	0
		To Springfield **	67–78	2–5	87	0
	Hartford**		67–78	0 to 6	87	0
	Middlesex		73	5	67–77	6 to 27
	New London		68–74	1 to 23	67–77	6 to 27
RI	Washington		68–73	2 to 23	67–79	17 to 27
	Kent		73–74	3 to 4	0	0
	Providence		69–74	3 to 4	0	0
MA	Bristol		73	5	0	0
	Norfolk		71–73	5 to 6	77–77	0
	Suffolk		66–74	3 to 6	0	0
	Hampden**		68–78	2 to 5	87	0

Source: NEC FUTURE team, 2016

* A value of "0" indicates that no projected FRA/FTA severe or moderate noise impact zones occur in Kings County.

** These counties include the existing Hartford/Springfield Line to Springfield, MA.

Dark Gray shading = Areas with noise or vibration impact.

Bold type font = Areas with severe noise impact.

Table 7.12-6: Environmental Consequences: Noise Residential Impacts – Preferred Alternative

Geography	County	Estimated Population within Noise Impact Zones			
		Noise		Vibration	
		Severe	Moderate		
D.C.	District of Columbia	880	1,540	0	
MD	Prince George's	2,870	6,010	0	
	Anne Arundel	2,020	3,570	0	
	Baltimore Co.	3,450	4,990	80	
	Baltimore City	2,140	3,930	5,070	
	Harford	6,580	5,840	1,140	
	Cecil	3,880	8,480	380	
DE	New Castle	6,380	10,090	260	
PA	Delaware	1,260	1,710	340	
	Philadelphia	7,740	9,600	3,030	
	Bucks	2,080	4,140	0	
NJ	Mercer	1,750	3,310	0	
	Middlesex	5,130	6,840	10,310	
	Union	2,310	4,920	0	
	Essex	920	1,930	0	
	Hudson	1,040	1,710	0	
NY	New York	340	400	220	
	Kings*	0	0	260	
	Queens	12,680	9,940	17,540	
	Bronx	10,070	10,280	0	
	Westchester	11,170	12,120	780	
CT	Fairfield	23,260	21,990	6,630	
	New Haven	To Boston	8,400	9,310	0
		To Springfield **	4,070	8,850	0
	Hartford**	5,570	14,350	0	
	Middlesex	470	690	10	
	New London	1,250	4,230	1,119	
RI	Washington	1,460	3,370	364	
	Kent	1,190	1,590	0	
	Providence	4,930	7,660	0	
MA	Bristol	2,380	3,320	0	
	Norfolk	1,680	2,260	0	
	Suffolk	7,720	10,910	0	
	Hampden**	1,440	3,530	0	
TOTAL		148,510	203,400	47,530	

Source: NEC FUTURE team, 2016

* A value of "0" indicates that no projected FRA/FTA severe or moderate noise impact zones occur in Kings County.

** These counties include the existing Hartford/Springfield Line to Springfield, MA.

Because noise and vibration impact depend on both existing and future levels according to FRA/FTA criteria, the estimated ranges of level changes (shown in Table 7.12-5 and Table 7.12-6) are not always directly indicative of potential impact. For example, noise impact can occur even when the projected noise increase is small if the existing noise levels are very high. In the case of vibration, the future levels must exceed the criteria and vibration events must significantly increase for impact to occur. This may require large vibration increases in areas where the existing levels are imperceptible and well below the limit. Thus, to supplement the information in Table 7.12-5, the counties that include areas where impact is projected are highlighted in the tables (Dark Gray shading = Areas with noise or vibration impact; bold type font = Areas with severe noise impact).

Tier 1 project studies typically do not include a quantitative noise analysis of stationary noise source activities. The noise effects of stationary sources—such as maintenance facilities or other track locations where locomotives may be idling—are very localized and based upon detailed design information. However, in the Tier 1 Final Environmental Impact Statement (Tier 1 Final EIS), the FRA includes a qualitative discussion of potential noise impacts from such activities for analysis that will be performed during subsequent Tier 2 project studies. In yards and other locations where locomotives will dwell and idle, onboard or offboard idle reduction technology should be considered as tools for reducing noise impacts.

In general, facilities such as rail maintenance yards are located in industrial or commercial areas. If locomotives idle near are idling in the vicinity of noise-sensitive land use, the difference in impact would be insignificant where impacts from NEC operations are already identified. In areas where idling trains may introduce a new project source near noise-sensitive land use, additional impacts may occur up to 1,000 feet from idling locomotives in rural areas and 650 feet from idling locomotives in suburban or urban areas, with intervening buildings providing some shielding from the train noise source.

7.12.5 Context Area

The areas of greatest concern within the 5-mile-wide Context Area are those with the greatest concentration of residences and other sensitive land uses, such as parklands and ecological resources.

7.12.6 Comparison to the Action Alternatives

On average, potential noise impact for the Preferred Alternative would increase by approximately 20 percent compared to the Action Alternatives. The Preferred Alternative would approximately double the amount of affected population compared to Alternative 1, but would reduce noise impact by approximately 25 percent compared to Alternative 3. The Preferred Alternative would reduce noise impact in most counties compared to Alternative 3, except for a few areas in Connecticut and Maryland. While the Preferred Alternative would introduce some additional noise impact in Connecticut and Hampden, MA, along the Hartford/Springfield Line, the Preferred Alternative would eliminate several counties in New York, Connecticut, and Massachusetts with noise impact in Alternatives 2 and 3.

Potential vibration impact for the Preferred Alternative would decrease by approximately 25 percent compared to the Action Alternatives. The Preferred Alternative would have comparable

vibration impact to Alternative 2, except along the Hartford/Springfield Line, which was not included in the Action Alternatives. There is no vibration impact predicted along the Hartford/Springfield Line, which includes Hartford and New Haven Counties, CT.

7.12.7 Potential Mitigation Strategies

Potential noise and vibration mitigation strategies will focus on minimizing impacts at the source (e.g., vehicle treatments, track treatments and horn-free quiet zones), along the transmission path (e.g., sound barriers and track vibration isolation treatments), and at the receiver (e.g., building sound insulation treatments).

7.12.8 Subsequent Tier 2 Analysis

This Tier 1 analysis identifies areas where sensitive land uses would be affected by noise and vibration impacts of the Preferred Alternative. However, this analysis does not include detailed design information, and does not include a quantitative analysis of impacts from ancillary facilities, stations, and project-related changes in roadway and aircraft traffic. Tier 2 project analyses will identify the actual numbers of affected residences, the types of land uses, and locations of sensitive receptors, and will include a quantitative evaluation of potential noise and vibration effects on wildlife and natural parks. The development of mitigation measures and designs to address site-specific impacts that will avoid or minimize noise and vibration effects will also be included in the Tier 2 project analyses.