

13. Vibration

13.1. Chapter Overview

13.1.1. Introduction

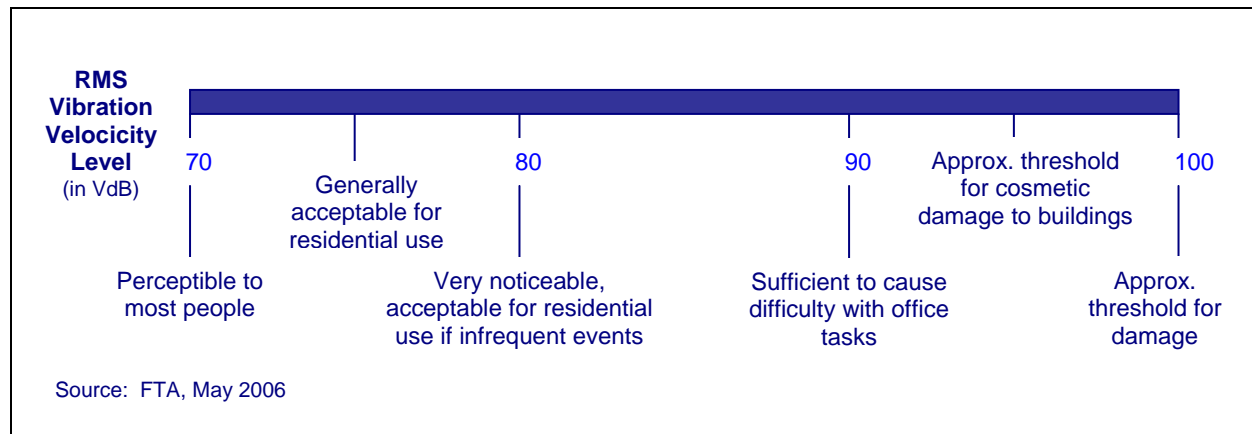
This chapter describes applicable vibration standards and criteria and also identifies high-sensitivity resources within the Northern Branch Corridor. In addition, this chapter estimates project-generated vibration impacts associated with each Build Alternative.

Vibration, which may be felt by adjacent properties, is typically generated as a result of the travel of train wheels rolling over rail. Ground-borne vibration is a common concern with rail transit projects and is manifested in the noticeable movement of building floors, rattling windows, shaking of items on shelves or hanging on walls, and rumbling sounds. Building damage is typically not a factor for normal transportation projects. Ground-borne vibration does not typically annoy people who are outdoors.

The level of vibration received at a neighboring structure is a function of the type of trains, track system and condition, speeds, distance from track, typical geological condition, and type of receiving structure.

The motion due to ground-borne vibration is described in vibration velocity levels, measured in decibels referenced to 1 micro-inch per second. Generally, the abbreviation for vibration decibels (VdB) is used to avoid potential confusion with the decibel used to describe sound levels. Typical ground-borne vibration levels are shown in Figure 13-1

Figure 13-1: Typical Ground-borne Vibration Levels



13.1.2. Summary of Findings

Light Rail to Tenafly (Preferred Alternative) and Light Rail to Englewood Route 4 would not impact residences or high-sensitivity resources between North Bergen and Englewood Route 4. Light Rail to Tenafly (Preferred Alternative) would impact three resources, Bennett Studios and a residence in downtown Englewood, and a residence in downtown Tenafly. Potential impacts to these resources resulting from the Light Rail to Tenafly (Preferred Alternative) can be mitigated during design such that the resources would not be impacted by the project. For the tracks near the two noted residences, high resilience fasteners would be incorporated into the design. For the tracks near Bennett Studios, resiliently supported ties will be used. Under Light Rail to Englewood Route 4, no vibration impacts would result as this alternative terminates at Route 4. Table 13-1 details the estimated project vibration level, and the mitigated vibration level, as compared to FTA's impact criteria.

Table 13-1: Vibration Levels of Buildings Impacted by Light Rail to Tenaflly (Preferred Alternative)

Building	Criteria	Estimated Project Vibration Level	Mitigated Vibration Level
<i>Englewood</i>			
Bennett Studios	65 VdB	73 VdB	63 VdB
Residence	72 VdB	74 VdB	69 VdB
<i>Tenaflly</i>			
Residence	72 VdB	73 VdB	68 VdB

13.2. Methodology

The methodology for this assessment involved a review of the FTA's *Transit Noise and Vibration Impact Assessment* published in May 2006. This document serves as the FTA's most recent guidance manual for the assessment of noise and vibration impacts in transportation projects. The manual establishes the methods and procedures for determining the level of noise and vibration impact resulting from Federally-funded transit projects and for determining what can be done to mitigate such impact. An assessment for potential vibration impacts as it applies to the Northern Branch Corridor was prepared based on a review of the criteria described below.

13.2.1. Criteria

The impact criteria for transit projects, as defined in the *Transit Noise and Vibration Impact Assessment*, are expressed for the three following land use categories:

- Category 1:** High Sensitivity – Buildings where vibration would interfere with operations within the building, which may be well below levels associated with human annoyance, such as research laboratories.
- Category 2:** Residential – This category covers all residential land uses and any buildings where people sleep, such as hotels and hospitals.
- Category 3:** Institutional – This category includes schools, churches, other institutions, and quiet offices that do not have vibration-sensitive equipment, but still have the potential for activity interference.

Impacts are determined by estimating future ground-borne vibration levels and comparing those levels to the criteria shown in Table 13-2. As this project would have more than 70 events per day, this assessment uses the criteria for frequent events.

Table 13-2: Ground-Borne Vibration and Noise Impact Criteria

Land Use Category	Ground-Borne Vibration Impact Levels (VdB re 1 micro in/sec)	
	Frequent Events (1)	Infrequent Events (2)
Category 1: Buildings where vibration would interfere with interior operations.	65 VdB	65 VdB
Category 2: Residences and buildings where people normally sleep.	72 VdB	80 VdB
Category 3: Institutional land uses with primarily daytime use.	75 VdB	83 VdB
(1) "Frequent Events" is defined as more than 70 vibration events per day. Most rapid transit projects fall into this category. (2) "Infrequent Events" is defined as fewer than 70 vibration events per day. This category includes most commuter rail systems. This criterion limit is based on levels that are acceptable for most moderately sensitive equipment such as optical microscopes. Vibration-sensitive equipment is not sensitive to ground-borne vibration noise.		

Source: FTA's Transit Noise and Vibration Impact Assessment (May 2006).

13.2.2. General Vibration Assessment

A general vibration assessment was conducted according to the procedures identified in FTA's *Noise and Vibration Guidance Manual* in order to identify the potential for vibration impacts associated with the Build Alternatives. According to the FTA guidance manual, for areas with infrequent existing rail traffic, less than three trains per day, existing vibration measurements are not required. To determine the distance within which an impact would occur, the "Generalized Ground Surface Vibration Curves", shown in Figure 13-2, and the impact criteria described in the FTA guidance manual were utilized. According to the suggested FTA guidance, the light rail vehicle uses the Rapid Transit/Light Rail Vehicle curve. The curve is then adjusted to account for project specific factors including track support system, speed, and local geology. Vibration sensitive receptors within the calculated distances were identified and specific vibration levels were estimated for each identified vibration sensitive receptor. Table 13-3 shows the impact distances identified by the generalized curve.

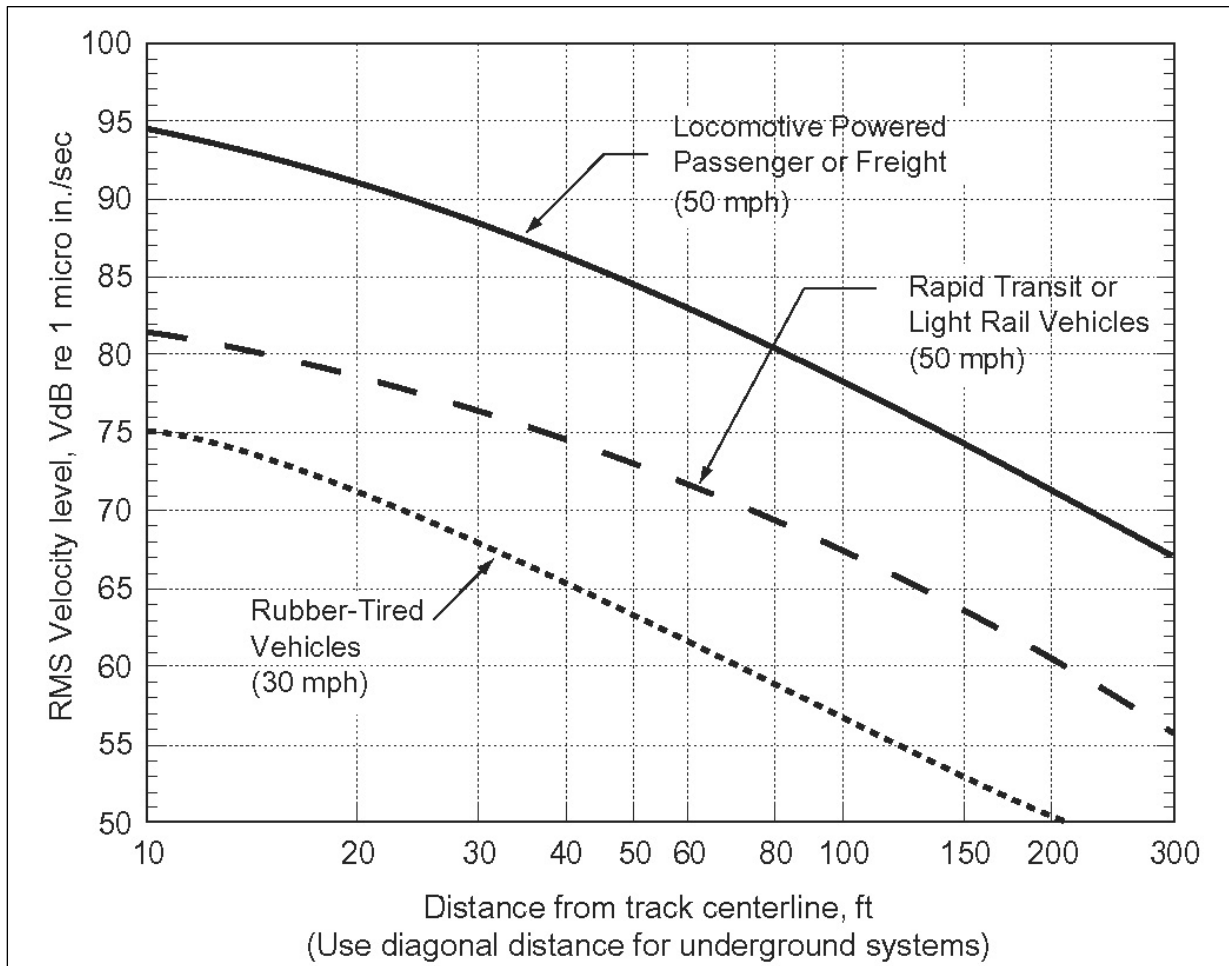
Table 13-3: Build Vibration Impact Distances

Category 1	Category 2	Category 3
50 feet	40 feet	15 feet
1. Criteria for frequent events was used. Light rail curve used with speed of 40 mph and track in good condition.		

Source: FTA's Transit Noise and Vibration Impact Assessment (May 2006) and Jacobs 2009.

Aerial imagery and field reconnaissance were utilized to identify specific buildings within these distances. Vibration levels were then estimated for each of the high-sensitivity buildings and the residences. Specific characteristics of the buildings including building construction material and number of floors were used to estimate building vibration levels. Speeds were then adjusted to account for any identified buildings that may be close to a station, reducing the train's passby speed.

Figure 13-2: Generalized Ground Surface Vibration Curves



Source: FTA Noise and Vibration Guidance Manual, May, 2006.

For receptors with project-related vibration levels above the criteria, mitigation measures were identified for inclusion in the design. Measures that would reduce VdB include the use of high resilience fasteners, ballast mats, resiliently supported ties and floating slab track bed (Refer to Table 13-4).

Table 13-4: FTA Vibration Mitigation Measures

Mitigation Measure	Effectiveness
High Resilience Fasteners	5 VdB
Ballast Mats	10 VdB
Resiliently Supported Ties	10 VdB
Floating Slab Trackbed	15 VdB

Source: FTA Transit Noise and Vibration Assessment, May 2006.

13.3. Environmental Review

The following section describes the existing vibration along the Northern Branch Corridor. For the purposes of this analysis, existing conditions, potential impacts, and mitigation methods are addressed at the municipal level.

13.3.1. North Bergen

13.3.1.1. Existing Conditions

The major existing source of vibration in North Bergen is the infrequent operation of the CSX freight train.

13.3.1.2. Potential Impacts and Mitigation

No Build Alternative

Under the No Build Alternative, rail freight service is anticipated to continue with minimal changes. As such, there would not be any direct vibration impacts on residences, institutional uses, or offices near the corridor.

Light Rail to Tenafly (Preferred Alternative) and Light Rail to Englewood Route 4

Impacts – No sensitive receptors were identified within the FTA vibration impact distances. No residences or high-sensitivity buildings would be impacted by the Build Alternatives in North Bergen. No significant adverse vibration impacts are anticipated as a result of the proposed project.

Mitigation – None required.

13.3.2. Fairview

13.3.2.1. Existing Conditions

The major existing source of vibration in Fairview is the infrequent operation of the CSX freight train.

13.3.2.2. Potential Impacts and Mitigation

No Build Alternative

Under the No Build Alternative, rail freight service is anticipated to continue with minimal changes. As such, there would not be any direct vibration impacts on residences, institutional uses, or offices near the corridor.

Light Rail to Tenafly (Preferred Alternative) and Light Rail to Englewood Route 4

Impacts – No sensitive receptors were identified within the FTA vibration impact distances. No residences or high-sensitivity buildings would be impacted by the Build Alternatives in Fairview. No significant adverse vibration impacts are anticipated as a result of the proposed project.

Mitigation – None required.

13.3.3. Ridgefield

13.3.3.1. Existing Conditions

The major existing source of vibration in Ridgefield is the infrequent operation of the CSX freight train.

13.3.3.2. *Potential Impacts and Mitigation*

No Build Alternative

Under the No Build Alternative, rail freight service is anticipated to continue with minimal changes. As such, there would not be any direct vibration impacts on residences, institutional uses, or offices near the corridor.

Light Rail to Tenafly (Preferred Alternative) and Light Rail to Englewood Route 4

Impacts – No sensitive receptors were identified within the FTA vibration impact distances. No residences or high-sensitivity buildings would be impacted by the Build Alternatives in Ridgefield. No significant adverse vibration impacts are anticipated as a result of the proposed project.

Mitigation – None required.

13.3.4. Palisades Park

13.3.4.1. *Existing Conditions*

The major existing source of vibration in Palisades Park is the infrequent operation of the CSX freight train.

13.3.4.2. *Potential Impacts and Mitigation*

No Build Alternative

Under the No Build Alternative, rail freight service is anticipated to continue with minimal changes. As such, there would not be any direct vibration impacts on residences, institutional uses, or offices near the corridor.

Light Rail to Tenafly (Preferred Alternative) and Light Rail to Englewood Route 4

Impacts – No sensitive receptors were identified within the FTA vibration impact distances. No residences or high-sensitivity buildings would be impacted by the Build Alternatives in Palisades Park. No significant adverse vibration impacts are anticipated as a result of the proposed project.

Mitigation – None required.

13.3.5. Leonia

13.3.5.1. *Existing Conditions*

The major existing source of vibration in Leonia is the infrequent operation of the CSX freight train.

13.3.5.2. *Potential Impacts and Mitigation*

No Build Alternative

Under the No Build Alternative, rail freight service is anticipated to continue with minimal changes. As such, there would not be any direct vibration impacts on residences, institutional uses, or offices near the corridor.

Light Rail to Tenafly (Preferred Alternative) and Light Rail to Englewood Route 4

Impacts – No sensitive receptors were identified within the FTA vibration impact distances. No residences or high-sensitivity buildings would be impacted by the Build Alternatives in Leonia. No significant adverse vibration impacts are anticipated as a result of the proposed project.

Mitigation – None required.

13.3.6. Englewood

13.3.6.1. Existing Conditions

The major existing source of vibration in Englewood is the infrequent operation of the CSX freight train. One residence, classified as a Category 2 use, is situated in close proximity to the alignment in Englewood. In addition, a recording studio, classified as a Category 1, use is situated adjacent to the alignment.

Bennett Studios is located in the town center of the City of Englewood, in the former railroad station building. As the closest and most sensitive receptor to the alignment, noise vibrations were monitored at the recording studio. The vibration monitor was located the same distance to the centerline of the track as the building, approximately 10 feet. The maximum vibration level during a freight train passby was 92 VdB, which is expected for a location at this distance with poor track condition. Bennett Studios, is equipped with its own special vibration isolation system, allowing it to operate alongside the CSX freight operation.

13.3.6.2. Potential Impacts and Mitigation

No Build Alternative

Under the No Build Alternative, rail freight service is anticipated to continue with minimal changes. As such, there would not be any direct vibration impacts on residences, institutional uses, or offices near the corridor.

Light Rail to Tenafly (Preferred Alternative)

Impacts – One high-sensitivity building, Bennett Studios, near the proposed Englewood Town Center Station, approximately 10 feet west of the rail right-of-way, and one residence located north of W. Ivy Lane, approximately 30 feet west of rail right-of-way, would be impacted by the Build Alternative. As seen in Table 13-4, the vibration level at Bennett Studios is 8 VdB over the criteria while the residence is 2 VdB over the criteria.

Table 13-4: Vibration Levels of Buildings in Englewood Impacted by Light Rail to Tenafly (Preferred Alternative)

Building	Criteria	Estimated Project Vibration Level	Mitigated Vibration Level
Bennett Studios	65 VdB	73 VdB	63 VdB
Residence north of W. Ivy Lane, west of rail right-of-way	72 VdB	74 VdB	69 VdB

Source: Jacobs, 2009.

Mitigation – To reduce the vibration levels associated with the project, resiliently supported ties will be used for the rail adjacent to Bennett Studios, and high resilience fasteners will be used adjacent to the residence north of W. Ivy Lane. With these design measures, the vibration levels would be reduced to 63 VdB at Bennett Studios, and 69 VdB at the residence, well below the FTA criteria of 65 VdB and 72 VdB, respectively.

Light Rail to Englewood Route 4

Impacts – No sensitive receptors were identified within the FTA vibration impact distances in Englewood south of the Englewood Route 4 Station. Vibration sensitive resources north of Route 4 including Bennett Studios and one residence would not be affected since this alternative terminates to the south of these resources at Englewood Route 4 Station. No significant adverse vibration impacts are anticipated as a result of the proposed project.

Mitigation – None required.

13.3.7. Tenaflly*13.3.7.1. Existing Conditions*

The major existing source of vibration in Tenaflly is the infrequent operation of the CSX freight train. One residence, classified as a Category 2 use is situated adjacent to the alignment in Tenaflly.

*13.3.7.2. Potential Impacts and Mitigation***No Build Alternative**

Under the No Build Alternative, rail freight service is anticipated to continue with minimal changes. As such, there would not be any direct vibration impacts on residences, institutional uses, or offices near the corridor.

Light Rail to Tenaflly (Preferred Alternative)

Impacts – This Build Alternative, which terminates at the proposed Tenaflly North Station, would impact one residence on Westervelt Avenue, approximately 40 feet west of the rail right-of-way. As seen in Table 13-6, the vibration level at the residence is 1 VdB over the criteria.

Table 13-6: Vibration Levels of Buildings in Tenaflly Impacted by Light Rail to Tenaflly (Preferred Alternative)

Building	Criteria	Estimated Project Vibration Level	Mitigated Vibration Level
Residence on Westervelt Avenue, west of rail right-of-way	72 VdB	73 VdB	68 VdB

Source: Jacobs, 2009.

Mitigation – To reduce the vibration levels associated with the project, high resilience fasteners will be used adjacent to the residence on Westervelt Avenue, reducing the vibration levels to 68 VdB at the residence, well below the FTA criteria of 72 VdB.

Light Rail to Englewood Route 4

Impacts – Light Rail to Englewood Route 4 terminates at Englewood Route 4 Station and does not extend through Tenaflly. No vibration impacts to Tenaflly Town Center Station or Tenaflly North Station would result as these proposed station sites would not be developed under the Light Rail to Englewood Route 4 Alternative.

Mitigation – None required.

13.3.8. Areas North of Tenafly

Neither Build Alternative will result in vibration impacts north of Tenafly. All improvements and proposed rail service will terminate at the border of Tenafly and Cresskill for Light Rail to Tenafly (Preferred Alternative) and at the Englewood Route 4 Station for Light Rail to Englewood Route 4. The shift to overnight freight service will not affect vibration as existing freight rail traffic is infrequent consisting of less than three trains per day. This frequency of existing rail traffic falls below the threshold for existing vibration measurements.

13.4. Summary of Potential Environmental Effects

Light Rail to Tenafly (Preferred Alternative) and Light Rail to Englewood Route 4 would not impact residences or high-sensitivity resources between North Bergen and Englewood Route 4. Under Light Rail to Englewood Route 4, no vibration impacts would result as this alternative terminates at Route 4. Since the Preferred Alternative serves a greater distance, it has the potential to affect a total of three resources from Englewood north of Route 4 through Tenafly, comprised of two residential uses and one facility from north of Englewood Route 4 through Tenafly. In Englewood, Bennett Studios, a recording studio housed in the former Englewood Train Station, and one residence adjacent to the right-of-way would be impacted under the Preferred Alternative. In addition, the Preferred Alternative would result in a potential impact to one residence situated adjacent to the alignment in Tenafly.

Potential impacts to these resources resulting from the Light Rail to Tenafly (Preferred Alternative) can be mitigated during design such that the resources would not be impacted by the project. For the tracks near the two noted residences, high resilience fasteners would be incorporated into the design. For the tracks near Bennett Studios, resiliently supported ties will be used.