Appendix F: Noise and Vibration

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F.1 Introduction

This section describes the noise monitoring, the data used to analyze the noise impacts, as well as the data and calculations used to identify vibration impacts.

F.2 Noise Monitoring

Pursuant to the *Transit Noise and Vibration Impact Assessment*, May 2006, sensitive noise receptors are defined according to the following three land use categories:

Category 1: Tracts of land where quiet is an essential element for their intended purpose. This category includes tracts of land set aside for serenity and quiet and includes uses such as outdoor concert pavilions and National Historical Landmarks with significant outdoor use. Since these uses are typically used during the daytime hours, the descriptor L_{eq} is used.

Category 2: Residential – This category covers all residential land uses and any buildings where people sleep, such as hotels and hospitals. Since these uses are concerned with noise both during the daytime and nighttime hours, the descriptor L_{dn} is used.

Category 3: Community facilities – This category includes schools, parks, libraries, cemeteries, and churches where it is important to avoid interference with such activities as speech, meditation and concentration on reading. Since these uses are typically used during the daytime hours, the descriptor L_{eq} is used.

The ambient noise environment potentially affected by the proposed project was determined through an extensive ambient noise monitoring program. Clusters of noise sensitive land uses with similar ambient noise exposure within a standard 1,000 feet screening distance were identified. For land uses such as residences and hospitals where nighttime sensitivity to noise is a factor (i.e., Category 2), a series of short- and long-term measurements were taken at representative locations to compute the L_{dn} noise metric for each study segment. For locations with predominantly daytime uses such as schools and churches (i.e., Category 3), short-term, one-hour L_{eq} measurements were used. Noise monitoring was performed in June, 2002, and January, 2008. In the descriptions that follow, each numbered monitoring site is associated with a letter prefix denoting the land use that it represents:

- R – Category 2 residential land uses;
- C – Category 3 community facilities or noise-sensitive businesses; or
- R and C – both residential and community facilities/noise-sensitive businesses.

Each study segment and associated noise monitoring results within the project corridor are described below and summarized in Table F-1.

North Bergen – Monitoring Site R1

This study segment extends from the southern tip of the project alignment at Paterson Plank Road in North Bergen to the municipal boundary of Ridgefield, near the intersection of Broad (US 1&9) and Franklin Avenues. The land use is primarily industrial within 1000 feet of the alignment, punctuated by the CSX rail yard stretching from 49th to 83rd Street. Noise monitoring took place in the residential

neighborhood on 48th Street. Despite frequent train activity from the proximate CSX rail yard, the contiguous row of industrial buildings adjacent to the alignment acts as an effective line-of-sight barrier between train noise and residences. In addition, Tonnelle Avenue is noticeably elevated relative to residences in this neighborhood, thereby limiting exposure to traffic noise. The L_{dn} for the North Bergen study segment is 59 dBA.

Table F-1: Existing Noise Levels Monitored by Study Segment (dBA)

Study Segment	Monitor Site	Ldn	Leq
North Bergen	R1	59	-
Ridgefield – south of Hendricks Causeway	R2	69	-
Ridgefield – north of Hendricks Causeway	R3	67	-
Ridgefield/Palisades Park – straddling Route 46	R4	68	
Palisades Park	R5	69	-
Leonia – south of Fort Lee Road	R6	58	-
Leonia – north of Fort Lee Road	R7	63	-
	C8	-	63
Leonia/Englewood – straddling I-80/95	R9	69	-
Englewood – south of Route 4	R10	66	-
Englewood – north of Route 4	R11	64	-
Englewood – central business district – near Palisade Avenue	R12	64	-
	C12	-	73
Englewood – residential – north of Demarest Avenue	R13	64	-
	C13	-	65
Tenafly – residential – south of Demott Street	R14	58	-
Tenafly – central business district – north of Demott Street	R15	65	-
	C15	-	71
Cresskill	R16	56	-
Demarest	R17	58	-
Closter	R18	63	-
Norwood/Northvale	R20	53	-

Note: "-" indicates that the L_{dn} or L_{eq} metric is not applicable to the respective land use present at this monitoring location

Source: Analysis & Computing 2004, Jacobs 2008

Ridgefield – Monitoring Sites R2 and R3

Monitoring site R2 captures the project alignment between Franklin and Edgewater Avenues as it continues northward through the industrial section of Ridgefield. The western edge of a residential neighborhood falls within the 1000 feet screening distance, as well several commercial activities along Broad Avenue (US 1&9). The noise monitor was placed on Marion Place approximately 100 feet from Broad Avenue. The dominant noise source at this location is heavy traffic on Broad Avenue. The L_{dn} in this portion of the Ridgefield study segment is 69dBA.

Industry is the predominant land use surrounding the project alignment through Ridgefield, with intermittent residential developments occupying the area from Hendricks Causeway north to Ray Avenue. For location R3, the noise monitor was placed at a two-story apartment building east of the alignment on Hoyt Avenue. The dominant noise sources at this monitoring location are the heavily traveled Broad Avenue (US 1&9) and the manufacturing activities and HVAC system of the factory adjacent to the west side of the railroad tracks which operates 24 hours a day. These activities accrue a high ambient nighttime sound level for this portion of the Ridgefield study segment, a L_{dn} value of 67 dBA.

Monitoring site R4 comprises the portion of the Ridgefield study segment straddling the municipal boundary between Ridgefield and Palisades Park, covering an area between Ray Avenue and Fairview Street occupied primarily by industrial and commercial uses and few residential developments. Location R4 was located at a residence near the corner of Grand Avenue and West Edsall Avenue in Palisades Park. While commercial land uses dominate the west side of Grand Avenue, only a handful of residences fall within 1000 feet of the project alignment. Traffic on Grand Avenue is the dominant source of noise at this location, with a high number of heavy trucks and no buffer between this arterial roadway and nearby residences. The L_{dn} for this portion of the Ridgefield study segment is 68 dBA.

Palisades Park – Monitoring Site R5

Between Fairview Street and West Edsall Boulevard, the land use surrounding the project alignment in this study segment is evenly mixed between industrial and residential with several spots of commercial development. The noise monitor was placed at a residence on Prospect Street, the nearest dwelling unit to the rail right-of-way approximately 100 feet away. Noise from a nearby industrial facility dominates both the daytime and nighttime noise environment at this location. The measured L_{dn} for the Palisades Park study segment is 69 dBA.

Leonia – Monitoring Sites R6, R7, and C8

This study segment lies between West Edsall Boulevard and the NJ Turnpike overpass in Leonia. West of the alignment is mostly open parkland while the east is residential. For site R6, the noise monitor was placed at the townhouse development on Station Parkway, capturing the ambient noise environment between West Edsall Boulevard and Fort Lee Road. The dominant noise source is traffic on local roadways. However, a majority of the residences are sufficiently set back from these roadways and experience minimal noise exposure. The L_{dn} for this portion of the study segment is 58 dBA.

Monitoring sites R7 and C8 cover a small area between Fort Lee Road and the NJ Turnpike overpass consisting of mostly community facilities, commercial uses, and several residential developments. Two monitoring sites were required to determine noise exposure for both Category 2 and 3 land uses in this portion of the study segment. R7 was located on Grand Avenue, several hundred feet north of Fort Lee Road. Several multi-family developments are located on both sides of Grand Avenue. The dominant noise source is Grand Avenue, which is heavily traveled and utilized by heavy commercial vehicles. The L_{dn} in this portion of the study segment is 63 dBA.

C8 was placed near the rail right-of-way between Overpeck Park and Leonia High School on Leyland Drive. The dominant noise source is traffic noise from nearby local roads and Interstate 80/95. The L_{eq} in this portion of the study segment is 63 dBA.

Englewood – Monitoring Sites R9, R10, R11, R&C12, and R&C13

Monitoring site R9 covers an area located between Ray Avenue and Brookside Avenue. Residential developments dominate this area, although small pockets of industrial and commercial land uses are also present. Noise monitoring took place on Brookside Avenue, approximately 150 feet east of the rail right-of-way. Immediately to the south is an elevated portion of Interstate 80/95 whose traffic dominates the noise environment of this location with contributions from truck traffic on Brookside Avenue. The L_{dn} for this portion of the Englewood study segment is 69 dBA.

Monitoring site R10 covers a large swath of commercial and industrial developments between Brookside Avenue and Route 4, as well as the Sheffield Garden apartments. The noise monitor was placed in the Sheffield Garden apartment complex along Sheffield Avenue. Major contributors to the ambient noise

environment include local traffic as well as distant traffic on Interstate 80/95 and Route 4. The L_{dn} for this portion of the Englewood study segment is 66 dBA.

Monitoring site R11 captures the project alignment as it travels through the southern industrial end of Englewood toward the commercial town center between Route 4 and Englewood Avenue. Several residential neighborhoods are captured at the fringe of the 1000 feet screening distance, including the new high-rise, mixed-use Englewood South development at which the sound monitor was placed. Located adjacent to the project alignment, the ambient noise environment consists of traffic on elevated Route 4 and Nordhoff Place, as well as commercial and light industrial activities on the opposite side of the alignment. The L_{dn} for this portion of the Englewood study segment is 64 dBA.

Monitoring site R&C12 captures an area between Englewood and Demarest Avenues, encompassing the entire town center of Englewood which consists mostly of commercial and residential development. This mix of land uses allows this monitoring location to measure both Category 2 and 3 noise sensitive sites. The noise monitor was placed at Bennett Studios, capturing the ambient noise environment for the audio recording studio, a school, and an apartment building north of Demarest Avenue. Major contributors to the ambient noise environment include parking lot activities adjacent to the track, local traffic and park activities. The L_{dn} and L_{eq} for this portion of the Englewood study segment are 64 dBA and 73 dBA, respectively.

Monitoring site R&C13 captures mostly residential land uses and several community facilities between Demarest Avenue and Ivy Lane as the project alignment approaches the Tenafly study segment. Similar to monitoring site R&C13, this mix of land uses allows this monitoring location to measure both Category 2 and 3 noise sensitive sites. Noise monitoring took place on Curry Avenue facing North Dean Street approximately 200 feet north of Englewood Hospital, with sensitive receptors including Englewood Hospital and residences. The dominant noise contributor to the ambient noise environment is traffic on North Dean Street as well as local neighborhood traffic. The L_{dn} and L_{eq} for this portion of the Englewood study segment are 64 dBA and 65 dBA, respectively.

Tenafly – Monitoring Sites R14 and R&C15

With the exception of Brookside Cemetery, the land use in the area between Ivy Lane and Demott Street is exclusively suburban residential. The monitoring site R14 was located at the last residence on Leonard Avenue facing North Dean Street about 100 feet from the project alignment. The dominant noise contributor to the ambient noise environment is traffic on North Dean Street in addition to typical neighborhood traffic. The L_{dn} for this portion of the Tenafly study segment is 58 dBA.

Located between Demott Street and Hudson Avenue, monitoring site R&C15 focuses on the commercial center of Tenafly. The noise monitor was situated near the intersection of East Clinton Avenue and Dean Drive. Our Lady of Mount Carmel School is located immediately to the north of this location and residences are a block to the east. This monitoring site represents both Category 2 and 3 land uses. Substantial traffic noise is audible at this location from Piermont Road and Clinton Avenue, both of which feed into the town center area. The L_{dn} and L_{eq} for this portion of the Tenafly study segment are 65 dBA and 71 dBA, respectively.

Cresskill – Monitoring Site R16

This monitoring site captures the noise environment between Hudson Avenue and County Road, featuring a mix of residential and commercial uses along the project alignment running parallel to Piermont Road. Of particular interest are three high-density residential developments adjacent to the alignment at the intersection of Madison Avenue and Piermont Road: Diabes Park Residence, Sunrise senior housing, and Cresskill Condominiums. The noise monitor was placed at the sidewalk of the Sunrise senior housing

development approximately 80 feet from the project alignment, which is situated between the residences and Piermont Road, the dominant source of noise approximately 150 feet away. The L_{dn} for the Cresskill study segment is 56 dBA.

Demarest – Monitoring Site R17

This monitoring site captures the project alignment between Lenox Avenue and Demarest Avenue as it travels through a residential section of suburban Demarest. The noise monitor was placed at a residence on Meadow Street, about 300 feet from the alignment. Other than light traffic on County Road, no other major sources of ambient noise could be identified. The L_{dn} for the Demarest study segment is 58 dBA.

Closter – Monitoring Site R18

Between Demarest Avenue and Blanch Avenue, this monitoring site represents a mixed-use town center environment. The project alignment crosses Harrington Avenue, a dense commercial and retail corridor sandwiched by suburban residential developments. The noise monitor was placed at a residence one block south of Harrington Avenue where the rail alignment crosses High Street. Traffic noise from High Street comprise the dominant source of noise. The L_{dn} for the Closter study segment is 63 dBA.

Norwood/Northvale – Monitoring Site R19

Located between Blanch Avenue in Norwood and the state border in Northvale, this study segment covers both Norwood and Northvale due to their exhibiting similar ambient noise environments. Specifically, both are primarily residential with small pockets of low density commercial uses. Primary noise sources for residences are generated from cross street traffic which is lightly traveled. The noise monitor was placed adjacent to the project alignment at a residence near the intersection of Paris Avenue and Railroad Avenue. The L_{dn} for the Norwood/Northvale study segment is 53 dBA.

F.3 Noise Model Input Data

Distances defining the moderate and severe impact areas were estimated using the FTA detailed assessment guidelines and the FTA spreadsheet model. Project details including the number of trains during the day and night, number of cars per train, speed, and topographic shielding were input into the model and compared to existing sound levels to determine the distances within which sensitive receptors would be impacted. Table F-2 shows the data used for each Build Alternative.

Table F-2: Noise Model Data Inputs by Alternative

Alternative		**Light Rail to Tenafly (Preferred Alternative)**				**Light Rail to Englewood Route 4**	
Service Area		North Bergen to Englewood		Englewood to Tenafly		North Bergen to Englewood	
Cars/Train		3		3		3	
Average Speed (mph)		30		30		30	
# of Daily Passbys	**Period**	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**
	Proposed Trains/Hour	13.20	2.10	6.50	0.80	13.20	2.10
	Existing Freight	0.00	0.22	0.00	0.22	0.00	0.22

Source: Jacobs, 2009

Noise impact contours were developed for each corridor to identify the number of sensitive receptors within the moderate impact and severe impact range. Figures 12-4 through 12-13 in Chapter 12: Noise show the general contours on top of aerial photography. Yellow dots indicate impacted residences.

F.4 Vibration

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 F-3. As this project would have between approximately 100 and 250 vibration events per day, this assessment uses the criteria for frequent events.

Table F-3: 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).

The general vibration curves from the FTA Guidance Manual are used to determine vibration levels compared to distance for different types of vehicles. The curve is then adjusted to account for project specific factors including track support system, speed, and local geology. Table F-4 shows the calculations used to determine the vibration impact level.

Table F-4: Calculation of Vibration Impact Distances

Mode	Category	Criteria	Speed Adjustment	Building Material/ Coupling/Amplification Adjustment	Adjusted Criteria	Impact Distance
LRT (rapid transit curve)	Cat 3 - frequent	75	1.9	3	79.9	15
	Cat 2 - frequent	72	1.9	1	74.9	40
	Cat 1 - frequent	65	1.9	6	72.9	50
Notes: category 3 - assume concrete builidngs - 1-2 story masony (+7), 1 floor up (+2), amplification (-6) = +3 category 2 - assume wood building (+5), 1 floor up (+2), amplification (-6) = +1 category 1 - assume concrete building - 3-4 story (+10), 1 floor up (+2), amplification (-6) = +6 for hospital recording studio - assume 1-2 story masonry (+7) and no amplification due to isolation system = +7						

Using aerial photography and field reconnaissance, specific buildings within these distances were identified. Two high-sensitivity buildings (Category 1) are within the impact distance of all of the alternatives: Kulite, a research and manufacturing facility adjacent to the Leonia Station, and Bennett Studios near the Englewood Town Center Station. Both facilities are immediately adjacent to the alignment. Two residences (Category 2) are within the impact distances. No Category 3 buildings fall within the impact distance under any of the alternatives.

Vibration levels were then estimated for each of the high-sensitivity buildings as well as the closest residence. Specific characteristics of the buildings were used to estimate the levels, such as building construction material and number of floors. Additionally, since Kulite and Bennett Studios are near proposed station stops, the speed of the train would be less than 20 mph as they pass. This adjustment was included in estimating the vibration level. Table F-5 shows the calculations used to estimate the vibration levels associated with each alternative.

Table F-5: Calculation of Vibration Levels at Buildings Within Impact Distances

Receptor	Category	Distance to Tracks	VdB along Vibration Curve	Speed Adjustment	Building Material/ Coupling/ Amplification Adjustment	Estimated Project Vibration Level	
						Light Rail to Tenafly (Preferred Alternative)	Light Rail to Englewood Route 4
Englewood residence	2	30 feet	77 VdB	0	3	74 VdB	n/a
Tenafly residence	2	40 feet	76 VdB	0	3	73 VdB	n/a
Kulite	1	40 feet	75 VdB	6	8	61 VdB	61 VdB
Bennett	1	10 feet	82 VdB	6	3	73 VdB	n/a

Source: Jacobs, 2009

Mitigation – For Light Rail to Tenafly (Preferred Alternative) 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 Englewood and Tenafly residences.

Light Rail to Englewood Route 4 would not impact any additional residences over the No Build; therefore, no mitigation is required.