ONE ALBUQUERQUE

IN COORDINATION WITH:

New Mexico DEPARTMENT OF TRANSPORTATION
MOBILITY FOR EVERYONE

RIO METRO
REGIONAL TRANSIT DISTRICT

SAN JOSE NEIGHBORHOOD/ RAIL YARD NOISE AND VIBRATION ASSESSMENT

TRUMBULL AVENUE TO WOODWARD ROAD

JUNE 2022

Parametrix

Table of Contents

EXECUTIVE SUMMARY

The City of Albuquerque Council Services Department in collaboration with the New Mexico Department of Transportation (NMDOT) Rail Bureau and Rio Metro Regional Transit District (RMRTD) commissioned a noise and vibration study of rail yard activities and the potential impact on the San Jose Neighborhood. The study focused on the geographic area between Trumbull Avenue (one block south of Avenida Cesar Chavez) and Woodward Road where freight cars are routinely stored, sorted, and moved. The study included: 1) an assessment of sound and vibration levels within the neighborhood that are generated from activities within the rail yard; and 2) identification and evaluation of potential noise abatement strategies.

A key element of the study was the collection of sound level data during early morning, evening, and night-time periods when noise sensitivity is usually the greatest. Sound levels were collected to identify and quantify noise conditions associated with rail yard activities as well as ambient neighborhood noise levels. The primary noise sources evaluated included: 1) NMRX, AMTRAK, and BNSF trains passing through the rail yard; 2) BNSF activities associated with coupling, uncoupling, and moving of freight cars as they are sorted, recombined, and moved within the rail yards and to and from nearby facilities. This activity includes noise from idling switcher locomotives as they wait and prepare for moves; 3) train horn noise from the track crossing at Woodward Road and within the rail yards during freight car moves; and 4) ambient noise conditions within the neighborhood from other noise sources including aircraft flyovers and typical neighborhood activities such as automobiles, buses, dogs, etc. The assessment of existing noise determined:

1. Rail yard activities are a significant contributor to noise affecting the residents living in proximity to the rail yard.
2. Noise from the rail yard occurs throughout the day and night. However, because background noise is lower in the late evening and early morning hours, noises produced by rail yard activities are likely more noticeable and therefore, more intrusive to area residents.
3. Other major sources of noise exist that are not typical of neighborhood activities. These include commercial and military aircraft flying over the neighborhood.
4. Noise levels from rail yard activities are at a level of “moderate impact” if Federal Railroad Administration (FRA) and Federal Transit Administration (FTA) standards are applied. However, the Noise and Impact Assessment Guidelines used by these agencies are not applicable to this specific circumstance because the rail yard is an existing use and not a new condition. Nonetheless, because FTA and FRA standards are an accepted and quantifiable metric, they were used to assess impact.

Strategies to reduce impact were identified and evaluated. The mitigation analysis found:

- Sound walls would provide a substantial reduction of rail yard noise within the neighborhood. However, wall heights of 17 feet to 22 feet would be needed to substantially reduce noise from locomotives and train horns. The construction of walls of this height may be incompatible with residential uses adjacent to the rail yards north of Wheeler Avenue and, at a cost of approximately $2,500 per linear foot, may be cost-prohibitive.
- Sounds walls ranging from 8 feet to 12 feet high would reduce noise from freight car coupling and other mechanical noise associated with freight car moves in the area generally north of Wheeler Avenue where most rail yard activities occur. The cost of construction for these wall heights would be approximately $570 to $880 per linear foot, respectively.

Other potential measures to reduce rail yard noise were evaluated and include:

- Voluntary operational changes implemented by BNSF to stage idling switcher locomotives at locations away from residential areas.
- Minimize warning horn use to the extent safe and practical. Because horns are used for safety purposes and allowed by FRA regulation, any change in horn use would require a safe alternative and the cooperation of the BNSF. The NMDOT and RMRTD have initiated construction of a new signals and crossing equipment at Woodward Road to eliminate horn noise at this crossing except for emergency situations.
- Retrofitting houses adjacent to the rail yard to reduce interior noise levels. The objective of this strategy is to better seal the parts of houses facing the rail yards by caulking and sealing gaps in building fenestrations, replacing older single pane windows with double pane glazing, and replacing doors.

The implementation of sound walls would require a funding source, additional investigation to verify constructability issues, and neighborhood coordination to determine public acceptance. Measures involving changes to switcher locomotives operations and horn use would require coordination with the BNSF to determine feasibility and practicality and would be voluntary actions by the BNSF. Measures involving the retrofitting of residences would require a funding source and development of procedures and guidelines that would enable equitable and legal implementation.

Vibration events from the rail yard are potentially at a level of annoyance to many residencies in the project area, but damage caused from the vibration is unlikely as measured levels were well below the FTA’s vibration damage threshold.

INTRODUCTION

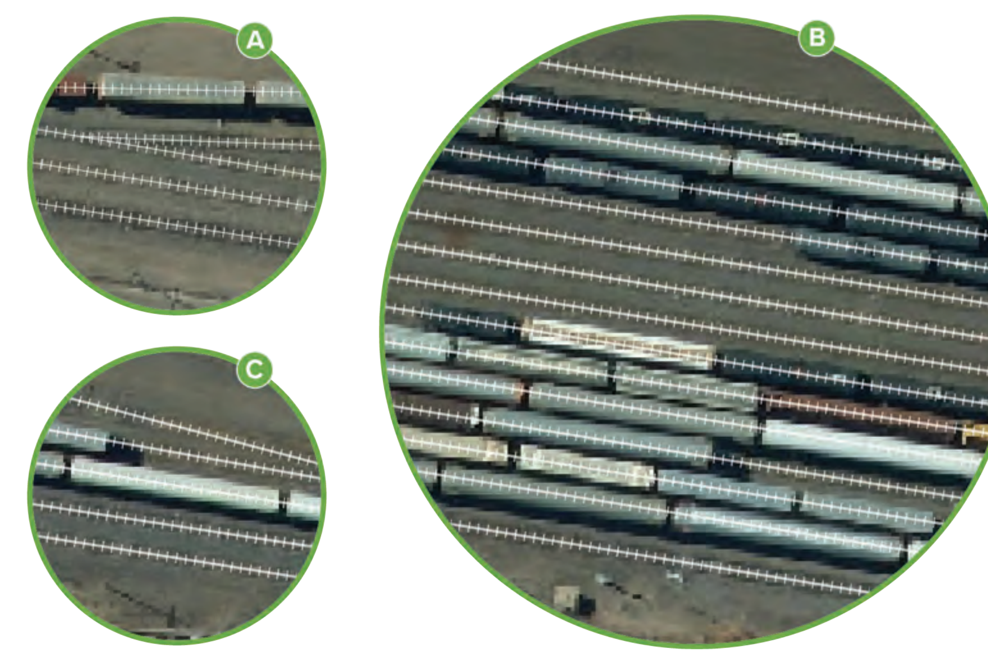
The San Jose Neighborhood/Rail Yard Noise Assessment is an undertaking by the City of Albuquerque Council Services Department in collaboration with the New Mexico Department of Transportation (NMDOT) Rail Bureau and Rio Metro Regional Transit District (RMRTD). In addition to these agencies, the investigations included discussions with representatives of the San Jose neighborhood and input from the BNSF. The primary objectives of this undertaking are to assess noise and vibration levels resulting from activities occurring within the rail yard that affect the San Jose neighborhood and identify and evaluate the feasibility of potential noise abatement strategies.

To better understand the challenges and opportunities of the abatement of noise from rail yard activities, it is first important to understand the operational and regulatory framework that govern this issue. Portions of the rail yard area are owned by the NMDOT and BNSF, depending on location. NMDOT owns the two mainline tracks used by AMTRAK, the New Mexico Rail Runner (NMRX), and Burlington Northern Santa Fe (BNSF). BNSF owns and operates the siding area to the west where freight cars are stored, sorted, and moved to other nearby freight facilities.

The Federal Transit Administration (FTA) has adopted standards, procedures, and guidelines for noise impact assessment and mitigation analysis for proposed new transit projects and major expansion of existing transit service. These are published in the document *FTA Transit Noise and Vibration Impact Assessment Manual*, September 2018. The Federal Railroad Administration (FRA) has adopted FTA's procedures. It is important to note that the FTA/FRA procedures apply to new projects and not noise impacts from existing service and operations.

FRA also has regulations specific to railroad noise from moving rail cars and locomotives (49 CFR 210). This rule prescribes compliance regulations for enforcement of the Railroad Noise Emission Standards established by the Environmental Protection Agency in 40 CFR 201 and is specific to sound emitted by moving rail cars and locomotives, switcher locomotives, car coupling operations, and other related noise sources.

Rail yard noise conditions affecting the San Jose neighborhood are a mixture of passenger and commuter rail service and freight operations. Even though the analysis is not for a proposed transit project, FTA's procedures are still a useful tool for the assessment of impact and evaluation of mitigation. Likewise, FRA's regulations for compliance are applicable to some aspects of rail yard activities. For this reason, the assessment conducted for this study used the impact standards and evaluation methodologies from both FTA and FRA regulations and guidelines. However, the findings of this study are not intended as regulatory. Rather, they should be viewed as quantitative data for consideration in the development of mitigation measures and evaluation of feasibility. Detailed information about standards and evaluation methodology are described later in this document.



Up to 15 rail sidings occur in the area between San Jose Avenue and Smith Avenue where car consists are routinely stored, rearranged, and moved to transload facilities south of Woodward Road.

EXISTING CONDITIONS

The area of interest encompasses the area within the San Jose neighborhood and the Albuquerque rail yards generally from Avenida Cesar Chavez Boulevard south to Woodward Road. Industrial and commercial land uses occur within this area at the north and south ends with mostly residential uses in between. For this reason, the data collection and impact analysis focused on the area generally between Smith Avenue at the north end to about 0.15 miles south of Bethel Avenue — a total distance of approximately one mile.

Several distinct noise producing rail yard activities occur within the study area and were identified as intrusive by neighborhood representatives. These activities include:

1. Passenger and commuter rail trains passing though the rail yards. This includes AMTRAK passenger trains that occur twice each day and NMRX commuter trains that occur 14 or more times per day starting at 4:45 in the morning and running until 8:30 at night. Sounds emanating from these trains include locomotive engine noise, mechanical noise from freight car wheels on the tracks, and general noise from the car chassis.
2. Engine noise from stationary switcher locomotives idling while they wait to move train cars in the rail yard storage area.
3. The coupling and moving of freight cars as individual cars are sorted, rearranged, and moved. This activity results in noise from the switcher locomotives, coupling, and movement of the car consists. Coupling produces a progressive clanging sound that ripples from car to car as train sets are being assembled.
4. Train horn noise to warn motorists when trains approach the at-grade crossing at Woodward Road. Train horns are also used to signal ground crews of imminent car movement while sorting and moving freight cars. Federal regulations allow

NMRX, AMTRAK, and BNSF trains passing through the neighborhood occur multiple times each day and generate high noise levels.

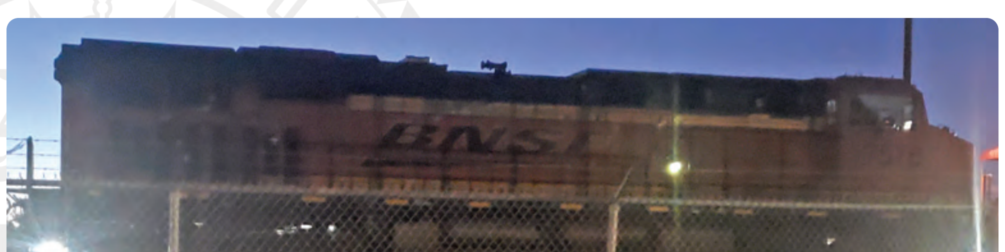
Switcher locomotives often idle for extended periods of time during the late evenings and early mornings resulting in noise that affects the neighborhood.

locomotive engineers to use train horns at their discretion if they deem it necessary to warn others of emergency situations and/or to prevent imminent danger and when other warning devices are malfunctioning.

An important consideration is the height of noise sources for each of the above activities.

- Locomotive engine noise is predominantly from engine exhaust stacks. Stacks are located at the top of a locomotive and are generally about 15 feet above the rail height.
- Noise from the coupling action of cars emanates from a few feet above the tracks. This is typically higher frequency sound.
- Mechanical noise from the car wheels and general chassis noise is also from the lower parts of cars and locomotives and is generally a higher frequency.
- Train horns originate from higher points. Because they are intentionally loud for safety purposes, they are difficult to fully mitigate.

The height and frequency of the various noise sources described above will influence the practicality of its mitigation, in particular for low frequency sounds emitted high above ground level.



Horn noise during car moves late at night can be intrusive to the neighborhood.

Coupling and moving freight cars is a noise source of concern to the neighborhood.

Activities from sorting, connecting, and moving freight cars occurs adjacent to the neighborhood along William Street..

NOISE DATA COLLECTION

Data collection focused on noise-producing activities identified with the assistance of neighborhood and RMRTD representatives and through field observations. The primary activities identified include:

1. Train movement through the area by AMTRAK, NMRX, and occasional BNSF freight trains;
2. Train car movement between the rail yard area immediately west of the San Jose neighborhood and the transload facilities south of Woodward Road;
3. Stationary locomotives idling for extended periods while preparing for train car moves; and
4. Train horns as they pass through the Woodward Road crossing and horns used to signal workers as they prepare to move cars between the rail yard and transload facilities.

The neighborhood also identified the times of day/night when train activities were most noticeable. Times described as having the most noticeable noise included late evening hours (8 PM to midnight) and early morning hours (2 AM to 6 AM).

Concerns with vibration were also mentioned by neighborhood representatives. Vibration sources mentioned by area residents included vibrations from the coupling of freight cars, locomotive and train pass by events, and idling locomotives.

The information provided by the neighborhood and RMRTD combined with a field review of the project area were used to identify locations to collect sound and vibration data representative of the broader neighborhood. Seven sites were identified that represent the following two conditions:

- Sites located in the northern, middle, and southern portions of the project area. These were selected to determine if noise and vibration levels vary within the overall project area due to varying activities.
- Sites located at different distances from the rail yard. These included: 1) homes adjacent to the rail yard right-of-way to assess impact to homes immediately adjacent to the rail yard; 2) sites along the east edge of William Street south of Wheeler Avenue to assess impact at homes with a clear line of site to the rail yards but set further back; and 3) sites situated several blocks east of the rail yards to assess sound and vibration within the neighborhood interior. This third condition also evaluates sound decay due to distance and loss from homes, large trees, and other physical features that block the path of sound waves.

The above exhibit illustrates the sites selected for data collection. Five of the seven monitoring locations represented receivers with direct line of sight to the rail yard. These points varied from 15 to 100 feet from the edge of rail yard right-of-way. Two sites were located 400 feet and 800 feet from the rail yard right-of-way, out of direct sight from the sound producing sources.

Noise levels were collected continuously for a 1- to 2-hour periods at each site. Multiple periods over several days were collected at sites 2 and 4 to determine how sound levels vary by time of day. Vibration data was also collected for sites 1 through 5 concurrent with the sound data collection. Vibration levels were not collected for sites 6 and 7.

For all data collection periods, field observations were kept for all major noise producing activities, e.g., train pass bys, train moves, train horns, car coupling, etc. In addition, major noise events from non-rail yard activities were also noted. These activities included aircraft flyovers, buses, and loud cars traveling near the measurement sites, sirens, barking dogs, and other typical activities that are part of ambient sound levels within a neighborhood. Observed activities were used to correlate noise events with measured values. For example, during a field session on December 2, a NMRX train traveling south passed the measurement site at 4:50 AM. The field notes documented “4:50 AM a SB NMRX was observed.” Follow-up comparisons of the sound meter data and documented sound events helped determine that the spike at 4:50 AM was caused by a NMRX train pass by. The observation notes allow for the cause of loud sound events captured by the sound meter to be determined.

Sound level data was collected using a calibrated Larson Davis SoundTrack LxT2 Sound Level Meter (SLM). Prior to each measurement period the meter was field calibrated using the Larson Davis Cal200 Precision Acoustic Calibrator. The meter was programmed to collect A-weighted sound levels, the standard filter used for projects assessing human impacts. A-weighting adjusts the sensitivity of the meter to mimic the human hearing range by reducing sensitivity to very low and high frequencies, the frequencies where human hearing is less sensitive. Additionally, the meter was set to a “slow” response, i.e., a 1-second response time for sound events. Use of a slow response filter reduces the sensitivity of the meter to instantaneous and sharp sound events such as a firecracker, single dog barks, impact

Sound level data was collected using a sound level meter.

noises from construction activities, etc. This filter places emphasis on continuous noise activities such as idling trains, a train pass, aircraft flyover, etc. The SLM was also set to collect several specific metrics, including:

L_{eq} The equivalent sound level which describes the cumulative noise exposure normalized to a specific time period. This provides an "average" sound level experienced over the time period.

L_{eq} is an important metric because it provides overall noise exposure for a specific time interval. L_{eq} is the primary evaluation metric referenced in most federal and state regulations.

L_n (for L_{10}, L_{50}, L_{90}) A-weighted percentile noise levels, where sound exceeds the reported noise levels for "n" percentage of time.

Percentile measures are useful to assess how "noisy" an area is and how intrusive specific events may be. For example, if a measurement location has an L_{10} of 70dB(A) and a L_{90} of 66 dB(A), the noise level was over 70 dB(A) for 10 percent of the measurement period and over 66 dB(A) over 90 percent of the measurement period. With a difference of 4 dB(A), the events above 70 would not be as noticeable or perceived as intrusive because the background noise is high most of the time. In comparison, a situation with an L_{10} of 70 dB(A) and a L_{90} of 41 dB(A) is generally quiet most of the time. Therefore the events at 70 dB(A) could be perceived as more intrusive because the noise environment is typically much lower.

L_{max} The maximum root-mean-squared (rms) A-weighted sound level reached during a sound event. Simply put, the maximum logarithmic average during a sound event.

L_{max} levels are important because they provide information on how high noise levels reach during a sound event. While not usually used for regulatory purposes, it provides detail on when loud events are occurring and the severity of such events.

L_{peak} The highest instantaneous pressure measured during a period. Differs from L_{max} as L_{peak} measures the highest pressure exerted instantaneously with no time-weighting or averaging. Not typically used when assessing environmental impacts of noise.

In addition to the overall sound levels for the measurement period, it was important to isolate individual sound event levels such as a train passing by. To get individual sound event data, the meter was programmed to collect time history every 5 seconds. Time history documents sound every 5 seconds, allowing data from single events to be isolated within the overall sound level reading.

Results

Sound level data was collected in one to two hour measurement periods at seven locations during daytime, late evening, and early morning hours. A total of 12 measurements were performed between November 12, 2021 through January 7, 2022. Tables 1, 2, 3, and 4 summarize the data collected for L_{eq} , L_{max}, L_{10}, and L_{90}. As mentioned previously, the noise data collection included time-correlated notes of observed noises. Various activities that were not related to rail yard activities were observed, including buses operating on William Street, loud vehicles, military and commercial jets flying over the site, and helicopters circling nearby. Aircraft and hovering helicopters were observed during most measurement periods including several late-night periods. While usually not as loud as train pass bys, these sources influenced the data collected. General observations of the measurements are summarized below.

L_{eq} ("average sound levels") ranged from a low of 50.1 dB(A) at Site 7 during a late morning period to a high of 61.9 dB(A) at Site 4 in the late evening. In general, sites 4 and 5 (i.e., the southernmost sites) experienced the highest L_{eq} levels of 61.9 dB(A) at Site 4 and 61.0 dB(A) at Site 5. This may be explained by the lack of obstructions between these sites and rail yard activities as compared to sites 1, 2, and 3. The residences represented by sites 4 and 5 have an unobstructed path for activities occurring within the rail yard. In contrast, all other sites are partially shielded by adjacent homes that can buffer noise from rail yard activities except when the activity is perpendicular of the measurement locations. Leq values were the highest in the early afternoon to early morning hours (12 PM to 4 AM) and noticeably lower in the early to late morning hours (4 AM to 12 PM).

While L_{eq} provides an indication of the general noise levels within an area, L_{max} values provide insights into the magnitude of sporadic noise events. The duration of trains passing through the areas, coupling and moving cars, and horn blasts are typically only a small percentage of the overall time when the data was collected. Consequently, their effect on L_{eq} is limited to how frequently they occur and how long they last. Sites 4 and 5 experienced the highest L_{max} levels with measured levels as high as 89.7 dB(A). Site 1 is located closest to the rail yard and experienced multiple rail yard events when data was collected, yet at 81.7 dB(A), the L_{max} at this site was 8 dB(A) less than sites 4 and 5. In comparison, sites 6 and 7 which are located furthest from the rail yard and have multiple other houses that obstruct sounds from the rail yard have L_{max} values of 10 to 20 dB(A) less than sites 4 and 5. An interesting finding is the L_{max} recorded at Site 3. No major rail-related events were observed during the measurement period for this site, yet the L_{max} is similar to the levels found at other sites which had multiple rail events. This finding indicates other ambient noises are also capable of creating high level sound events. These include buses, loud cars, and aircraft flyovers observed at this site during data collection.

L_{10} and L_{90} follow a similar pattern as the L_{eq} and L_{max} data. Important findings provided by these two metrics shows that sound levels above 60 dB(A) occurred less than 10 percent of the time data was collected and sound levels are less than 50 dB(A) most of the time (L_{90}). Much higher L_{90} values were observed at Site 4 in the late evening and early morning hours. These were attributed to a constant humming noise coming from an industrial/manufacturing site immediately west of this measurement site. This noise was observed during late evening and early morning periods and was continuous.

Overall, several observations can be made from the data collected:

1. Rail yard activities are a significant contributor to noise affecting the residents living in proximity to the rail yard.
2. Noise from the rail yard occurs throughout the day and night. However, because background noise is lower in the late evening and early morning hours, noises produced by rail yard activities is more noticeable and therefore, more intrusive.
3. Other major sources of noise that are not typical of neighborhood activities include aircraft flying over or hovering above the neighborhood. While commercial jets flying over are a common occurrence, military aircraft are also a significant noise source including during late evening hours.

Table 1: L_{eq} Values

	12 AM - 4 AM	4 AM - 8 AM	8 AM - 12 PM	12 PM - 4 PM	4 PM - 8 PM	8 PM - 12 AM
Site 1			55.5 dB			
Site 2	50.4 dB	55.9 dB		55.1 dB	54.6 dB	
Site 3				58.7 dB		
Site 4	60.0 dB				61.9 dB	58.6 dB
Site 5				61.0 dB		
Site 6					53.0 dB	
Site 7			50.1 dB			

Table 2: L_{max} Values

	12 AM - 4 AM	4 AM - 8 AM	8 AM - 12 PM	12 PM - 4 PM	4 PM - 8 PM	8 PM - 12 AM
Site 1			81.7 dB			
Site 2	74.0 dB	83.2 dB		86.0 dB	78.8 dB	
Site 3				84.7 dB		
Site 4	83.5 dB				88.9 dB	89.6 dB
Site 5				87.7 dB		
Site 6					78.8 dB	
Site 7			67.6 dB			

Table 3: L_{10} Values

	12 AM - 4 AM	4 AM - 8 AM	8 AM - 12 PM	12 PM - 4 PM	4 PM - 8 PM	8 PM - 12 AM
Site 1			56.7 dB			
Site 2	46.8 dB	54.1 dB		51.0 dB	53.4 dB	
Site 3				57.7 dB		
Site 4	60.3 dB				60.8 dB	56.9 dB
Site 5				60.8 dB		
Site 6					51.3 dB	
Site 7			52.1 dB			

Table 4: L_{90} Values

	12 AM - 4 AM	4 AM - 8 AM	8 AM - 12 PM	12 PM - 4 PM	4 PM - 8 PM	8 PM - 12 AM
Site 1			40.8 dB			
Site 2	41.4 dB	46.0 dB		40.5 dB	38.6 dB	
Site 3				40.7 dB		
Site 4	55.0 dB				44.2 dB	52.8 dB
Site 5				55.7 dB		
Site 6					38.9 dB	
Site 7			44.7 dB			

Train Noise Isolation

The data collected provide an understanding of general sound levels within the neighborhood and help identify the primary sources of noise; however, the measurement data alone cannot be used to determine if an impact exists. FTA impact assessment procedures determine impact based on the incremental increase in noise caused by a rail project and the level of existing noise. The incremental increase allowed is greater in areas with low ambient conditions than for areas with higher ambient conditions. In this use, ambient means the general background noise level without the new source of noise considered. For example, an area with an existing ambient noise level of 40 dB(A) would be considered moderately impacted if the new noise source increases overall noise by 10 dB(A) and severely impacted in the noise level increases by 15 dB(A). In comparison, an area with existing ambient levels of 55 dB(A) would have moderate impacts if the new noise source increases by 4 dB(A) and severely impacted if the increase is 7 dB(A) or more.

FTA impacts were estimated by comparing the L_{eq} for conditions with and without train-related noise and comparing the differences to FTA criteria. Typically, FTA impact assessment guidelines are used to determine the increase in noise from a proposed project. Because rail activities are already present in the San Jose neighborhood, the contribution of rail yard activities to overall noise had to be estimated. This was accomplished by extracting noise produced by rail yard activities (train pass bys, train horns, coupling, etc.) from the data collected during each measurement period. This was accomplished using the time history measurement data. Spreadsheets of the time histories for each collection period were prepared in 5-second increments for the entirety of the measurement period (See Appendix 1). Sound events caused by rail yard activity for each measurement period were identified from the time-correlated field documentation and then extracted from the spreadsheet. The remaining sound levels were then recalculated to estimate the L_{eq} without rail sources. Because decibels are units of energy and L_{eq} values are a logarithmic average, determining the new L_{eq} required converting each 5-second L_{eq} level into their antilogs, averaging the antilogs, and then calculating the new logarithmic value.

After L_{eq} values were assembled and calculated for each site with and without rail yard noise sources, their difference was calculated to determine the noise increase that occurs as a direct result of rail yard activities. The results are summarized in Table 5 and shown in the following figures. For the sites evaluated, moderate noise impacts were identified at sites 1, 2, and 4. One measurement period at Site 4 approached the severe impact level. It should be noted that even though data was collected over a 7-week period and included 12 measurement intervals of one to two hours each, the data available is still somewhat limited. Nonetheless, it does provide a good estimate of noise from rail yard activities and its impact to the San Jose neighborhood.

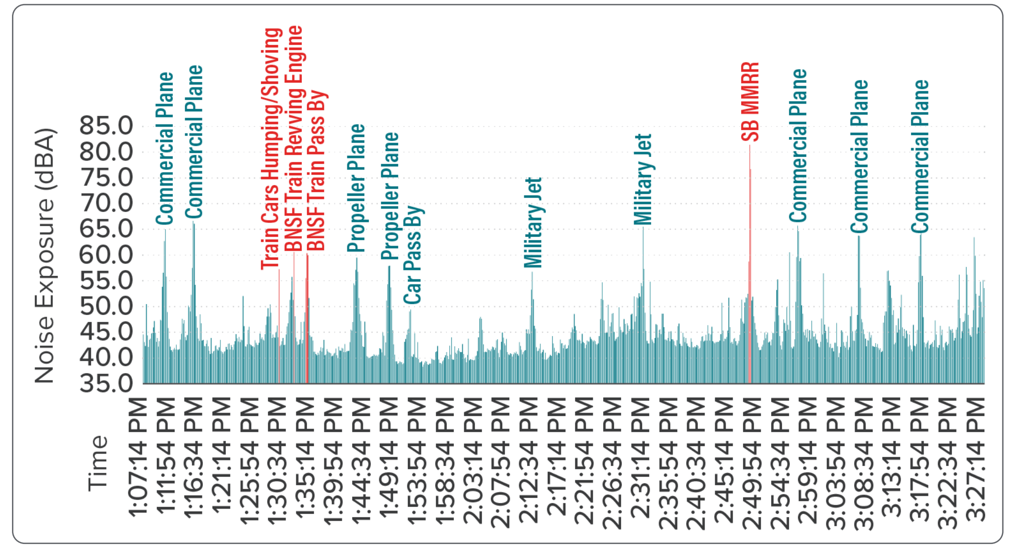
The incremental increases calculated may appear as minor, however, it is important to recognize that decibels are logarithmic and not linear. Therefore, the perceived levels of loudness are different than what would be expected for a linear situation. In a linear relationship, an increase from 10 to 15 can be understood as 50 percent greater. Logarithmic comparisons are not as easily understood. For example, a 3dB increase means the sound pressure has doubled in energy. While most people would notice the increase, they would not perceive it to be twice as loud. It is generally accepted that a 10 dB increase is perceived as twice as loud, e.g., 60 dB(A) to 70 dB(A). The sound level increases identified by this study range from 1.5 dB(A) and 7.2 dB(A) and are noticeably louder than ambient levels.

Table 5: L_{eq} Increase Resulting from Rail Noise Sources

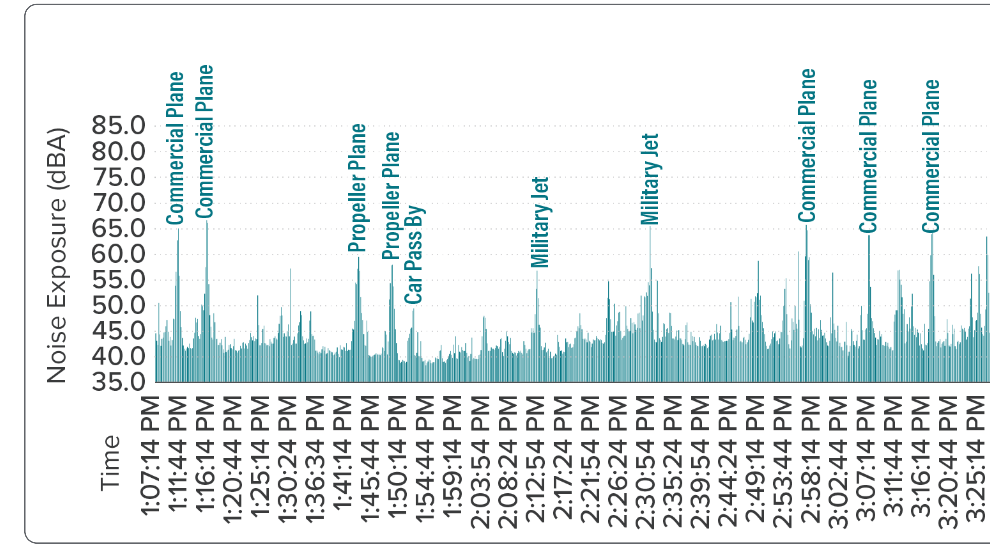
	12 AM - 4 AM	4 AM - 8 AM	8 AM - 12 PM	12 PM - 4 PM	4 PM - 8 PM	8 PM - 12 AM
Site 1			2.6 dB			
Site 2	6.1 dB	4.4 dB		5.2 dB	4.9 dB	
Site 3				N.A.		
Site 4	2.2 dB				7.2 dB	1.5 dB
Site 5				N.A.		
Site 6					0 dB	
Site 7			0 dB			

Note: Rail noise events could not be extracted from Sites 3 and 5. No major rail activities were observed during the measurement period for Site 3. An idling locomotive was present for most of the measurement period at Site 5, which greatly influenced background noise.

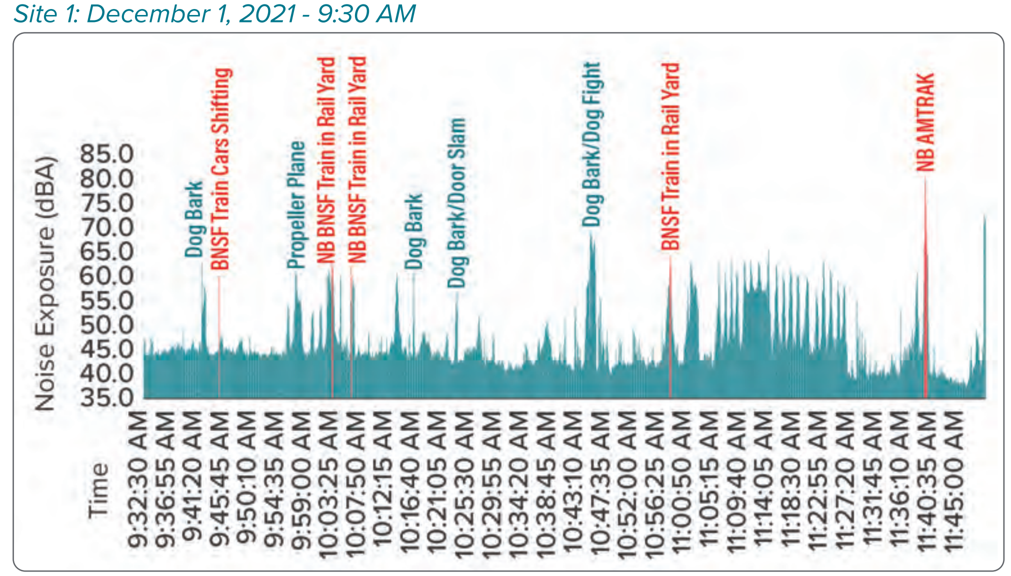
Site 2: November 12, 2021 - 1:00 PM



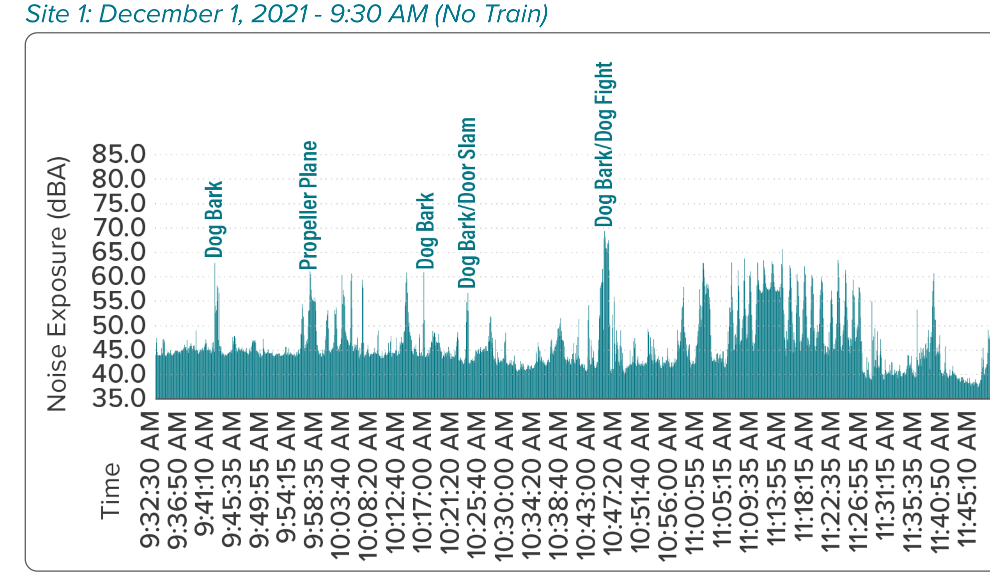
Site 2: November 12, 2021 - 1:00 PM (No Train)



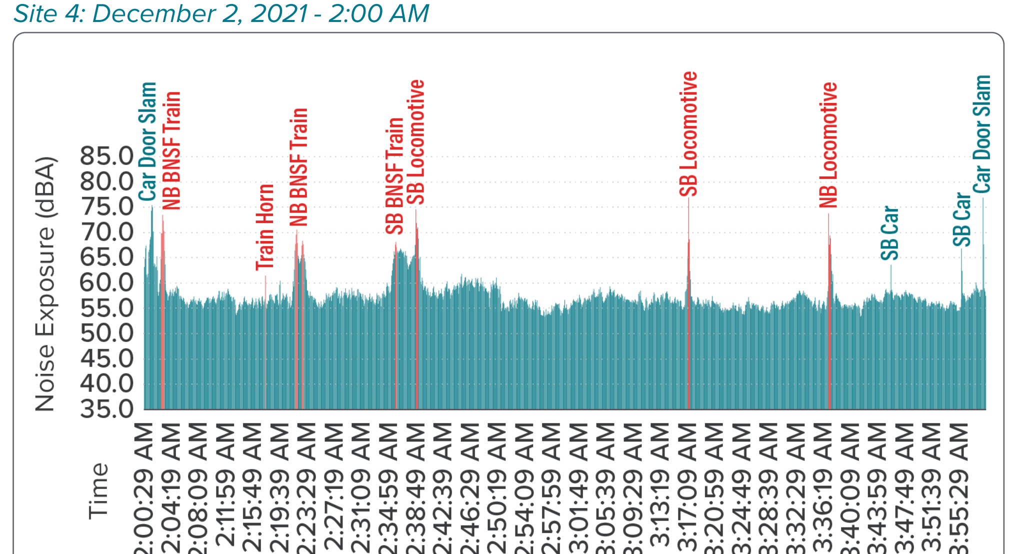
Site 1: December 1, 2021 - 9:30 AM



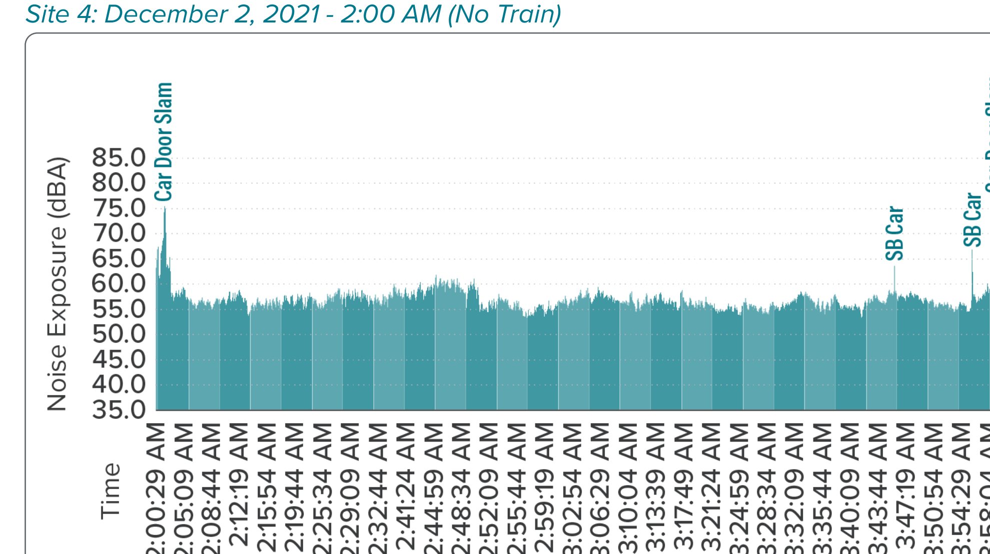
Site 1: December 1, 2021 - 9:30 AM (No Train)



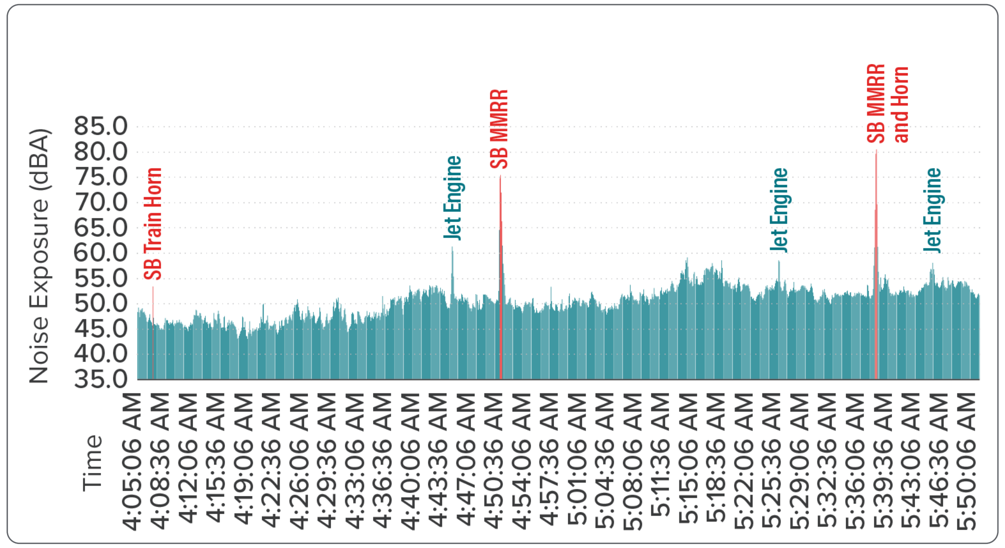
Site 4: December 2, 2021 - 2:00 AM



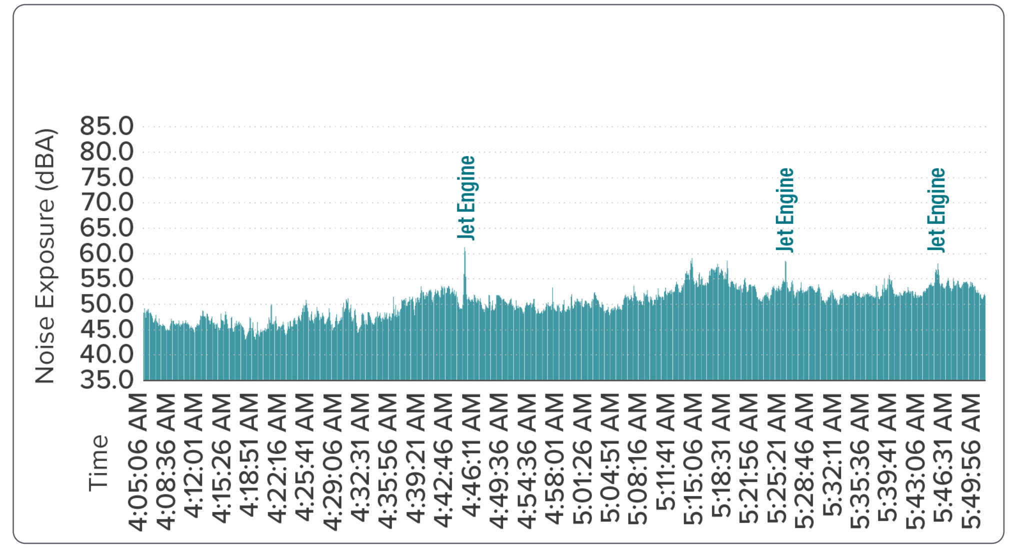
Site 4: December 2, 2021 - 2:00 AM (No Train)



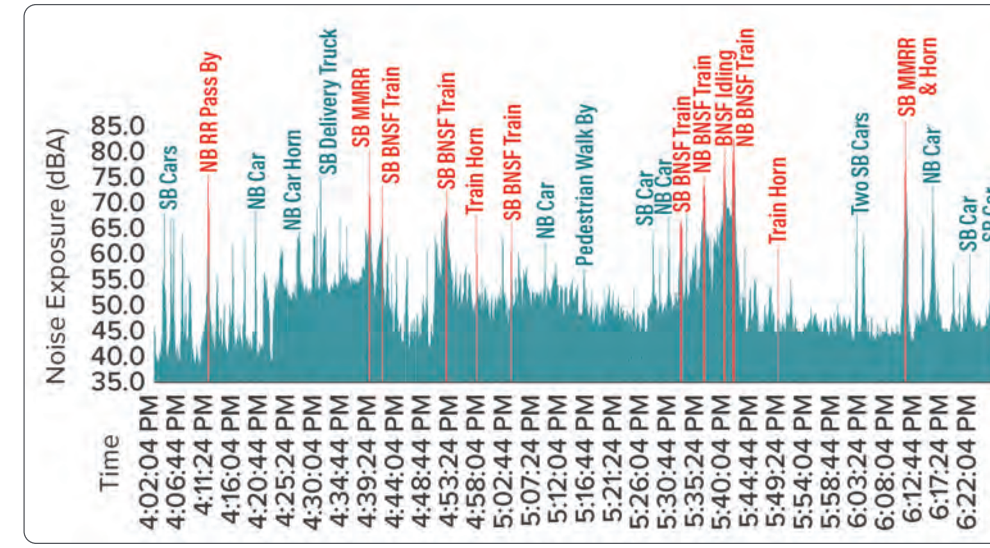
Site 2: December 2, 2021 - 4:00 AM



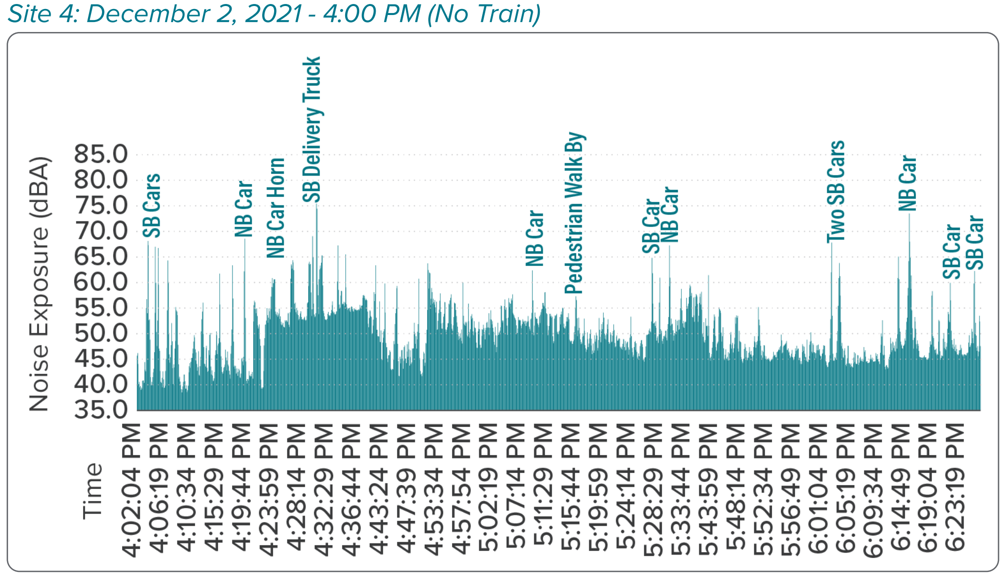
Site 2: December 2, 2021 - 4:00 AM (No Train)



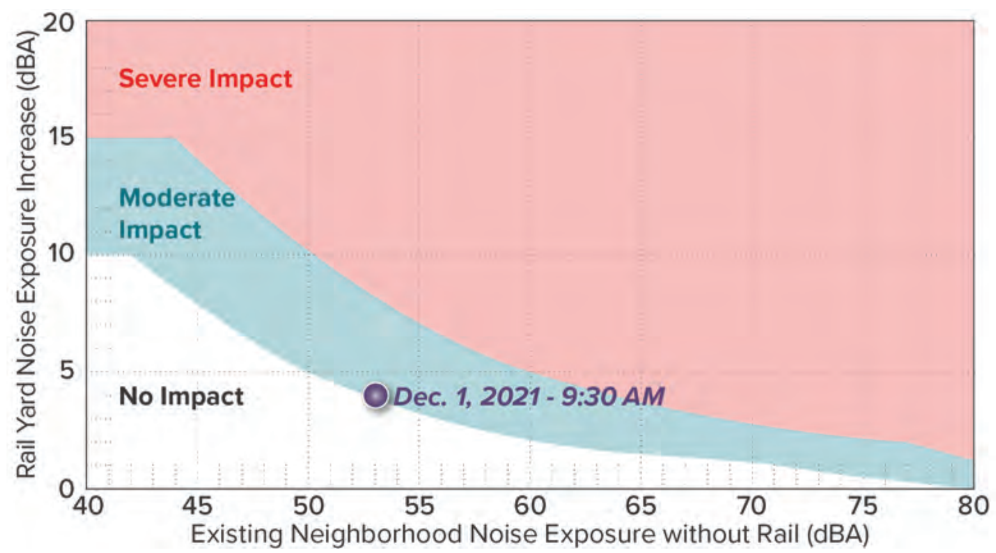
Site 4: December 2, 2021 - 4:00 PM



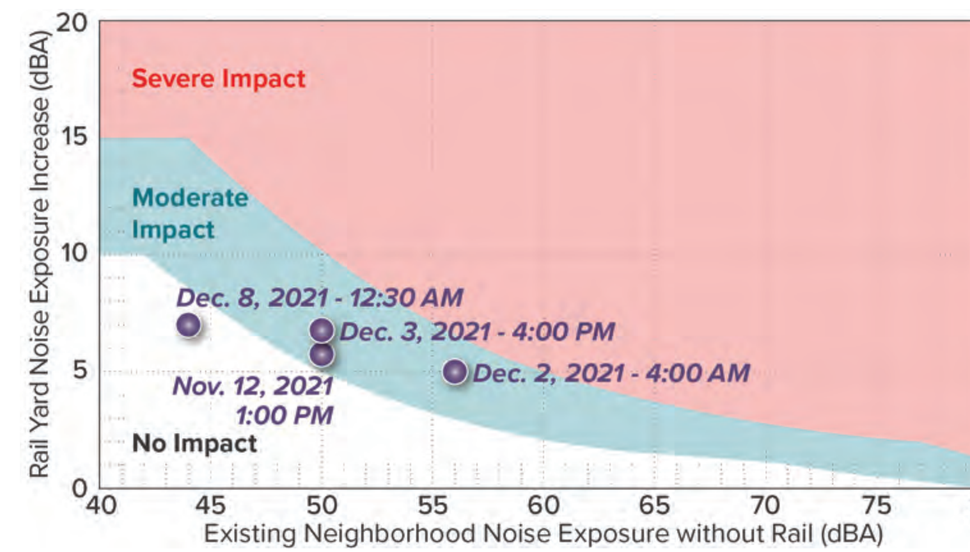
Site 4: December 2, 2021 - 4:00 PM (No Train)



Site 1



Site 2



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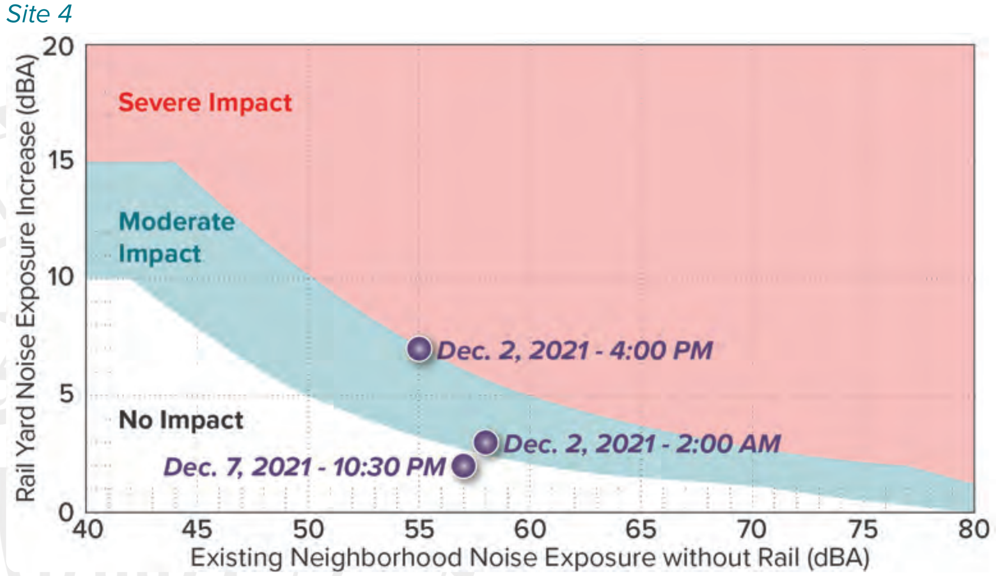

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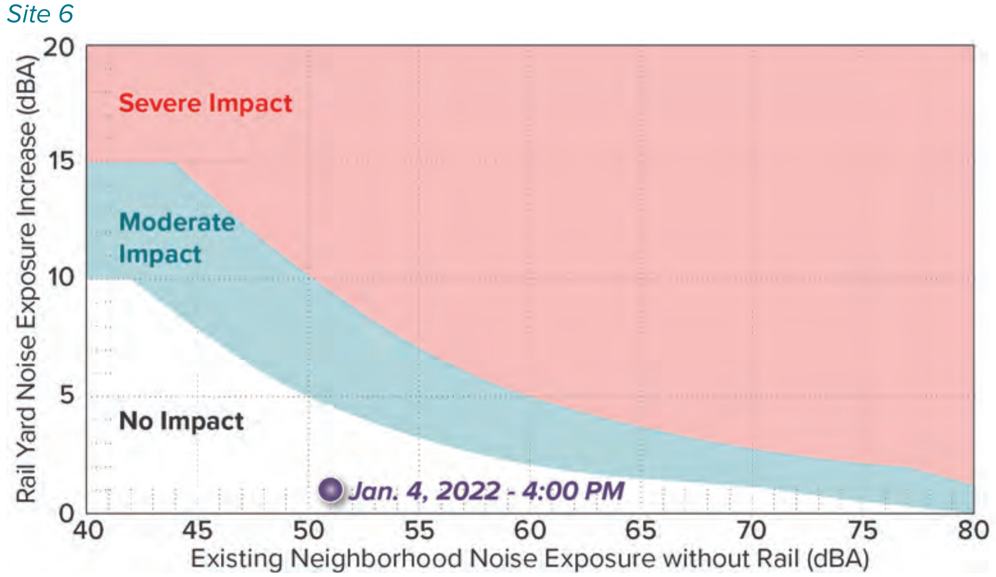

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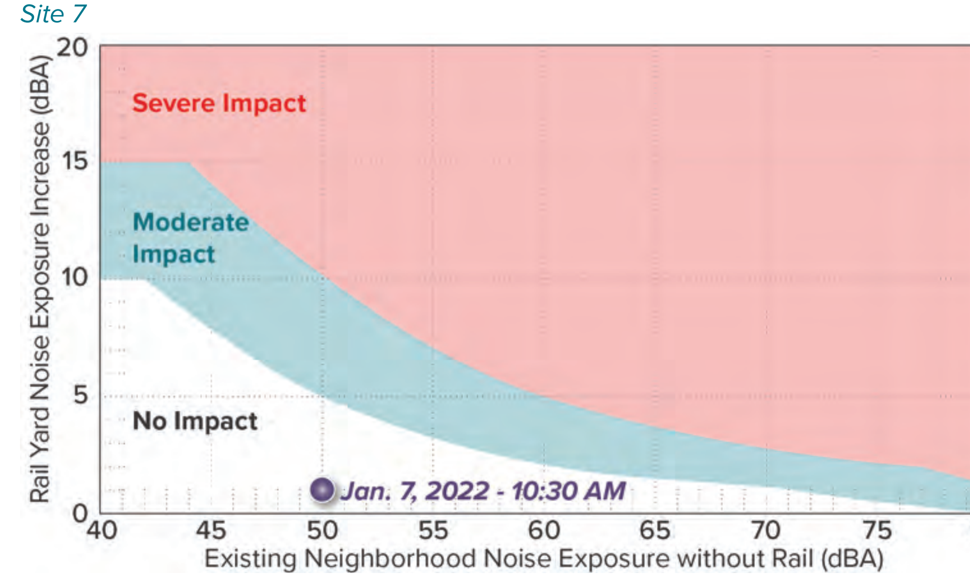


VIBRATION DATA COLLECTION

Vibration data was collected using an Instantel Micromate with an Instantel Seismograph and Geophone. The vibration levels were collected in "Peak Particle Velocities" (PPV) in inches/sec. Three wave types are collected by this equipment: transverse (waves that propagate perpendicular to the direction they advance), longitudinal (waves that propagate parallel to the direction of travel), and vertical (up and down). PPV is the peak signal value of an oscillating vibration velocity waveform (FTA).

Results

The PPV levels for vibration from rail activities near sites 1 and 5 ranged from 0.0186 in/s to 0.0543 in/s. The geophone collected values in PPV units, which are the maximum instantaneous vibrations during a measurement period, rather than the average (L_{eq} vs L_{peak}). PPV levels are typically used to monitor the stress that buildings experience and to assess if vibration is at a level that could potentially cause damage to homes in the project area. While there are multiple standards for vibration monitoring, guidelines regarding transit/freight vibration damage criteria are typically associated with construction activities. The FTA's Construction Vibration Damage Criteria Table (See Table 7) can be used as the basis to estimate the potential for vibration damage levels from rail yard activities. All measured vibrations levels were well below the minimum PPV level of 0.12 in/s, at which vibration can potentially cause damage to buildings classified as "susceptible to vibration damage." Most residential buildings fall under the classification of "non-engineered timber and masonry buildings" which have a higher damage threshold of 0.2 in/s.

Vibration events from the rail yard are potentially at a level of annoyance to many residencies in the project area, but damage caused from the vibration is unlikely as measured levels were well below the FTA's vibration damage threshold.

Vibration data was collected using an Instantel Micromate. Photo courtesy of Specto Technology.

Table 6: Peak Rail Vibration Measurements

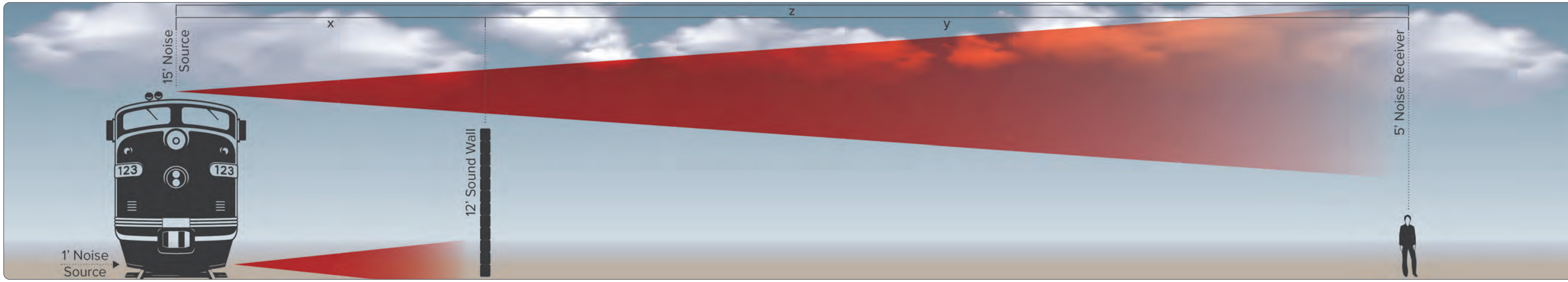
	PEAK PARTICLE VELOCITY TRAN	PEAK PARTICLE VELOCITY VERT	PEAK PARTICLE VELOCITY LONG
Site 1	0.055	0.025	0.054
Site 2	0.022	0.030	0.025
Site 3	0.019	0.029	0.024
Site 4	0.022	0.030	0.030
Site 5	0.038	0.038	0.038

Vibration within the project corridor is at a level of annoyance for the neighborhood, but below the damage threshold for buildings. Further analysis would need to be conducted to determine the exact level of annoyance caused by vibration levels, but vibration born damage from rail yard activities is unlikely.

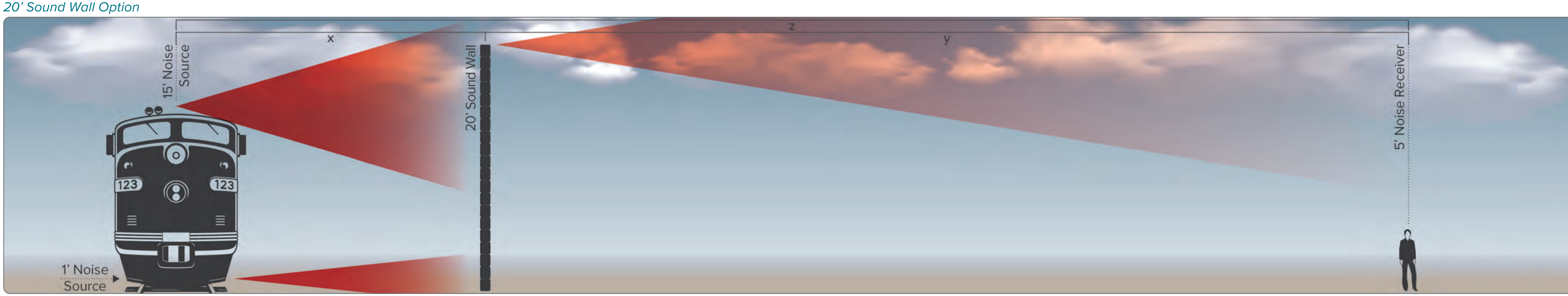
Table 7: Construction Vibration Damage Criteria

BUILDING/ STRUCTURAL CATEGORY	PPV, IN/SEC	APPROXIMATE LV
I. Reinforced-concrete, steel, or timber (no plaster)	0.5	102
II. Engineered concrete and masonry (no plaster)	0.3	98
III. Non-engineered timber and masonry buildings	0.2	94
IV. Buildings extremely susceptible to vibration damage	0.12	90

12' Sound Wall Option



20' Sound Wall Option



SOUND WALLS

Sound walls can be an effective strategy to mitigate excessive noise if they are feasible and practical. The following key factors were considered in the evaluation of sounds walls between the rail yards and adjoining neighborhood:

- The source of the noise to be mitigated and the physical relationship between the noise source, barrier location, and receiver (home) location;
- The height of barrier needed to result in a reasonable sound level reduction;
- The physical space available to construct a wall, including the wall foundation and the wall itself;
- The cost of the wall; and
- Consequential impacts of the wall.

A description of the primary noise sources from the rail yard is provided in the introduction section. These sources include trains passing through the rail yards, noise within the rail yards from sorting and moving cars between the yard and locations to the south, and use of train horns. Each of these activities produce different types of noise:

- Sounds emanating from trains moving through the rail yard include locomotive engine noise, mechanical noise from freight car wheels on the tracks, and general noise from the car chassis.
- Sounds from rail yard activities include engine noise from switcher locomotives and the coupling and moving of freight cars as they are sorted, rearranged, and moved.
- Train horn noise to warn motorists when trains approach the at-grade crossing at Woodward Road and to signal ground crews of imminent car movement while sorting and moving freight cars or for other emergency situations.

Each of these activities produce different noises and from different heights ranging from the top of the track to the top of the locomotives. The activities also vary in loudness and frequency (pitch) with locomotives typically the loudest. Car coupling generally produces lower volume sound levels but it can be intrusive to nearby residents because it consists of a series of sharp impact sounds (banging noise). Locomotive engine noise is predominantly from engine exhaust stacks. Stacks are located at the top of locomotives and are generally about 15 feet above the rail for standard locomotives and slightly less for switcher locomotives. Noise from car coupling is generally a few feet above the tracks. Noise from train movement, whether it is freight or passenger cars, includes various mechanical sounds from car wheels, the tracks themselves, and general chassis noise from the lower parts of the cars and locomotives. Train horns are typically located on the top of locomotives or cab control cars and are generally 12 to 15 feet above track level.

Considering the above, a sound wall must be able to physically block the path from the noise source to the receiving property. While the noise source is never fully blocked because sounds propagate in waves that vary based on their frequency (pitch), the objective of a sound wall is to block a significant amount of the noise. Thus, the physical relationship between the noise source, barrier, and receiver is critical.

The location of noise sources within the rail yard varies from about 25 feet from the edge of the rail yard right-of-way to over 200 feet. For the purposes of the barrier analysis, a conservative condition was assumed with the noise source 30 feet from the edge of the right-of-way, i.e., the eastern-most tracks. Likewise, receivers (homes) were located 15 feet from the right-of-way for residents north of Wheeler Avenue, and 75 feet east of the right-of-way for residents along William Street south of Wheeler Avenue.

The height or track ballast and rails above the adjacent ground varies. At the north end of the study area, the ballast and track height are one to two feet above grade.

At the south end, the ballast and tracks are four to five feet above grade. This is an important factor because the added height of the ballast/track combined with the top of a locomotive at the south end of the study area results in a noise source height of 20 feet (5 feet + 15 feet = 20 feet).

BARRIER HEIGHT ANALYSIS

The height of sound wall needed was estimated using FTA guidance based on equations that consider the distance between the noise source and sound wall, the height of the wall, and the distance between the sound wall and the receiver. The equations are not applicable when the height difference between the noise source and sound wall is negative, i.e., the source is higher than the wall. While some noise reduction will occur with this condition, it is negligible. Using these factors, the sound level reduction, i.e., the "insertion loss," can be calculated for various noise source/barrier height/receiver distance scenarios. Tables 8 and 9 summarize the sound reduction for different noise sources and locations within the neighborhood.

As shown in Tables 8 and 9, a relatively short wall of 8 to 12 feet in height is effective at blocking noise sources that originate close to the ground, i.e., coupling noise, wheel/track noise, and other mechanical noise emanating from the lower portions of locomotives and freight cars. However, they would not be effective at blocking noise from locomotive stacks and/or horns. For these sources a much taller wall of 17 to 22 feet is necessary to achieve meaningful reductions.

Table 8: Barrier Insertion Loss for Car Coupling and Wheel/Track Sources

Location	Top of Rail Height	Coupling Height	Barrier Height	Reduction in dB(A)
Bethel Ave.	5.5 ft	8.5 ft	8	3.7
			12	12.6
			16	12.0
			20	19.9
			22	21.0
Wheeler Ave.	3.6 ft	6.6 ft	8	6.5
			12	13.9
			16	17.8
			20	20.4
			22	21.4
Hosher Ave.	3.3 ft	6.3 ft	8	11.5
			12	17.6
			16	21.0
			20	23.6
			22	24.3
Abilene Ave.	2.6 ft	5.6 ft	8	9.6
			12	16.5
			16	20.2
			20	22.7
			22	23.7

Notes: Residence locations were assumed to be approximately 80 feet from the existing rail yard property fence at Bethel Ave. and Wheeler Ave. Residence locations were assumed to be approximately 15 to 20 feet from the existing rail yard property fence at Hosher Ave and Abilene Ave.

Table 9: Barrier Insertion Loss for Noise from Locomotives and Warning Horns

Location	Top of Rail Height	Top of Locomotive Height	Barrier Height	Reduction in dB(A)	Reduction in dB(A) 2nd Row
Bethel Ave.	5.5 ft	20.5 ft	8	0.0	NA
			12	0.0	NA
			16	0.0	NA
			20	10.7	NA
			22	13.7	NA
Wheeler Ave.	3.6 ft	18.6 ft	8	0.0	NA
			12	0.0	NA
			16	0.0	NA
			20	10.7	NA
			22	14.1	NA
Hosher Ave.	3.3 ft	18.3 ft	8	0.0	0
			12	0.0	0
			16	18.5	2.4
			20	20.2	12.9
			22	21.2	15.1
Abilene Ave.	2.6 ft	17.6 ft	8	0.0	0
			12	0.0	0
			16	7.2	2.4
			20	17.6	12.3
			22	19.4	15.1

Notes: Residence locations were assumed to be approximately 80 feet from the existing rail yard property fence at Bethel Ave. and Wheeler Ave. Residence locations were assumed to be approximately 15 to 20 feet from the existing rail yard property fence at Hosher Ave and Abilene Ave. Sound walls were determined effective at locations where the reduction was 10 dB(A) or more (teal shading). For Hosher Ave. and Abilene Ave. wall heights were determined effective if the reduction was more than 10 dB(A) at second row receivers.

Wall Feasibility

Implementing a sound wall is affected by significant constraints and challenges that affect wall feasibility, constructability, and cost. Existing conditions that must be considered include:

- Railroad standards prohibit above ground improvements within 25 feet of the closest track centerline. The existing rail yard right-of-way fence varies from approximately 27 feet from the track centerline in the southern half of the study area to less than 20 feet at the northern end. Obtaining additional right-of-way to meet the 25-foot setback requirements is not practical because residential structures are within 15 feet of the existing fence. Thus, constructing a wall along the existing right-of-way would require an exemption to the 25-foot setback standard.
- Overhead utilities and various pieces of railroad equipment occur throughout the limits of the project area. These include overhead power and communication lines, several railroad signals, and a bungalow located along the fence near Hosher Avenue. The overhead utility line is within 2 feet of the right-of-way fence in most areas. Depending on the type of wall constructed, it would be several feet wide, including foundations. This width could conflict with the existing utility poles and other railroad equipment.
- Two sets of fiber optic lines run between the tracks and the fence. Based on available as-built plans, the closest fiber optic line appears to be about seven feet west of the fence from Woodward Road to Wheeler Avenue. This likely would not conflict with the proposed wall foundation, but the lines would need to be located for design.
- At the south end of the project area the curb and gutter for William Street is within one foot of the fence. North of where William Street shifts east, buildings, private landscaping, and yard improvements are adjacent to the right-of-way fence limiting the area available for wall construction.

Because of the limited space available, construction impacts to the existing improvements on both sides of the existing fence would occur. The existing curb and gutter along William Street could be removed and replaced, along with a strip of the existing asphalt pavement. Impacts to the existing utility poles along the west side of the fence could be minimized by notching the foundation. However, the existing overhead lines may need to be temporarily deenergized to avoid the risk of damage or injury from construction operations. Wall construction may also impact trees, landscaping, pavement, gates, and side yard fences. These would need to be removed/replaced where they would conflict with the proposed wall construction.

Structural Considerations

Sound walls typically use solid vertical panels, made of concrete, concrete masonry unit blocks, steel, aluminum, and/or polycarbonate plastic. Concrete and block walls are commonly used because of their reasonable cost and durability. Concrete walls can be precast or cast-in-place.

The wall would be supported by engineered foundations. Options include reinforced concrete spread footings (buried concrete slabs) or drilled shafts. The selection would be dictated by the wall height and soil characteristics. Spread footings are usually more economical to build, but they increase in width as wall height increases, which increases potential impacts. Drilled shafts are more expensive, but they have a smaller footprint and therefore fewer impacts. Because of the location near the river, the shallow depth of groundwater can increase the cost and difficulty of drilled shafts.

Other considerations include access for maintenance and graffiti removal. Rail yard access currently occurs at several sides streets where gates are installed. It is anticipated that not all the current access would have to be maintained, but some access may be necessary. Gate construction would have to allow the wall to function as a continuous part of the sound barrier and could be accommodated by sliding or swing gate options. Graffiti could be managed by using a roughened surface like the sound walls along I-25 and I-40. This surface type discourages spray painting but does not eliminate all graffiti. Alternatively, anti-graffiti coatings can be used that enable paint removal by pressure spraying; however, a disadvantage of these coatings is that they typically must be reapplied each time after cleaning.

Wall construction would require temporary access to NMDOT, City, and private property. In addition, removal and replacement of existing residential improvements and possibly utilities would be required. This would include connections from the proposed wall to existing side fences. Right-of-way and construction maintenance easements would be determined as part of wall design and approval.

Cost to Construct

Preliminary construction costs were estimated for wall heights of 8 feet, 12 feet, and 20 feet. Unit costs were based on recent bid prices for similar projects. The 8-foot and 12-foot wall heights were assumed to be concrete block with 32-inch and 48-inch-wide concrete footings, respectively. For the 20-foot wall, a precast sound wall was assumed with 4-foot diameter drilled shaft foundations spaced every 12 feet. Because of the anticipated shallow groundwater, permanent casings are assumed in the cost.

The costs include an estimate of construction items, including surveying and staking, mobilization, traffic control and barricading, railroad flagging and insurance, inspection and testing, construction engineering, and utility relocations. A 30 percent contingency was also included. Gross receipts tax and right-of-way costs were not included. Linear foot costs were estimated for each wall type plus an overall cost for the length of wall needed.

The study area extends from Trumbull Avenue south to Woodward Road — approximately 6,950 feet. Significant portions of the study area are predominantly commercial and industrial uses and would not require noise abatement. For the purposes of estimating cost, the area from Smith Avenue to a point 750 feet north of Woodward Road was assumed. An additional 750 feet were omitted in this segment because of industrial uses between Anderson Avenue and Thaxton Avenue resulting in an overall length of 4,400 linear feet of wall needed. Linear foot and overall cost to construct each wall height is shown in the following table.

Table 10: Estimated Costs of Wall Construction

WALL TYPE AND HEIGHT	COST PER LINEAR FOOT	OVERALL COST
8-foot Concrete Block	$570/ft	$2.5M
12-foot Concrete Block	$880/ft	$3.9M
20-foot Precast Concrete	$2,500/ft	$11.0M

Note: Estimated costs include surveying and staking, mobilization, traffic control and barricading, railroad flagging and insurance, inspection and testing, construction engineering, and utility relocations. A 30 percent contingency is also assumed.

Other Considerations

The cost of constructing a wall along the rail yard right-of-way is affected by challenges with existing utilities, private properties, and other existing conditions. In addition, the length and height of wall is a major factor in overall cost. While cost is an important consideration, sound wall construction should also consider cost-effectiveness and reasonableness. As discussed above, mitigating locomotive and horn noise would require a wall height of 17 to 22 feet depending on location along the corridor. This height of wall may not be reasonable given the cost and construction-related impacts to residents adjacent to the wall. A lower height wall of 8 feet to 12 feet would shield some noise from sorting, coupling, and moving freight cars, but would provide negligible shielding of AMTRAK and NMRX locomotives as these trains pass through the rail yard.

Wall visual impacts to the neighborhood are also a consideration. Taller walls would affect views from nearby homes and would shade homes located adjacent to the wall in the north end of the study area. This could be of concern, especially during winter months. Buy-in from the affected residents is essential in a decision to implement any wall. The visualizations shown help illustrate this impact.

Shorter walls, i.e., 8-foot to 12-foot in height, could be considered for partial mitigation and aesthetic purposes. While these wall heights would not reduce sound from locomotive activity, they would reduce noise associated with the sorting and moving of freight cars. This benefit would primarily occur in the area north of Wheeler Avenue where the switcher sidings are located. Shorter walls would also partially block the view of the rail yards from the neighborhood. The aesthetic benefits, especially if a wall includes artistic elements, could help mitigate some of the impact resulting from having a residential area adjacent to an industrial yard.

OTHER MITIGATION OPTIONS

In addition to a noise barrier, noise levels within the project area could be reduced using other mitigation strategies. According to information published by FTA and FRA, the most effective noise mitigation treatments involve reducing noise from the source directly, examples of which could include:

- Operational restrictions such as speed reductions, reduction of horn use, and a decrease in nighttime operations.
  - Speed reductions would not likely have substantial benefit because NM Rail Runner and AMTRAK trains already operate at reduced speeds through this area. However, plans to increase speed by either railroad should consider the noise implications.
  - Reduction of horn noise may be a viable option. Implementation of a quiet zone crossing at Woodward Road will eliminate most horn noise at this location. In addition, changes to horn use policy during train moves could be discussed with BNSF. It may be possible to substantially reduce horn use by using two-way radios to communicate between train operators and ground crews.
  - Night operations may be more intrusive to area residents because ambient noise is lower than during the day making rail yard activities more noticeable and intrusive. If feasible, actions to reduce nighttime operations could eliminate most of the noise issues of concern. One particular operation mentioned by area residents as intrusive is stationary switcher locomotives that idle for long periods of time near residential areas. While it is not practical to shutdown and restart locomotives, it may be feasible to move them to a staging area south of the neighborhood. A reduction in nighttime operations and moving switcher locomotives to a different staging area can be discussed with the BNSF.
- Vehicle treatments such as damped or resilient wheels and vehicle skirts/undercar absorption. This strategy could provide some reduction in the mechanical noise associated car movements; however, it may not be practical because treated freight cars may be shifted to other rail yards.
- Preventative maintenance such as removing and preventing wheel flats, and rail grinding to ensure the smoothness of the rail. Based on field observations, wheel flats were not a major source of noise. In addition, welded rail is used on the main lines. Thus, preventative maintenance is unlikely to provide significant benefit.

The above mitigation strategies could reduce the overall sound levels in the project area. However, these options require coordination and cooperation from the users of the rail yard (RMRTD, BNSF, AMTRAK). Implementation of these mitigation options would need additional analysis and coordination to determine their feasibility.

A second and very different approach is to reduce noise at the receiver (homes in the project area). This strategy is uncommon but is feasible and can be very effective at reducing interior noise. This is accomplished by caulking and sealing gaps in building fenestrations, installing new windows and doors, and, when practical, sealing or relocating vents away from the noise source. According to information published by FTA, these types of improvements can reduce noise by 5 to 20 dB depending on the existing age and condition of the homes. This amount of noise reduction is equal to what can be achieved by wall barriers. Because many of the homes in the study area were constructed pre-1970, windows may be single pane and may be poorly sealed, and doors may be thinner. This strategy does not require the replacement of all windows and doors, just those facing the noise source, and has the added benefit of increasing energy efficiency, helping reduce greenhouse gas emissions, and improving home values. A downside of this strategy is that it does not reduce exterior noise. However, because most intrusion and annoyance occur at night, the lack of exterior benefits is not a major problem.

The cost of home improvements in combination with the operational strategies discussed previously can be cost-effective. Assuming an average cost of $20,000 per home and treatment of 50 to 75 residences, the total cost would be approximately $1.0M to $1.5M. While this could be an effective strategy, its implementation would have to be reviewed for compliance with anti-donation laws and other legalities and liabilities to the City, and a program would have to be set up to administrator grants to individual residents.

SUMMARY OF FINDINGS AND NEXT STEPS

The analysis of rail yard noise and its effect on nearby residents found:

1. Rail yard activities are a significant contributor to noise affecting the residents living in its proximity.
2. Noise from the rail yard occurs throughout the day and night. However, because background noise is lower in the late evening and early morning hours, noises produced by rail yard activities are likely more noticeable and therefore, more intrusive to area residents.
3. Other major sources of noise exist that are not typical of neighborhood activities. These include commercial and military aircraft flying over the neighborhood.
4. Noise levels from rail yard activities are at a level of “moderate impact” if FRA and FTA standards are applied. However, the Noise and Impact Assessment Guidelines used by these agencies are not applicable to this specific circumstance because the rail yard is an existing use and not a new condition. Nonetheless, because FTA and FRA standards are an accepted and quantifiable metric, they were used to assess impact.

Strategies to reduce impact were identified and evaluated. The mitigation analysis found:

- Sound walls would provide a substantial reduction of rail yard noise within the neighborhood. However, wall heights of 17 feet to 22 feet would be needed to substantially reduce noise from locomotives and train horns. The construction of walls of this height may be incompatible with residential uses adjacent to the rail yards north of Wheeler Avenue and, at a cost of approximately $2,500 per linear foot, may be cost-prohibitive.
- Sounds walls ranging from 8 feet to 12 feet high would reduce noise from freight car coupling and other mechanical noise associated with freight car moves in the area generally north of Wheeler Avenue where most rail yard activities occur. The cost of construction for these wall heights would be approximately $570 to $880 per linear foot, respectively.

Other potential measures to reduce rail yard noise were evaluated and include:

- Voluntary operational changes implemented by BNSF to stage idling switcher locomotives at locations away from residential areas.
- Minimize warning horn use to the extent safe and practical. Because horns are used for safety purposes and allowed by FRA regulation, any change in horn use would require a safe alternative and the cooperation of the BNSF. The NMDOT and RMRTD have initiated construction of a new signals and crossing equipment at Woodward Road to eliminate horn noise at this crossing except for emergency situations.
- Retrofitting houses adjacent to the rail yard to reduce interior noise levels. The objective of this strategy is to better seal the parts of houses facing the rail yards by caulking and sealing gaps in building fenestrations, replacing older single pane windows with double pane glazing, and replacing doors.

Rail-related noise impacts within the San Jose neighborhood could be reduced using a combination of the above strategies including walls at select locations and changes in BNSF operations that stage switcher locomotives away from residential areas when they are not actively moving freight cars. Retrofitting houses would also be cost-effective at reducing interior noise levels but would not change exterior noise. This strategy requires further investigations to a determine an appropriate funding source and to develop procedures and guidelines for equitable implementation.

Several activities remain before an implementation strategy can be finalized. These include:

- Meeting with BNSF to share the assessment findings and discuss the feasibility of operational changes within the rail yard.
- Meeting with the San Jose neighborhood to share the findings of the assessment and determine their interest in pursuing the potential strategies discussed within this report.
- Identifying additional funding opportunities. Construction costs (especially for structures) have increased significantly since the initial request for funding was considered.
- Completing more detailed engineering and barrier investigations to further refine the best locations of sound walls, their height, and cost. If funding is not available for full implementation, a priority phasing plan should also be determined.