3.8 NOISE

This section analyzes potential impacts from airborne noise and groundborne vibration and assesses their impact in relation to the operation of the railroad, construction activities associated with Bakers Creek, Foss Creek, Black Point Bridge, and the Lombard Siding, and and routine maintenance and repair activities associated with the operation of the railroad. The study area is 3,000 feet on either side of the NWP right-of-way. The noise and vibration study was conducted by Bollard and Associates in May 2008. Details of the study and additional data that supports this analysis is presented in "*Environmental Noise Assessment, North Coast Railroad Authority Russian River Freight Rail Project- Northern California*", attached in Appendix H (Noise Technical Report).

3.8.1 Introduction

Noise is often described as unwanted sound. Sound is defined as any pressure variation in air that human hearing can detect. The number of pressure variations per second is called the frequency of sound, and is expressed as cycles per second, or Hertz (Hz). Human hearing is generally capable of detecting sound between 20 Hz and 20,000 Hz.

Human hearing is generally capable of processing air pressure variations (sound) over an extremely broad dynamic range. Therefore, the measurement of sound directly in terms of pressure would require a very large and awkward range of numbers. The logarithmic treatment of these numbers – converting measured sound pressure (Pa) into sound pressure level (decibels, dB) – was developed primarily to limit the range of numbers. The decibel scale allows for 5 orders of sound pressure magnitude to be expressed within a range of 0-100 dB.

The perceived loudness of sounds is dependent on many factors, including sound pressure level and frequency content. However, within the usual range of environmental noise levels, perception of loudness is relatively predictable, and can be approximated by the A-weighting network. There is a strong correlation between A-weighted sound levels (expressed as dBA) and the way human hearing perceives noise. For this reason, the A-weighted sound level has become a standard tool for environmental noise assessment. All noise levels reported here are A-weighted.

Community noise is commonly described in terms of the "ambient" noise level, which is defined as the all-encompassing noise level associated with a given noise environment. A common statistical tool used to measure the ambient noise level is the average, or equivalent sound level (L_{eq}), which corresponds to a steady-state, A-weighted sound level containing the same total energy as a time-varying signal over a given time period (usually 1 hour). The L_{eq} is the foundation for the day/night average level (L_{dn}).

The L_{dn} is based on the average noise level over a continuous 24-hour period, with a +10 dB weighting (or penalty) applied to noise occurring during nighttime (10 p.m.-7 a.m.) hours. The nighttime penalty is based on the assumption that people generally react to nighttime noise exposures as though they are twice as loud as daytime exposures. Because the L_{dn} represents a 24-hour average, it tends to disguise short-term variations in the noise environment.

Table 3.8-1 provides definitions of acoustical terminology relevant to this study.

Table 3.8-1
Relevant Acoustical Terminology

Acoustics	The science (or physics) of sound.
Ambient Noise	The distinctive acoustical characteristics of a given environment consisting of all noise sources audible at a given location. In many cases, the term ambient is used to describe an existing or pre-project condition such as the setting in an environmental noise study.
Attenuation	The reduction of noise.
A-Weighting	A frequency filter that conditions a given sound signal to approximate human hearing response.
CNEL	Community Noise Equivalent Level. Defined as the 24-hour average noise level with noise occurring during evening hours (7 - 10 p.m.) weighted by a factor of three and nighttime hours (10 p.m. - 7 a.m.) weighted by a factor of 10 prior to averaging.
Decibel or dB	A Bel is defined as the logarithm of the ratio of the sound pressure squared over the reference pressure (20 µPa) squared. A Decibel is one-tenth of a Bel.
Frequency	The measure of the rapidity of alterations of a periodic signal, expressed in cycles per second or hertz (Hz).
L_{dn}	The day/night average level. Similar to CNEL but with no evening weighting. The hours of 7–10 p.m. are considered daytime.
L_{eq}	Equivalent or energy-averaged sound level.
L_{max}	The highest root-mean-square (RMS) sound level measured over a given period of time.

Table 3.8-1 (Continued)
Relevant Acoustical Terminology

L_n	The measured sound pressure level exceeded (n) percent of the time.
Loudness	A subjective term for the sensation of the magnitude of sound.
Noise	Unwanted sound.
Threshold of Hearing	The lowest sound that can be perceived by the human auditory system, generally considered to be 0 dB at 1,000 Hz for persons with good hearing.
SEL	A single-number rating indicating the total energy of a discrete noise event compressed into a 1-second time duration.

3.8.2 Regulatory Setting

The regulatory setting is based on the information that was available in 2008 when the March 9, 2009 DEIR was under preparation.

3.8.2.1 Federal Regulations

Applicable noise regulations and guidelines provide a basis for evaluating potential noise impacts. Federal regulations pertaining to environmental impacts are codified in 23 CFR 771.

Chapter 3 of the FTA's Guidance Manual regarding Transit Noise and Vibration Impact Assessment offers regulations regarding noise exposure associated with certain rail projects such as the proposed project (Harris Miller Miller & Hanson, Inc., April 1995/May 2006). The FRA has adopted these criteria. Additional information on FTA regulations and noise impact criteria is presented in Section 3.8.3.1, Significance Criteria.

3.8.2.2 State and Local Regulations

In California, local plans establish exterior noise levels that are compatible with state guidelines. The proposed project would directly affect people or properties within the communities of Willits, Redwood Valley, Calpella, Ukiah, Hopland, Cloverdale, Geyserville, Healdsburg, Windsor, Santa Rosa, Rohnert Park, Cotati, Petaluma, and Novato. The majority of these communities offer transportation-related noise exposure limits within their respective General Plan Noise Element. Details of the noise exposure limits for local communities are presented in Section 3.8.3.1, Significance Criteria.

3.8.3 Environmental Setting

The environmental setting is based on the information that was available in 2008 when the March 9, 2009 DEIR was under preparation.

3.8.3.1 Existing Land Uses

The proposed project area is extensive (approximately 142 miles in length) and is adjacent to numerous different land uses. Some acoustically sensitive uses adjacent to the rail line include single- and multi-family residences, transient lodging (e.g., hotels, motels), schools, libraries, churches, hospitals, performing arts venues, and parks and other outdoor recreation areas. Also adjacent to the rail corridor are relatively noise-insensitive properties, including commercial/office, retail, and light- and heavy-industrial uses. Please refer to Section 3.7, Land Use for details of land use along the railroad right-of-way.

3.8.3.2 Existing Ambient Noise Environment

To quantify the existing ambient noise environment in the proposed project vicinity, 24-hour ambient noise level measurement surveys were conducted at 25 different locations along the right-of-way. A majority of the measurements (20) were completed in 2003 by Parsons Brinckerhoff Quade & Douglas, Inc. for the 2006 SMART EIR project. The remaining ambient noise level measurements, which included sites along the rail line between Novato and Lombard and between Cloverdale and Willits, were completed by Bollard Acoustical Consultants, Inc. on December 11-12, 2007. The ambient noise measurement locations are shown on Figure 3.8-1, and the results are summarized in Table 3.8-2.

Table 3.8-2
Summary of Ambient Noise Level Measurement Results

Measurement Site	Description of Measurement Site	Average Daytime L_{eq}, dB	L_{dn}, dB
1	2567 Dale Avenue, Sonoma	52	61
2	20 Beattle Lane, Novato	53	54
3	Railroad Avenue and West Orange Ave., Novato	61	64
4	Payran Street, Petaluma	48	53
5	North McDowell Boulevard, Petaluma	60	66
6	Oak Street at East Street, Penngrove	57	67
7	Lacrosse Park, Rohnert Park	50	58
8	Windmill Farms Drive, Cotati	53	59
9	Seed Farm Road, Rohnert Park	53	58
10	Anteeo Way, Santa Rosa	57	65
11	Whitewood Drive at Hearn Avenue, Santa Rosa	63	71
12	Cleveland Ave. – 10th and 11th Streets, Santa Rosa	63	67
13	Barnes Road at Hopper Avenue, Santa Rosa	53	55
14	Eagle Drive at 13th Hole Drive, Windsor	44	49
15	Bell Road, Windsor	53	58
16	Park Glen at Windsor Drive, Windsor	49	52
17	University Street, Healdsburg	49	51
18	Grove Street at Healdsburg Avenue, Healdsburg	52	55
19	Healdsburg Ave. at Lytton Springs Road, Lytton	49	51
20	Railroad Avenue at Merrill Street, Geyserville	53	59
21	McCray Road, Cloverdale	43	50
22	41 McAsey Lane, Hopland	52	55
23	15 Olga Place, Ukiah	51	57
24	204 Ford Street, Ukiah	53	57
25	270 E. San Francisco Street, Willits	51	56

Notes: Data for Sites 3-21 was taken from the SMART EIR Noise Study of 2004 prepared by Parsons Brinckerhoff Quade & Douglas, Inc. The average daytime L_{eq} data was estimated based on graphics (Figure 4.1) in the noise study.

Data for Sites 1, 2, and 22-25 was recorded by Bollard Acoustical Consultants, Inc. on December 11-12, 2007. These measurements were completed specifically for the NCRA RRD Freight Rail project.

Existing ambient noise levels recorded by Bollard Acoustical Consultants, Inc. staff were completed using Larson-Davis Laboratories (LDL) Model 820 precision integrating sound level meters equipped with LDL Model 2560 of G.R.A.S. 40AQ ½" microphones. The meters were calibrated before use with an LDL Model CAL200 acoustical calibrator to ensure the accuracy of the measurements. The equipment used meets all pertinent specifications of the American National Standards Institute (ANSI) for Type 1 (precision) sound level meters (ANSI S1.4). Noise level measurement equipment and techniques incorporated by Parsons Brinckerhoff Quade & Douglas, Inc. are unknown.

3.8.4 Impacts and Mitigation Measures

This section analyzes the potential environmental impacts to residents and structures in the study area from airborne noise and groundborne vibrations. A description of the general criteria used to determine the level of significance for potential impacts as well as specific federal and local exposure limits are provided.

3.8.4.1 Significance Criteria

Project-related effects from noise and vibration were considered significant when these impacts would result in the following conditions:

- Expose persons to or generation of noise levels in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies.
- Expose persons to excessive groundborne vibration or groundborne noise levels established in the local general plan or noise ordinance, or applicable standards of other agencies.
- Expose persons to significant permanent increase in ambient noise levels in the project vicinity above levels existing without the project.
- Expose persons to significant temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project.
- Where located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, expose people residing or working in the project area to excessive noise levels established in the local general plan or noise ordinance, or applicable standards of other agencies.

- Where located within the vicinity of a private airstrip, would the project expose people residing or working in the project area to excessive noise levels established in the local general plan or noise ordinance, or applicable standards of other agencies.

FTA and FRA - Specific Criteria for Airborne Noise

The FTA offers regulations regarding noise exposure, and the FRA has adopted these criteria. "Moderate impact" and "severe impact" criteria are established based on the existing ambient noise environment and the noise sensitivity of the receiving land use. Three categories of land use are established for the impact analysis.

- Category 1: Includes lands set aside for serenity and quiet or for outdoors performing arts entertainment (e.g., national historic landmarks, outdoor amphitheaters).
- Category 2: Residences and buildings where people normally sleep (e.g., homes, hospitals, hotels).
- Category 3: Institutional land with primary daytime and/or evening use (e.g., schools, libraries, churches, medical offices, theaters, parks).

Figure 3.8-2 is a graphical representation of FTA's noise impact criteria. Please note that Categories 1 and 3 apply the L_{eq} for the noisiest hour of train-related activity during hours of noise sensitivity. For these categories, the criteria are established based on the average hourly L_{eq} measured during the daytime hours (7 a.m.-10 p.m.) at the ambient measurement sites presented in Table 2 of the Environmental Noise Assessment (Bollard, 2008), Appendix H. Category 2 applies the L_{dn} since these receivers may be impacted by nighttime (10 p.m.-7 a.m.) train events.

Subjectively speaking, a "moderate impact" is generally noticeable to most people but may not be sufficient to cause strong, adverse reactions from the community. A "severe impact" would likely produce a high percentage of highly annoyed people in the community.

General Plan Standards for Airborne Noise

As discussed above, the proposed project extends through parts of Mendocino, Sonoma, Marin, and Napa Counties, and would directly affect people or properties within the communities of Willits, Redwood Valley, Calpella, Ukiah, Hopland, Cloverdale, Geyserville, Healdsburg, Windsor, Santa Rosa, Rohnert Park, Cotati, Petaluma, and Novato. Most of the affected jurisdictions – with the exception of the City of Cotati – applies a "normally acceptable" transportation noise exposure limit of 60 dB L_{dn} for noise-sensitive receptors (i.e., residential). In some cases, a "conditionally acceptable" level of up to 70 dB L_{dn} may be allowed if the 60 dB L_{dn} criterion cannot be met with reasonable planning or construction efforts. It is assumed that the City of Cotati has established a "normally acceptable" limit of 65 dB L_{dn}.

Construction - Specific Standards for Airborne Noise

No standardized noise exposure criteria currently exist to address short-term construction noise exposure. Construction noise is generally not regulated due to its necessity and relatively short duration. It is generally regarded as a short-term nuisance for nearby receivers unless levels are high enough to produce adverse health effects. To address the issue of potential health effects, the FTA/FRA, as presented in Chapter 12 of the FTA Guidance Manual, proposes the basic construction noise level limits presented in Table 3.8-3. It is assumed that these levels would be applied at outdoor recreations areas or where people would congregate.

Table 3.8-3
Proposed FTA/FRA Construction Noise Criteria

Land Use	Hourly L_{eq} (dB)	
	Daytime (7 a.m.-10 p.m.)	Nighttime (10 p.m.-7 a.m.)
Residential	90	80
Commercial	100	100
Industrial	100	100

Source: FTA Guidance Manual, Chapter 12

FTA and FRA- Specific Criteria for Groundborne Vibrations

Based on extensive research involving human subjective reaction to groundborne vibration produced by passenger train operations, the FTA and FRA have established groundborne vibration impact limits as summarized in Table 3.8-4. A more detailed explanation of the standards is provided within Chapter 8 of the FTA Guidance Manual.

Table 3.8-4
Groundborne Vibration Impact Criteria
(Frequent Train Events) – FTA/FRA Guidelines

Land Use Category	Vibration Level (VdB re 1 µinch/sec)	Vibration Velocity (max RMS, inches/sec)
1 – High Sensitivity[1]	65	0.0018
2 – Residential[2]	72	0.0040
3 – Institutional[3]	75	0.0056

1 Buildings where low ambient vibration is essential for interior operations (e.g., vibration-sensitive research and manufacturing, hospital research areas, concert halls, TV/recording studios).

2 Residences and buildings where people would sleep (e.g., all residential, hospital patient rooms, hotels).

3 Institutional land uses with primarily daytime use (e.g., schools, churches, commercial offices).

Please note that vibration-sensitive land uses are split into three primary categories in order of sensitivity. These categories should not to be confused with the categories specified in Figure 3.8-2 for airborne noise. One should also note that the "frequent event" criteria are applied for the proposed project due to the extended duration of individual freight train events and not due to the total number of daily operations. This approach is recommended by the FTA/FRA, and is considered to be a conservative assessment of project-related train vibration.

Construction-Specific Criteria for Groundborne Vibration

Like airborne noise produced by short-term construction associated with the proposed project, groundborne vibration associated with this activity is generally considered to be a nuisance, and is accepted and not limited. The exception to this general rule occurs when the vibration is potentially strong enough to create structural damage to nearby buildings. In these cases, the FTA/FRA have developed general construction vibration damage criteria as summarized in Table 3.8-5. See Chapter 12 of the FTA Guidance Manual for more detail regarding this topic.

Table 3.8-5
Construction Vibration Damage Criteria
FTA/FRA Guidelines

Building Category	PPV (in/sec)	Approximate L_v (VdB)*
I. Reinforced concrete, steel, or timber (no plaster/stucco)	0.5000	102
II. Engineered concrete and masonry (no plaster/stucco)	0.3000	98
III. Non-engineered timber and masonry	0.2000	94
IV. Buildings extremely susceptible to vibration damage (e.g., historic)	0.1200	90

* Calculations assume a crest factor of 4 (i.e., PPV/RMS velocity = 4). Vibration level or velocity level (VdB) re 1 µinch/sec.

Please note that the construction vibration criteria in Table 3.8-5 are in terms of peak particle velocity (PPV) not the root-mean squared (RMS) velocity used to evaluate vibration associated with train operations.

3.8.4.2 Impact Assessment Methodology

Reference Freight Train Noise Level Measurements

Reference freight train noise level measurements were conducted at several locations in Placer County, California during the months of November and December, 2007. Noise level measurements of Union Pacific Railroad (UPRR) freight trains were recorded in the Cities of Lincoln and Auburn. These sites were selected because the location, type of trains (freight), and lengths of trains were considered representative of the proposed project.

The reference noise level measurements were recorded using LDL Model 820 precision integrating sound level meters equipped with LDL Model 2560 ½" microphones. The meters were calibrated before use with an LDL Model CAL200 acoustical calibrator to ensure the accuracy of the measurements. The equipment used meets all pertinent specifications of ANSI for Type 1 (precision) sound level meters (ANSI S1.4).

The reference noise level measurements were taken at a distance of 50 feet from the center of the tracks. The track at all measurement locations was continuous welded rail. The measurement microphones were placed approximately 5 feet above the ground, and within ±3 feet of the track elevations. Weather conditions during the measurement sessions included temperatures of 30-45º F, calm-light winds, and moderate humidity.

A total of 18 freight train events were recorded during the measurement sessions. Train speeds ranged from approximately 15-50 mph, with an average speed of approximately 35 mph. Freight train locomotives (engines) and cars were measured independently for each train pass. The average train locomotive and car produced a sound exposure level (SEL) of approximately 94 dB and 90 dB, respectively, at a distance of 50 feet from the center of the tracks. Using the FTA methodology presented below, the recorded noise levels were adjusted to a normalized train speed of 50 mph, producing SELs of approximately 96 dB and 85 dB for individual freight locomotives and cars, respectively. These levels were used in the modeling of project-related freight train noise exposure.

FTA/FRA Train Noise Modeling

Modeling of freight trains on the proposed project rail was completed using the methodology documented in Chapters 5 and 6 of the FTA's Guidance Manual. This methodology has been adopted by the FRA. The modeling methodology applied is as follows.

Establish reference noise levels for locomotives, rail cars, and warning horns at a distance of 50 feet from the center of the tracks. Levels for locomotives and cars were established through reference measurements to be 96 dB SEL and 85 dB SEL, respectively, as discussed above. Levels of 108 dB SEL and 105 dB SEL were assumed for warning horns at 50 feet from the grade crossing and ½-Zone points, respectively. In this case, the warning horn "zone" is assumed to include ¼-mile (1,320 feet) on each side of a given grade crossing. More details regarding the approach and assumptions used to evaluate warning horn noise exposure and its modeling are presented below.

1. Collect data regarding track type. For this project all track is assumed to be jointed. A majority of the track witnessed during our project rail inspection was jointed.

2. Collect operations data including total number of train operations (events/pass-bys); number of locomotives, cars, train speeds; and day/night distribution of operations.

3. Using the reference and operations data (items1-3, above) and the equations summarized in Table 3.8-6 (see Table 6-4 of the FTA's Guidance Manual), calculate Hourly L_{eq} and L_{dn} noise exposure at a distance of 50 feet from the tracks.

4. Based on the established ambient noise level data, determine the moderate impact and severe impact noise levels/thresholds using Figure 3.8-2.

5. Assuming a sound propagation attenuation rate of -4.5 dB per doubling of distance from the tracks (accounting for cylindrical divergence and ground absorption appropriate for a moving point source), determine the locations of the noise contours (i.e., moderate impact, severe impact, and General Plan criteria).

Table 3.8-6
Train Noise Modeling Computation Equations
FTA/FRA Guidelines

Locomotives Hourly L_{eq} at 50 feet:	$L_{eqL}(h) = SEL_{ref} + 10\log(N_{locomotives}) - 10\log\left(\frac{S}{50}\right) + 10\log(V) - 35.6$
Rail Cars Hourly L_{eq} at 50 feet:	$L_{eqC}(h) = SEL_{ref} + 10\log(N_{cars}) + 20\log\left(\frac{S}{50}\right) + 10\log(V) - 35.6 + 5$ *Note: The +5 dB accounts for additional noise from jointed rail*
Warning Horns Hourly L_{eq} at 50 feet:	$L_{eqH}(h) = SEL_{ref} - 10\log\left(\frac{S}{50}\right) + 10\log(V) - 35.6$
Combined Hourly L_{eq} at 50 feet:	$L_{eq}(h) = 10\log\left[10^{\left(L_{eqL}/10\right)} + 10^{\left(L_{eqC}/10\right)} + 10^{\left(L_{eqH}/10\right)}\right]$
Daytime L_{eq} at 50 feet:	$L_{eq}(day) = L_{eq}(h)\big\vert_{V=V_d}$
Nighttime L_{eq} at 50 feet:	$L_{eq}(night) = L_{eq}(h)\big\vert_{V=V_n}$
L_{dn} at 50 feet:	$L_{dn} = 10\log\left[15\cdot 10^{\left(L_{eq}(day)/10\right)} + 9\cdot 10^{\left(L_{eq}(night)+10/10\right)}\right] - 13.8$

SEL_{ref} = Reference sound exposure level

$N_{locomotives}$ = average number of locomotives per train

N_{cars} = average number of cars per train

S = train speed in miles per hour (MPH)

V = average hourly volume of train traffic

V_d = average hourly daytime (7 a.m.-10 p.m.) volume of train traffic

V_n = average hourly nighttime (10 p.m.-7 a.m.) volume of train traffic

Source: FTA Guidance Manual, Chapter 6

Train Related Noise

Train-related noise exposure was calculated based on operations data provided by NCRA for train operations. A summary of the input modeling information is presented in the Environmental Noise Assessment (Bollard, 2008), Appendix H. Also included in Appendix H are summaries of the modeling results for the proposed project, including operations with warning horns (i.e., at grade crossings) and those without warning horn noise (i.e., between grade crossings). The noise modeling and contours do not reflect the effects of atmospherics (e.g., winds, inversions) or topographic or structural shielding (e.g., buildings, barriers). In this case we have conservatively assessed project-related noise exposure since these effects would tend to impede sound propagation and mitigate noise exposure.

Train Warning Horn Noise

With respect to train warning horn noise exposure, FRA field measurements have shown that warning horns are generally sounded using intermittent, short bursts between ¼- and ⅛-mile from the grade crossing. This area is referred to as the "½-Zone". As the train approaches the grade crossing, the horn is generally sounded with more continuous and louder bursts. With respect to the modeling of train warning horn noise exposure, an SEL of 108 dB at 50 feet perpendicular to the tracks is assumed at the grade crossing. This level decreases linearly to a level of 105 dB SEL in the ½-Zone area (i.e., between 660-1,320 feet from the crossing) at 50 feet perpendicular to the tracks. Finally the warning horn noise exposure is assumed to decrease at a rate of -4.5 dB per doubling of distance along the track until the "no horn" noise exposure is intersected. The distance along the tracks between the grade crossing and the intersection of the "horn" and "no horn" noise contours is referred to as the "H-Zone" distance. Results of the train warning horn noise modeling is summarized in the Environmental Noise Assessment (Bollard, 2008), Appendix H.

Project Construction Noise

Airborne noise from construction equipment associated with project construction and maintenance would be expected to add to the noise environment in the immediate project vicinity. Activities included in project construction/maintenance would likely generate maximum noise levels ranging from 76-101 dB at a distance of 50 feet.

Reference construction equipment noise levels are summarized in Table 8 of the Environmental Noise Assessment (Bollard, 2008), Appendix H. Construction activities would be temporary in nature and would generally occur during normal daytime working hours (7 a.m.-6 p.m.). Still, existing residences located in the vicinity of the construction areas could be impacted by this noise.

Noise would also be generated during the construction phases by increased truck traffic on local area roadways and construction hy-rail traffic on the rail tracks. A potentially significant project-generated noise source would be truck and rail traffic associated with the transport of heavy materials and equipment to and from the rehabilitation, repair and construction sites.

Based on reference construction equipment noise levels and a noise attenuation of -6 dB per doubling of distance from the construction noise source(s), it may be expected that project-related construction noise could impact residential receivers within 175 feet of the activities. That is, project-related construction noise, assuming operation of the loudest equipment (e.g., 101 dB at 50 feet), could be expected to exceed 90 dB L_{eq} at distances within 175 feet of the construction activities.

<u>Reference Freight Train Groundborne Vibration Levels</u>

Reference freight train vibration level measurements were measured at two locations in Auburn, California (Placer County) during the months of November and December, 2007. Vibration levels produced by UPRR freight trains were recorded at the two sites.

The reference vibration level measurements were recorded using an LDL Model HVM 100 vibration meter equipped with a PCB Piezotronics, Inc. accelerometer. The equipment used meets all pertinent specifications of the International Organization for Standardization (ISO) for Type 1 (precision) vibration measurement equipment (ISO 8041).

The reference vibration level measurements were taken at a distance of 50 feet from the center of the tracks. The track at all measurement locations was welded rail. The measurement accelerometer was attached rigidly to a ¼" steel stake (½" head) which had been hammered into the ground to a depth of approximately 1 foot. The accelerometer was attached to the head of the stake using an adhesive. The head of the stake and measurement accelerometer was no more than 4 inches above the ground and ±3 feet of the track elevations for all measurements. Weather conditions during the measurement sessions included temperatures of 30-45º F, calm-light winds, and moderate humidity.

A total of eight freight and passenger (AmTrak) train events were recorded during the measurement sessions. Train speeds ranged from approximately 15-35 mph. Maximum measured RMS train vibration levels ranged from approximately 0.0049-0.0080 inch/sec. at a distance of 50 feet from the center of the tracks. These values translate to decibel vibration velocity levels (L_v) of approximately 74-78 VdB (re 1 µinch/sec.). Therefore, at a distance of 50 feet from the tracks, it can be expected that the FTA/FRA 65-75 VdB criteria (Table 3.8-4) would be exceeded.

Train Vibration

Assuming a vibration level of 78 VdB at 50 feet from the tracks and a reduction in vibration level of -6 VdB per doubling of distance from the tracks, the 65 VdB vibration velocity impact contour for an individual freight train event and Category 1 receiver would be approximately 225 feet from the tracks. The 72 VdB (Category 2-Residential) and 75 VdB (Category 3) contours would be approximately 100 feet and 70 feet from the tracks, respectively. It is expected that corresponding land uses within these contours would be impacted by long-term, groundborne freight train vibration. This is a conservative assessment of the areas that would be impacted by ground-borne vibration associated with the long-term operation of proposed project freight trains.

The assessment of impact with respect to vibration produced by train operations is not a function of potential damage to building structures but is related to the subjective reaction and requirements for vibration-sensitive receivers and uses.

Construction Vibration

Construction at the rehabilitation, repair and new construction sites would be expected to introduce groundborne vibration into the surrounding areas. Project construction operations could produce vibration levels as-high-as 105 VdB at a distance of 25 feet depending on the type of equipment used.

Based on the reference levels for equipment and a reduction of -6 VdB per doubling of distance from the construction equipment source(s), daytime construction vibration levels could impact residential structures (Category III) at distances of no more than 90 feet from the source(s). Extremely sensitive structures (Category IV) may be impacted at distances within 140 feet of the construction source(s).

3.8.4.3 Impacts and Mitigations

<u>Rehabilitation and Construction Activities</u>

Bakers Creek

The proposed project rehabilitation construction would introduce additional noise into the surrounding environments. It is anticipated that this noise exposure could significantly impact residential receivers (outdoors) within 175 feet of the construction activities.

The proposed project rehabilitation construction could introduce groundborne vibration into the surrounding areas. It is anticipated that this vibration could significantly affect residential structures within 90 feet of the construction and extremely sensitive structures within 140 feet of the construction.

However, the Bakers Creek site is more than a mile from the nearest residential receptor and located within a canyon where noise and vibration would be attenuated. Rehabilitation activities will be short-term and temporary. Therefore, noise and vibration impacts related to construction activities at Bakers Creek are considered to be less than significant.

Foss Creek

Rehabilitation activities will be short-term and temporary. The proposed project rehabilitation construction could introduce groundborne vibration into the surrounding areas. It is anticipated that this vibration could significantly affect residential structures within 90 feet of the construction and extremely sensitive structures within 140 feet of the construction.

However, the Foss Creek rehabilitation site is located in a rural area, several miles from the nearest town and well over 175 feet from the nearest residence.

Use of vibrating equipment to reduce noise associated with pile driving is the standard method used for driving sheet piles.

Therefore, noise and vibration impacts related to rehabilitation activities at Foss Creek are considered to be less than significant.

Black Point Bridge

Rehabilitation of the Black Point Bridge will not involve heavy construction equipment that would generate significant noise levels or groundborne vibrations. Rehabilitation activities will be short-term and temporary. In addition, the nearest residence is located well over 750 feet to the west. Therefore, noise and vibration impacts related to rehabilitation activities at the Black Point Bridge are considered to be less than significant.

Lombard Siding (MP 1.0 – MP 2.0)

Construction of the siding from MP 1.0 to MP 2.0 will include grading, placement of track ballast and clean fill, placement of 5,300 feet of new track, extending a culvert, reestablishing drainage ditches, widening an existing timber deck bridge, the embankment, and constructing culverts. Construction activities for the siding from MP 1.0 to MP 2.0 will be short-term and temporary. There is a single residence located over 100 feet to the south. Therefore, noise and vibration impacts related to construction activities at the Siding MP 1.0 – MP 2.0 are considered to be less than significant.

Novato Consent Decree (MP 35.5 – MP 18.7)

Improvements required by the Novato Consent Decree include establishing quiet zones at fourteen or more crossings, welding of rails, fencing as required for safety, and landscaping to reduce the effects of glare from trains running after dusk.

The crossings identified in the Novato Consent Decree and the milepost designations are as follows:

1. Rush Creek Place (MP 28.5);
2. Golden Gate Place (MP 28.4);

3. Olive Avenue (MP 28.3);
4. Grant Avenue (MP 28.1);
5. Pedestrian/Bike Crossing (Manuel Drive) (MP 27.5);
6. Novato Creek (Private) (MP 26.9);
7. Wetlands Access (Private) (MP 26.2);
8. Hanna Ranch Road (MP 25.9);
9. Private Crossing (Highway 37) (MP 24.4);
10. Renaissance Road (MP 23.5);
11. Private Crossing (Harbor Drive Business Park) (MP 23.2);
12. Grandview Avenue (MP 23.0);
13. Private Driveway (Hunter's Club Drive) (MP 22.9);
14. Trail crossings immediately to the east of Petaluma River (MP 21.9); and
15. Other intersections of the NWP Line with pedestrian trails or vehicular right-of-ways as may be required or recommended by the regulatory agencies.

Specific improvements at crossings vary depending on the type of crossing (public road vs. private or pedestrian), size of the street, and volume of traffic. They include construction of short mountable medians, 3-feet wide medians, quad gates, short pedestrian gates and swing gates, and signage. Except for part of a 200 feet median strip that extends off of the railroad right-of-way at Hanna Ranch Road, road improvements, gates, and signage will be constructed on existing roads or disturbed areas adjacent to the crossings.

The locations of crossings were specified by the City of Novato to reduce noise from engine warning horns. The track welding was specified to reduce groundborne chatter on the rail in residential and commercial areas that are most susceptible to impacts. Elimination of horn noise and reduction of rail chatter will reduce the impact of noise locally. However, according to the Noise Analysis Study (see section 3.8, Noise, and Appendix H), the establishment of quiet zones will reduce, but not eliminate the impact of noise for those residing near the rail line. There will still be an unavoidable and significant impact from the operation of the railroad due to noise (see impact N-OP1).

The construction of medians, gates, signage, fencing, and landscaping are relatively common, routine, and short-term projects. There is no indication that these projects will occur at night or outside of normal business hours. Therefore, noise impacts from construction activities are considered to be less than significant.

Operations

The proposed project train noise resulting from operations and horn warning noise exposure data is provided in Appendix H. Although not necessary for an evaluation of potential impacts from noise exposure, noise exposure contours similar to the example provided in Figure 3.8-3 can be prepared from the data in Appendix H. Figure 3.8-3 provides an example of FTA/FRA Category 2 (residential) train noise and horn warning noise exposure at the Starr Road grade crossing in Windsor and serves as an example of how noise geometry changes as a train approaches an intersection, and how the two types of noise cumulatively impact the study area. Train noise impacts, plotted as moderate and severe impact zone contours closely parallel the track and impact residents immediately adjacent, whereas warning horn-related noise will impact residents at much larger distances at crossings.

Train Noise

Impact N-OP1: Airborne train noise generated by rail operations will exceed FTA/FRA and local jurisdictional impact criteria where houses are present immediately adjacent to the rail right-of-way.

Noise exposure generated by proposed project freight train operations is expressed in terms of the noise exposure contour information presented in Appendix H. Based on this data, the proposed project would be expected to produce at least a moderate level of impact at noise-sensitive uses directly adjacent to the tracks.

No mitigation measures that would reduce the impact to a less than significant level are known or recommended at this time. Therefore, this impact is considered significant and unavoidable. ***[Significant and Unavoidable]***

Warning Horn Noise

Impact N-OP2: Warning horn noise generated by rail operations will exceed FTA/FRA and local jurisdictional impact criteria at vehicle crossings.

The proposed project-related noise impact increases substantially near grade crossings due to the use of train warning horns. Along some sections of the line, there is the potential for severe impact contours near residential uses that are within approximately 700 feet of the tracks (Category 2).

The application of quiet zones is not included as a part of this proposed project except within a 6.3 mile stretch of trail/road roughly between MP 28.5 and MP 21.9. The potential application of quiet zones along portions of the proposed project corridor would help to reduce the number of people potentially impacted by the rain warning horn. However, quiet zones would not mitigate noise exposure to a less than significant level. Noise exposure produced by freight train events without the warning horn would still produce a moderate noise exposure impact at many residential uses within approximately 375 feet of the tracks, with severe impacts within approximately 150 feet of the tracks in some sections.

The removal of warning horns can not be considered as a possible mitigation since that would significantly increase the impact to safety at many crossings and would violate FRA safety regulations. Neither NCRA nor its operator is willing to accept the liability from decreased safety associated with the removal of warning horns, and the cost to construct quiet zones exceeds project funding.

No mitigation measures that would reduce the impact to a less than significant level are known or recommended at this time. Therefore, this impact is considered significant and unavoidable. ***[Significant and Unavoidable]***

Freight Train Vibration

Impact N-OP3: Groundborne vibration generated by rail operations will impact exceed FTA/FRA impact criteria along some parts of the rail line.

It is expected that adjacent uses with high sensitivity to groundborne vibration (Category 1) could be impacted by the proposed project train operations if they are within 225 feet of the tracks. Likewise, residential uses (Category 2) could be impacted by vibration produced by the proposed project freight trains within 100 feet of the tracks, and institutional uses (Category 3) could be impacted if they are within 70 feet of the tracks. For the proposed project, it is believed that a significant number of residential uses lie within 100 feet of the rail tracks, and may be impacted by long-term operations of the proposed project freight trains.

No mitigation measures that would reduce the impact to a less than significant level are known or recommended at this time. Therefore, the project-related impact regarding groundborne vibration from long-term freight train operations is considered significant and unavoidable. ***[Significant and Unavoidable]***

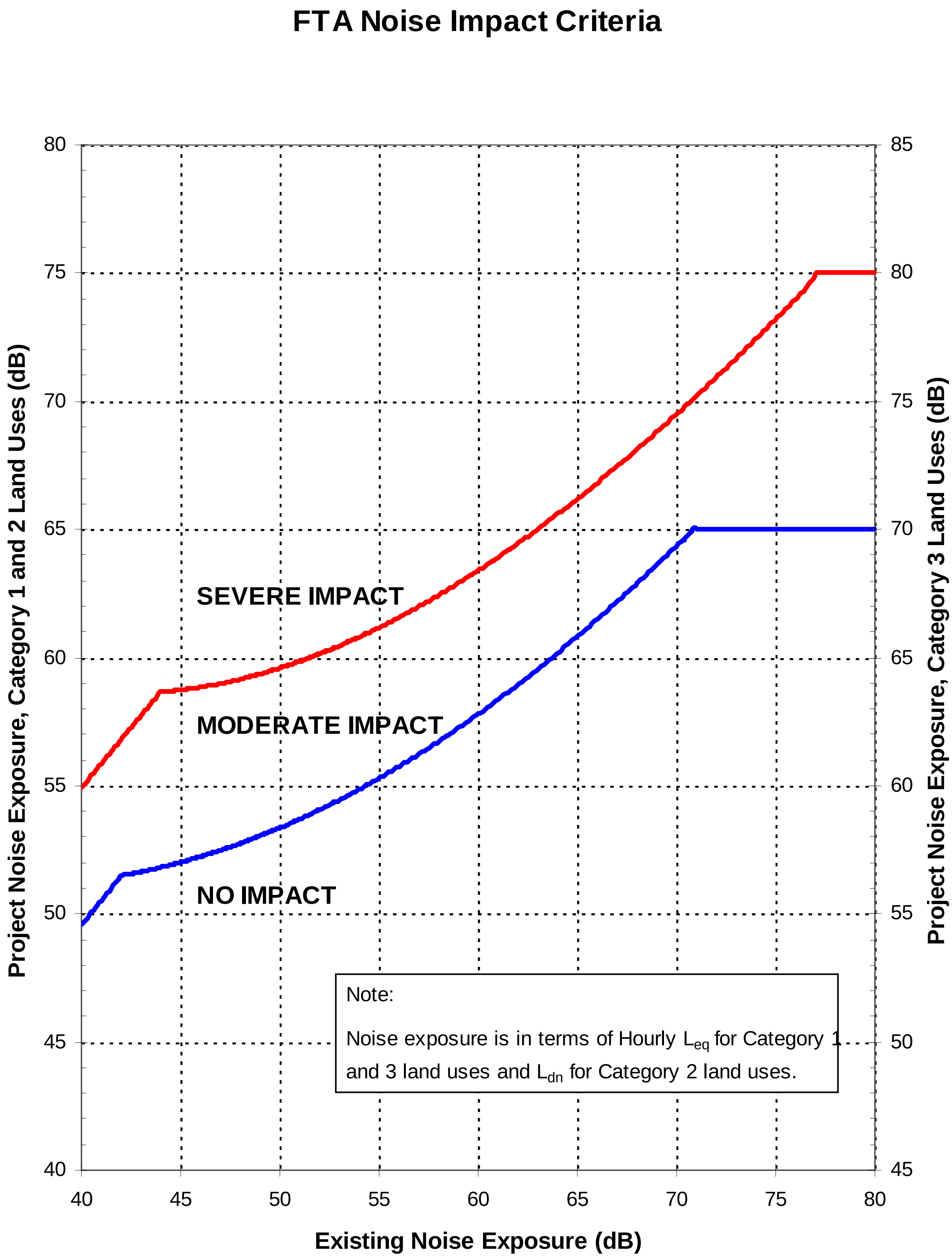
Impact N-OP4: Groundborne vibration generated by rail operations may impact historic structures such as train depots located within many of the towns and cities along the rail line. ***[Less Than Significant with Mitigation Measure N-OP4]***

Mitigation N-OP4: The SHPO shall be consulted and recommendations shall be implemented if it is found to have a significant impact on historic structures.

Impact N-OP5: Routine repair activities such as bridge, grade crossing signals, and track maintenance could introduce groundborne vibration into the surrounding areas. Based on the reference levels for equipment and a reduction of -6 VdB per doubling of distance from the construction equipment source(s), daytime construction vibration levels could impact residential structures (Category III) at distances of no more than 90 feet from the source(s). ***[Less Than Significant with Mitigation Measure N-OP5]***

Mitigation N-OP5: Ongoing maintenance activities will be short-term and temporary and conducted in accordance with NCRA's BMPs. For situations where residences are within 90 feet of the maintenance activities, alternative techniques will be used to minimize groundborne vibration, if feasible.

KLEINFELDER Bright People. Right Solutions. www.kleinfelder.com	PROJECT NO. 78207	PROJECT AND NOISE MEASUREMENT LOCATIONS	FIGURE
	DRAWN: 5/10/08		3.8-1
	DRAWN BY: IPM		
	CHECKED BY: BE	NORTH COAST RAILROAD AUTHORITY RUSSIAN RIVER DIVISON FREIGHT RAIL PROJECT	
	FILE NAME: Figure 3.8-1		



KLEINFELDER
Bright People. Right Solutions.
www.kleinfelder.com

PROJECT NO.	78207
DRAWN:	5/10/08
DRAWN BY:	IPM
CHECKED BY:	BE
FILE NAME:	Figure 3.8-2

FTA NOISE IMPACT CRITERIA

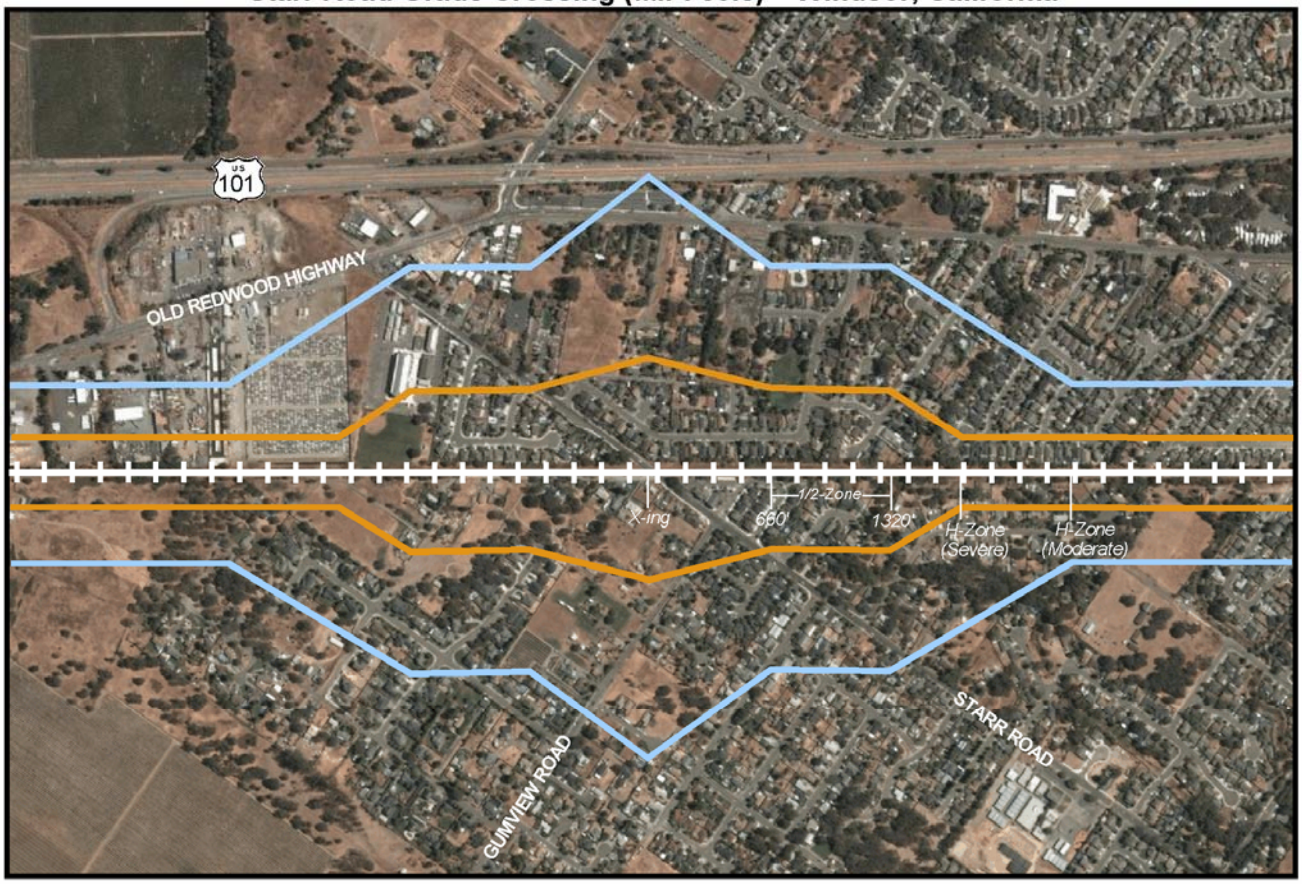
NORTH COAST RAILROAD AUTHORITY
RUSSIAN RIVER DIVISON
FREIGHT RAIL PROJECT

FIGURE

3.8-2

Example of Train Warning Horn Noise Exposure (Cumulative Impacts)

Starr Road Grade Crossing (M.P. 63.8) – Windsor, California



: FTA/FRA Category 2 Moderate Impact Zone Contour

: FTA/FRA Category 2 Severe Impact Zone Contour

250' 750'

0 500' 1,000'

KLEINFELDER Bright People. Right Solutions. www.kleinfelder.com	PROJECT NO. 78207	**EXAMPLE NOISE CONTOURS**	**FIGURE**
	DRAWN: 5/10/08		3.8-3
	DRAWN BY: IPM		
	CHECKED BY: BE	NORTH COAST RAILROAD AUTHORITY RUSSIAN RIVER DIVISON FREIGHT RAIL PROJECT	
	FILE NAME: Figure 3.8-3		