3.10 NOISE AND VIBRATION

Introduction

The Proposed Project would provide new transit services into eastern Contra Costa County, particularly for the cities of Pittsburg and Antioch. The proposed Diesel Multiple Unit (DMU) has its own noise and vibration characteristics that could affect communities along the project corridor. The noise would be similar to that which a person might experience adjacent to a highway or local roadway, but noise and vibration from DMU pass-bys would occur much less frequently (based on the Proposed Project's daily operating schedule) than noise and vibration from motor vehicles traveling a busy highway. Rapid residential development along the corridor has introduced a number of "sensitive receptors" who could be annoyed by the proximity of transit service. In fact, at the public scoping meetings held in 2005 to solicit community input into the environmental review process, concern over potential noise impacts was among the most frequently raised issues.

One noise-related comment received in response to the NOP requested that the effectiveness of sound walls be evaluated when they are proposed as mitigation for road and rail noise, especially when breaks in their frontage are required to accommodate natural and structural features.

This section provides an introduction to basic concepts and terminology necessary to understand noise and vibration. Background, or ambient, noise levels are described for representative segments of the corridor, based on specific noise measurements. This baseline information is important to understand how conditions will change with the introduction of enhanced transit service in the project corridor. The increase in noise resulting from the transit vehicles is then compared to thresholds that the U.S. Federal Transit Administration (FTA) has adopted to identify adverse community response. As appropriate, mitigation measures are recommended that would reduce noise impacts from the Proposed Project.

Existing Conditions

Characteristics of Sound and Noise

Sound is generated when an object vibrates and causes minute periodic fluctuations in atmospheric pressure. Human perception of sound is dependent on various factors including frequency, magnitude, and duration. Frequency is the number of pressure variations per second (Hertz). Humans can typically hear sound waves with frequencies between 20 and 20,000 Hertz.

Since the human range of hearing is so large, sound magnitude is measured in units of decibels (dB) on a logarithmic scale. The human ear does not perceive sound at the low and high frequencies as well as it does at the middle frequencies. When sound magnitude is measured by a sound level meter, the low and high frequencies are given less weight than the middle frequencies before the average sound magnitude is obtained. This single number, which better characterizes the average noise level perceived by a human ear, is called the A-weighted average and is designated "dBA."

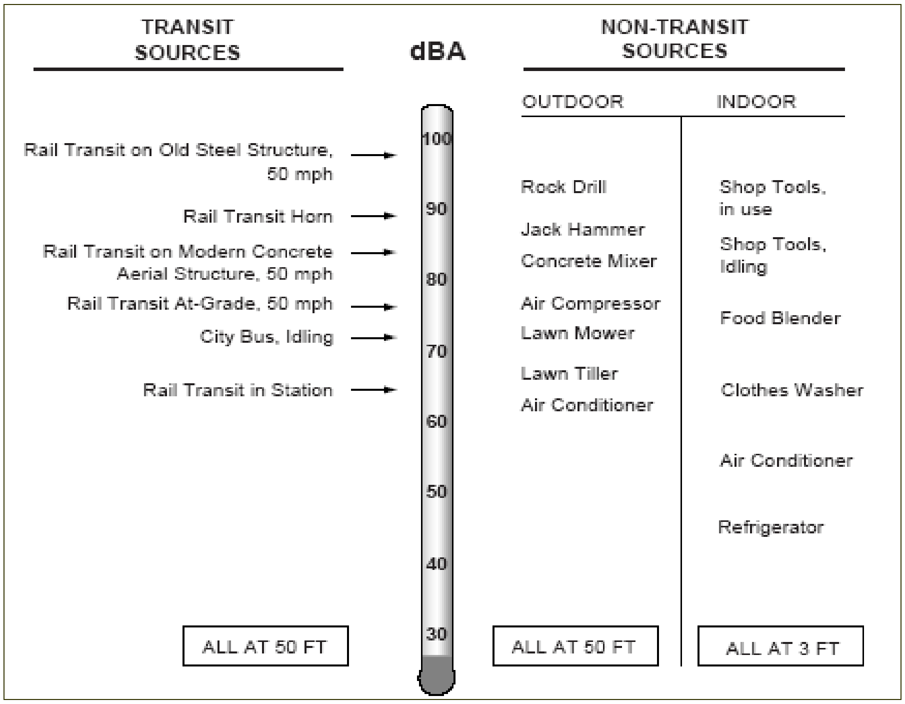
Noise is the term generally given to the "unwanted" aspects of sound. Many factors influence how a sound is perceived and whether it is considered annoying to a listener. These include the physical characteristics of a sound (e.g., frequency, magnitude, duration, etc.) and also non-acoustic factors (e.g., the acuity of a listener's hearing ability, the activity of the listener during exposure, etc.) that can influence the judgment of listeners regarding the degree of "undesirability" of a sound. Excessive noise can negatively affect the physiological or psychological well-being of individuals or communities.

All quantitative descriptors used in environmental noise assessments recognize the strong correlation between the high acoustical energy content of a sound (i.e., its loudness and duration) and the disruptive effect it is likely to have as noise. Because environmental noise fluctuates over time, most descriptors average the sound level over the time of exposure, and some add "penalties" during the times of day when intrusive sounds would be more disruptive to listeners. The most commonly used descriptors are:

- Equivalent A-weighted sound level (L_{eq}). The L_{eq} is an average or constant sound level over a given period that would have the same sound energy as the time-varying A-weighted sound over the same period. The period is typically taken over 1 hour and represented as L_{eq} (h).
- Day-night average sound level (L_{dn}). The L_{dn} is a 24-hour average sound level, but for the night hours between 10:00 P.M. and 7:00 A.M., 10 dBA is added to the average. This additional 10 dBA accounts for the tendency of people to perceive noise more loudly at night.
- Community noise equivalent level (CNEL). The CNEL is similar to the L_{dn} except that, in addition to the 10:00 P.M. to 7:00 A.M. 10 dBA penalty, a 5 dBA penalty is applied to noise levels occurring from 7:00 P.M. to 10:00 P.M.

Figure 3.10-1 gives examples of typical noise levels from various transit and non-transit sources.

Figure 3.10-1 Examples of Typical Noise Levels for Various Sources



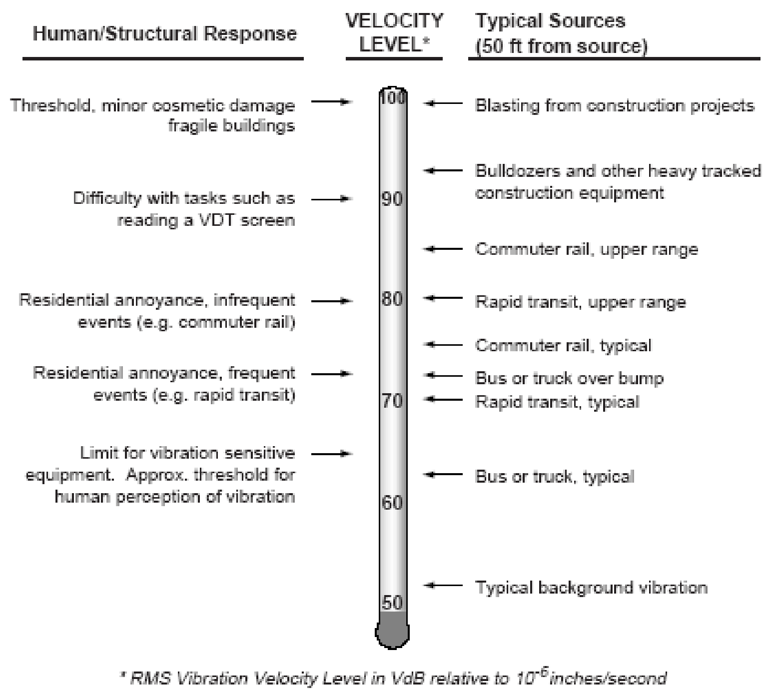
Source: FTA, *Transit Noise and Vibration Impact Assessment, Final Report,* May 2006.

Definition and Measurement of Vibration

While sound is the transmission of energy through the air, groundborne vibration is the transmission of energy through the ground or other solid medium. Humans perceive vibrations as the motion of the floor or building. Such vibrations within buildings can, in turn, generate noise by transmitting energy through the air causing a rumble called groundborne noise. The magnitude of vibration is measured in vibration decibels (VdB). People can usually perceive vibrations of 65 VdB or greater, with levels exceeding 75 VdB commonly considered annoying. Typical background vibration in residential areas is 50 VdB or lower, below the typically perceptible threshold of 65 VdB. However, near rapid transit or light rail systems, vibration levels are usually between 70 and 80 VdB. Figure 3.10-2 provides other examples of typical vibration levels. The occurrence of vibration events with a magnitude large enough to cause annoyance is not as common as noise exposures severe enough to cause annoyance. For example, vibrations do not generally cause an adverse reaction from people who are outdoors.

Besides being an annoyance, extreme levels of vibration can also damage fragile structures. The potential for building damage from vibration is typically evaluated by examining the peak particle velocity (PPV), which is maximum instantaneous peak of a vibration signal.

Figure 3.10-2 Examples of Typical Vibration Levels for Various Sources



Source: FTA, *Transit Noise and Vibration Impact Assessment, Final Report,* May 2006.

Vibration levels near transit systems are influenced by a number of factors, which may include:

- vehicle design (e.g., suspension, wheel design);
- guideway design (e.g., stiffness, type of joints);
- geology (e.g., type and depth of soil); and
- receiving building design (e.g., wood, masonry).

Existing Noise and Vibration Sources

Currently, the dominant and consistent source of noise near the project corridor is on-road vehicle traffic. Sensitive receptors (i.e., land uses that are particularly sensitive to changes in the ambient noise environment, such as residential areas, schools, and hospitals) between Pittsburg and Antioch near the project corridor are exposed to noise originating from State Route 4 (SR 4). Other existing noise sources include short-term construction activities and trains along the Union Pacific tracks. There are no nearby airports, which can generate high levels of noise in the project corridor. The closest airport is the Buchanan Airport, which is located in Concord more than six miles away from the project corridor.

Typically, indoor vibration levels near traffic corridors are below the threshold of human perception (below 65 VdB). In some instances, poorly maintained, rough roads with heavy-duty vehicles may generate perceptible vibrations; however, perceptible vibration levels would more likely be generated from construction equipment during project construction than from transit vehicles traveling the project corridor after construction is complete.

Noise Measurements

Existing noise levels along the project corridor were characterized by measuring noise using a sound level meter at the locations described in Table 3.10-1 and identified in Figure 3.10-3. These locations were selected based on predominant noise sources, type of land use, and locations potentially affected by the Proposed Project. Specifically, locations were selected at or near land uses that would be sensitive to noise such as residences and schools. These noise measurement locations were identified to be representative of existing noise levels along the corridor at locations that may be impacted by the Proposed Project.

At these locations, 24-hour measurements were taken using a Metrosonics db-3080 Noise Dosimeter (a Type II meter), calibrated at the sites. Information collected included 1-minute L_{eq}, L_{max}, and L (99.9), all in dBA. L_{max} is the maximum sound level and L (99.9) is the noise level that is exceeded 99.9 percent of the time period being measured, essentially the minimum noise level. A summary of the measurements is found in Table 3.10-1. Note that this dosimeter provides readings of all measured parameters in 0.1 dBA increments. This does not imply that the measured parameters are known to this accuracy. Environmental noise levels have a relatively large intrinsic variability (e.g., it would not be unusual for a series of CNEL values measured at the same location over a period of several days to extend over a range of 1 to 2 dBA). Also, the dosimeter itself is not perfectly accurate. As a Type II meter, its readings are regarded as likely being within 1 dBA of the true parameter values, at best. However, it is standard practice to report measured values exactly as the measuring instrument displays them and this convention has been carried over to the parameters displayed in Table 3.10-1.

Sensitive Receptors

The project corridor traverses the cities of Pittsburg and Antioch. The noise criteria used to determine level of impact are based on the representative land use types along the project corridor; therefore, land uses along the project corridor need to be identified as part of the analysis. In particular, land uses that support noise-sensitive receptors need to be recognized. Such sensitive receptors include residences, schools, libraries, churches, hospitals, nursing homes, auditoriums, and outdoor recreation areas. Figures 3.3-2A through 3.3-2D in Section 3.3, Land Use, of this EIR show the existing and proposed land uses along the project corridor.

Table 3.10-1
Summary of Existing Noise Measurements along the Project Corridor, 2006–2008

Location	Predominant Noise Source	Primary Land Use Category	Descriptor	Measured Value (dBA)
N1-Construction Site at Power and Railroad Avenues, Pittsburg. The construction site is situated between SR 4 to the south and the Pittsburg Library to the north. The noise meter was located at the southernmost edge of a construction site closest to the project corridor, about 200 feet from the edge of SR 4.	Traffic on SR 4	Residence and Institution	24-hour L_{eq}	64.3
			Min. hourly L_{eq}	53.2
			L_{max}	96.9
			L_{dn}	68.2
			CNEL	68.7
N2-Bidwell High School at 800 Gary Avenue, Antioch. The school property is surrounded by homes to the north and west, and is adjacent to the existing Union Pacific right-of-way to the south. The noise meter was located on the southwestern portion of the property closest to the project corridor about 100 feet from the edge of Gary Avenue.	Traffic on Gary Avenue. No major roadway nearby.	Residence and Institution	24-hour L_{eq}	57.1
			Min. hourly L_{eq}	44.1
			Min. hourly L_{eq} (during school hours)	47.1
			L_{max}	82.9
			L_{dn}	59.7
			CNEL	60.7
N3-Residence at 4370 Neroly Road, Oakley. The property is in a residential area adjacent to Neroly Road to the south, which is well traveled and runs parallel to the existing UP tracks. Currently, open land lies to the other side of the tracks to the south. The noise meter was located along the southern portion of the property about 50 feet from the edge of Neroly Road.	Traffic on Neroly Road.	Residence	24-hour L_{eq}	62.3
			Min. hourly L_{eq}	51.6
			L_{max}	87.6
			L_{dn}	65.9
			CNEL	66.3
N10-Business at 670 Bailey Road, Pittsburg. Bailey Road is a well-traveled road that BART riders would take to access the Pittsburg/Bay Point Station. The noise meter was located more than 1,000 feet south of SR 4. To the east and south of the meter are residences, while to the west are businesses. The noise meter was located about 22 feet west of the edge of the roadway.	Traffic on Bailey Road	Residence	24-hour L_{eq}	66.1
			Min. hourly L_{eq}	53.7
			L_{max}	90.0
			L_{dn}	70.8
			CNEL	71.0

Table 3.10-1
Summary of Existing Noise Measurements along the Project Corridor, 2006–2008

Location	Predominant Noise Source	Primary Land Use Category	Descriptor	Measured Value (dBA)
N11-Residence at 324 Drake Street, Antioch. Drake Street is not well traveled and runs adjacent and parallel to SR 4, which is located to the south. There is no sound wall along the freeway at this location. Residences are located along Drake Street. The noise meter was located south of a home about 220 feet from the centerline of the freeway.	Traffic on SR 4	Residence	24-hour L_{eq} Min. hourly L_{eq} L_{max} L_{dn} CNEL	62.2 57.9 85.8 67.7 68.0
N12-Residence at Hillcrest Meadows on Renwich Drive, Antioch. The noise meter was located southeast of the residential complex. The complex is located in a quiet area about 750 feet north from the centerline of SR 4 and 500 feet west from Hillcrest Avenue. The complex has a sound wall that only covers the first floor of complex. The meter was located more than 100 feet away from the wall.	Traffic from SR 4 and Hillcrest Avenue	Residence	24-hour L_{eq} Min. hourly L_{eq} L_{max} L_{dn} CNEL	50.6 43.8 77.6 55.6 55.9
N13-Residence at Oakley Road near Willow Avenue, Antioch. Residences are located on north side of Oakley Road and undeveloped land is located on the south side. SR 4 is located about 1,500 feet to the south. The noise meter was located on the south side of the road about 150 feet from Willow Avenue.	Traffic on Oakley Road	Residence	24-hour L_{eq} Min. hourly L_{eq} L_{max} L_{dn} CNEL	59.8 46.7 94.4 63.9 64.2
N14-Near Residence at Clover Court near Larkspur Drive, Antioch. Clover Court is a cul-de-sac perpendicular to SR 4, which is located to the north. The noise meter was located on a median in the center of the road about 260 feet from the centerline of the freeway. There was no sound wall along this portion of the freeway; however, the meter is partially shielded from the freeway by homes on both sides of Clover Court.	Traffic on SR 4	Residence	24-hour L_{eq} Min. hourly L_{eq} L_{max} L_{dn} CNEL	66.1 57.0 91.2 70.5 71.0

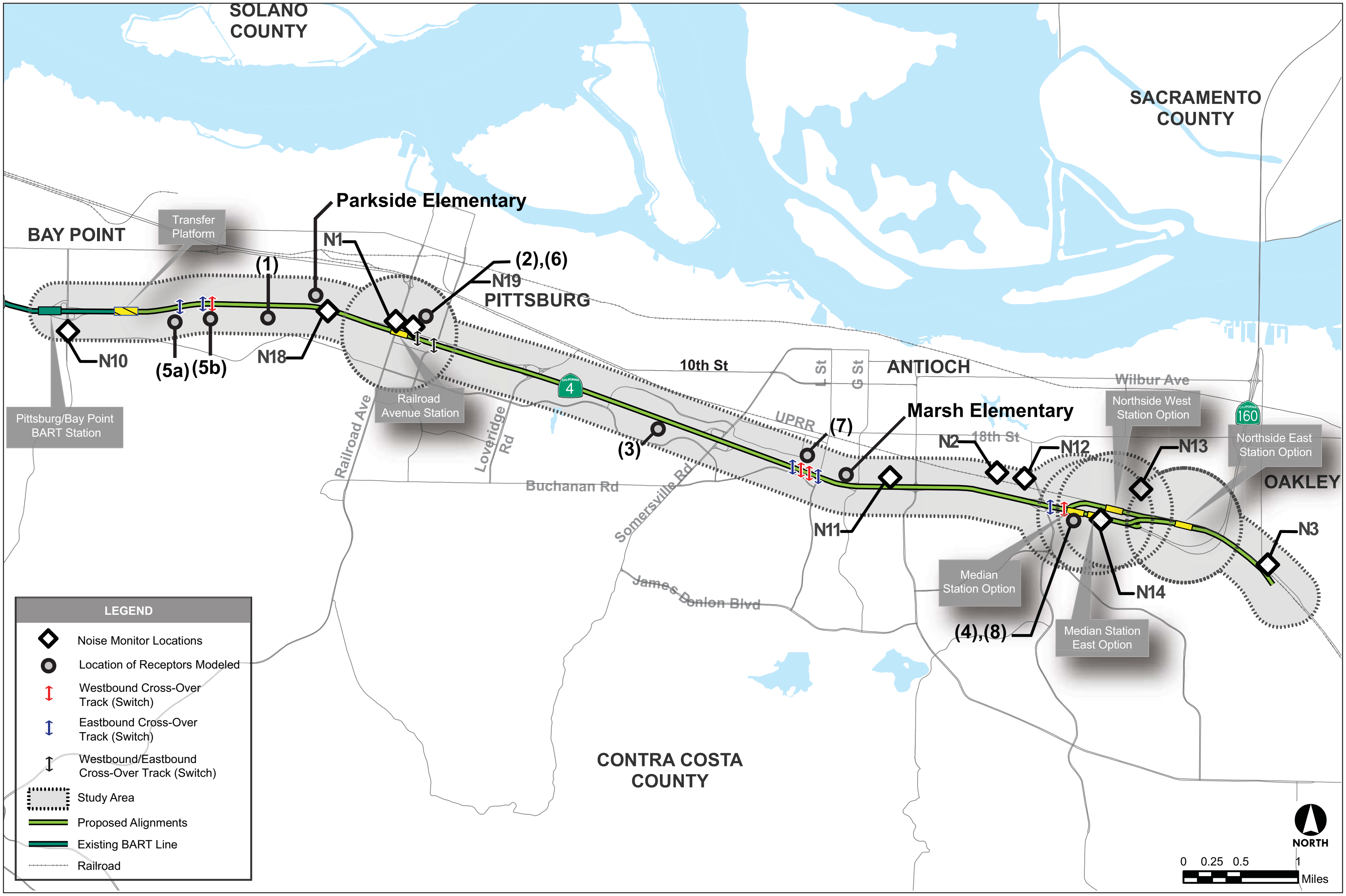
Table 3.10-1
Summary of Existing Noise Measurements along the Project Corridor, 2006–2008

Location	Predominant Noise Source	Primary Land Use Category	Descriptor	Measured Value (dBA)
N18-North Fenceline of Los Medanos Elementary School (near Frontage Road and Chelsea), Antioch. The school is located north of SR 4. The noise meter was located on the north fenceline of the school about 55 feet from the sound wall and about 130 feet from the centerline of the freeway. A walking path is located between the monitor and sound wall.	Traffic on SR 4	Residence	24-hour L_{eq}	62.2
			Min. hourly L_{eq}	55.7
			L_{max}	87.5
			L_{dn}	67.6
			CNEL	68.0
N19-Near Residence on California Avenue between Clyde Street and Avon Street, Antioch. California Avenue is located between a row of homes to the north and SR 4. The terrain blocks the line of sight between most of SR 4 the homes. However, California Avenue is a well traveled by passenger automobiles and trucks. The monitor was located on the side fence of a home behind a bush and about 150 feet from the edge of SR 4.	Traffic on California Avenue and SR 4	Residence	24-hour L_{eq}	71.5
			Min. hourly L_{eq}	59.4
			L_{max}	98.8
			L_{dn}	71.5
			CNEL	71.8

Source: Noise measurements taken by ERM 2006, 2007, and 2008.

Note:

Additional noise measurements taken outside the project corridor are presented in the Noise Technical Report.



Source: PBS&J; ERM 2008.

LOCATION OF NOISE MONITORS AND RECEPTORS MODELED ALONG PROJECT CORRIDOR

FIGURE 3.10-3

Applicable Policies and Regulations

The FTA noise guidelines are commonly recognized as the basis for determining significant impacts. BART has adopted the FTA construction and operational noise criteria as its own. BART is exempt by State law (California Government Code Section 53090) from local city and county general plans and land use policies and ordinances; however, as background information, the noise requirements or policies contained in the city or county codes and general plans are also described below.

FTA Guidelines. In its document, *Transit Noise and Vibration Impact Assessment*,[1] the FTA provides guidance for occasions when noise and vibration impacts are significant. In particular, Figure 3.10-4 identifies degrees of impact for transit projects based on land use and existing and project-associated noise levels. The land use categories are described in Table 3.10-2. Category 1 includes outdoor amphitheaters, while Category 2 includes homes, hospitals, and hotels where people sleep. Category 3 land uses are typically indoor, such as schools, libraries, and churches, and the criteria take into account the reduction in average noise levels provided by a building structure. The L_{dn} noise descriptor is used for Category 2 because it includes greater human sensitivity to nighttime noise, which would be most likely to disrupt sleep at the affected sensitive land uses. The criteria for Categories 1 and 3 are based on the hourly L_{eq} noise descriptor for the noisiest hour of transit-related activities, which could affect essential activities at the sensitive land uses.

As seen in Figure 3.10-4, the criteria allow a project to generate more noise in areas with higher existing noise levels, before triggering an adverse human response. However, the overall effect is to permit a smaller increase in total or cumulative noise levels (existing plus project) as the ambient noise increases. This trend is more apparent in Figure 3.10-5.

The FTA criteria for groundborne vibration and resulting groundborne noise impacts are identified in Table 3.10-3. Similar to the noise criteria, the criteria in Table 3.10-3 are based on type of land use. Category 1 land uses include hospitals and manufacturing facilities that have vibration-sensitive equipment. All types of residential land uses are considered Category 2 land uses. Category 3 land uses are institutional land uses with facilities used primarily in the day such as schools and churches.

State Guidelines. In California, the 2003 General Plan Guidelines published by the Governor's Office of Planning and Research specify elements to be included in a city or county general plan. In particular, the General Plan Guidelines suggest acceptable noise levels to be based on land use and projected daily noise levels (either using CNEL or L_{dn}). These noise levels are the same as will be discussed for the City of Pittsburg General Plan (see Table 3.10-4).

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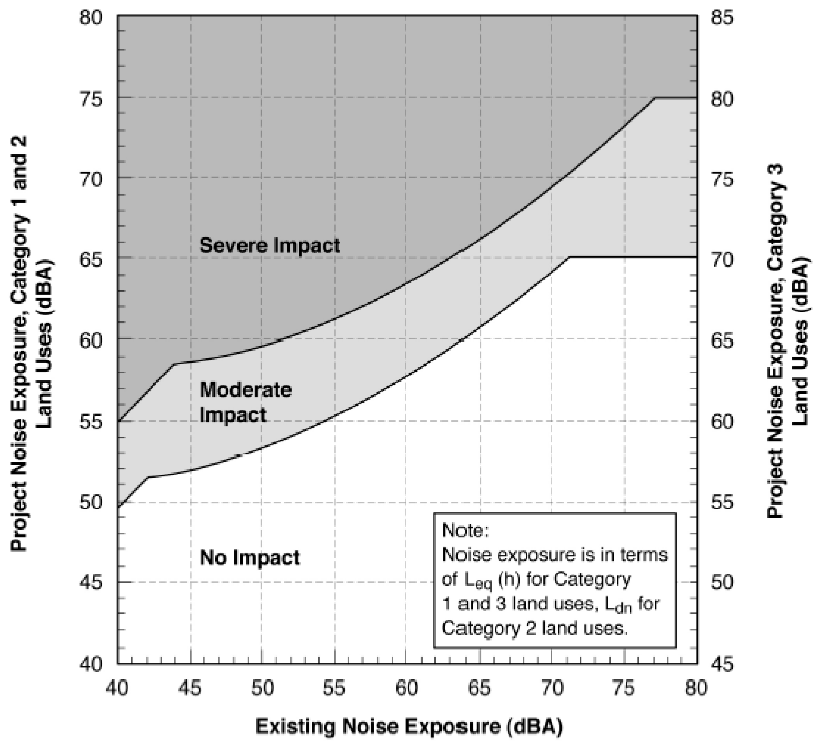
1 FTA, *Transit Noise and Vibration Impact Assessment*, FTA-VA-90-1003-06, May 2006.

Figure 3.10-4 FTA Noise Impact Criteria for Transit Projects



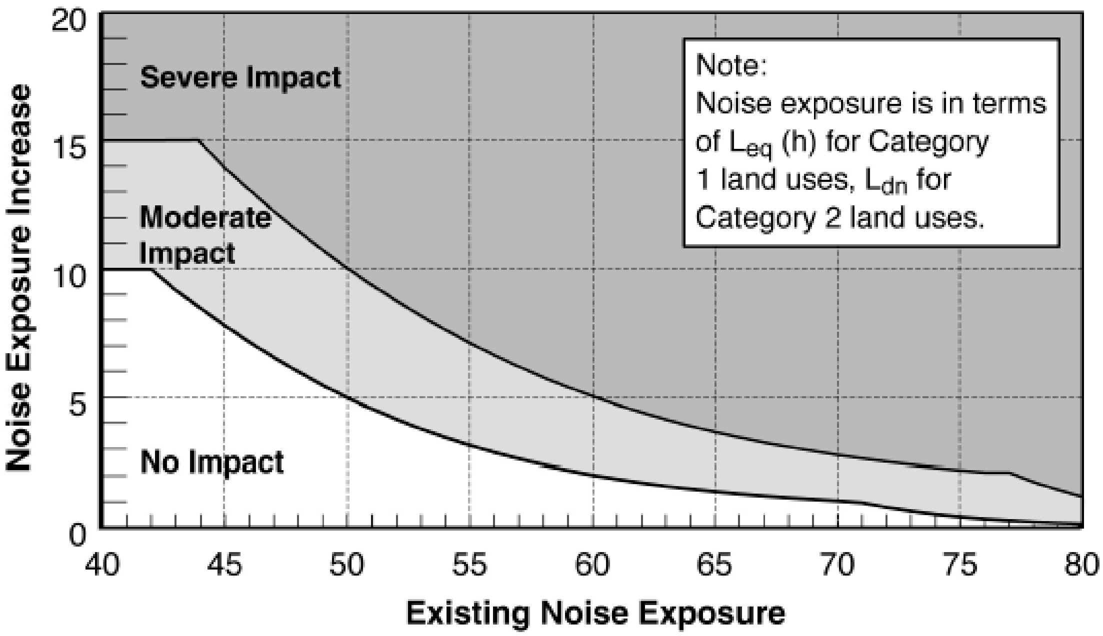
Source: FTA, *Transit Noise and Vibration Impact Assessment, Final Report,* May 2006.

Table 3.10-2
FTA Land Use Categories

Land Use Category	Description
1	Tracts of land where quiet is an essential element in their intended purpose. This category includes lands set aside for serenity and quiet, and such land uses as outdoor amphitheaters and concert pavilions, as well as National Historic Landmarks with significant outdoor use.
2	Residences and buildings in which people normally sleep. This category includes homes, hospitals, and hotels where a nighttime sensitivity to noise is assumed to be of utmost importance.
3	Institutional land uses with primarily daytime and evening use. This category includes schools, libraries, and churches where it is important to avoid interference with such activities as speech, meditation, and concentration on reading material. Buildings with interior spaces where quiet is important fall into this category, and include medical offices, conference rooms, recording studios, and concert halls. Places for meditation or study are associated with cemeteries, monuments, and museums. Certain historical sites, parks, and recreational facilities are also included.

Source: FTA, *Transit Noise and Vibration Impact Assessment, Final Report,* May 2006.

Figure 3.10-5
Increase in Cumulative Noise Levels Allowed by Noise Impact Criteria for Transit Projects



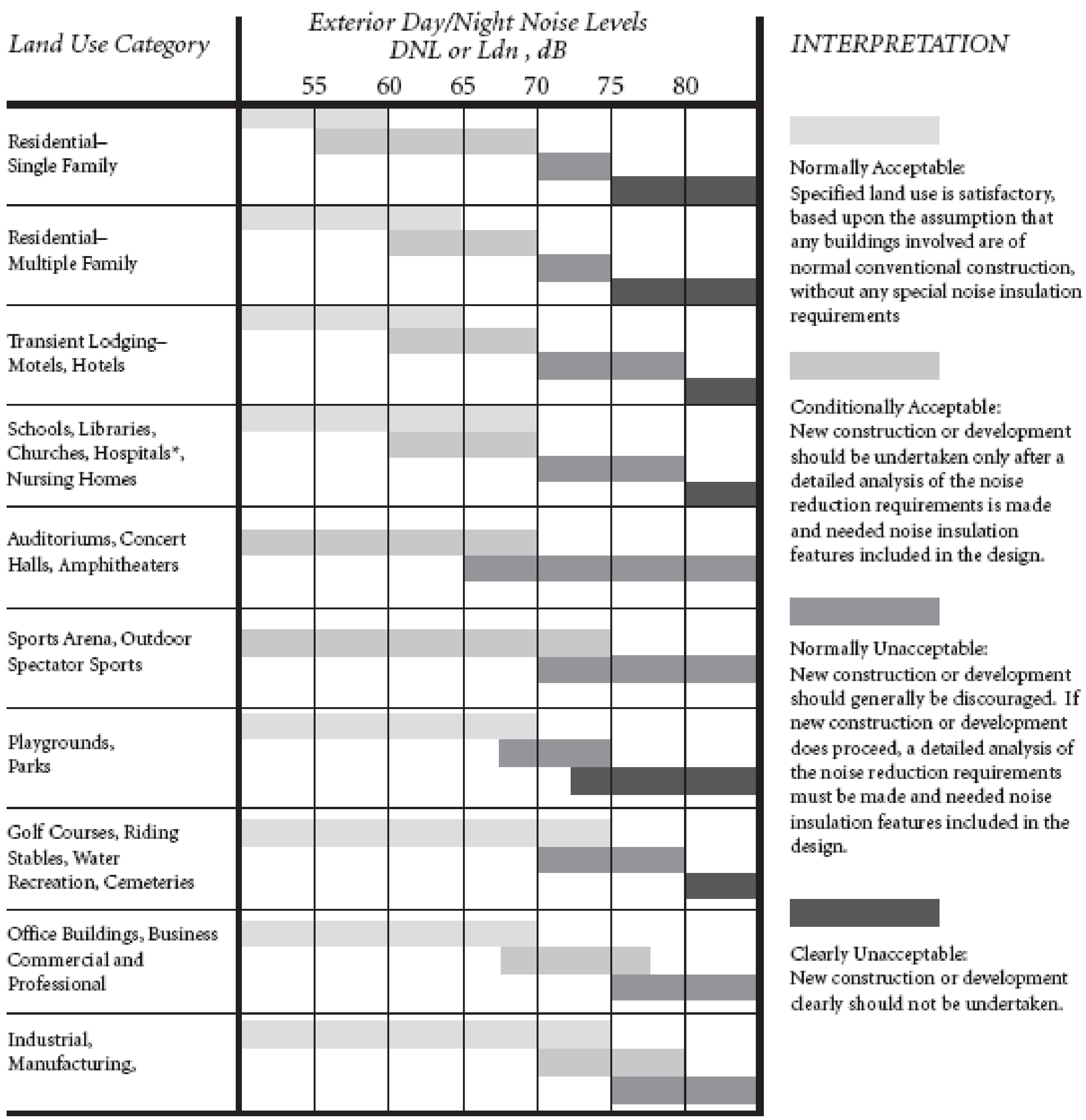
Source: FTA, *Transit Noise and Vibration Impact Assessment, Final Report,* May 2006.

Table 3.10-3
FTA Vibration Impact Criteria for Transit Projects

Land Use Category	Groundborne Vibration (VdB)	Groundborne Noise (dBA)
Category 1: Buildings where vibration would interfere with interior operations.	65	None
Category 2: Residences and buildings where people normally sleep.	72	35
Category 3: Institutional land use with primarily daytime use.	75	40

Source: FTA, *Transit Noise and Vibration Impact Assessment*, Final Report, May 2006.
Note:
Criteria are for frequent events defined as more than 70 vibration events per day.

Table 3.10-4
City of Pittsburg General Plan
Land Use/Noise Environment Compatibility Guidelines



Source: Pittsburg 2020, *A Vision for the 21st Century, City of Pittsburg General Plan*, December 2004.

In addition, Title 24 of the California Code of Regulations requires that when exterior noise exceeds 60 dB CNEL at planned multifamily dwelling units, an acoustical analysis demonstrating that the proposed dwelling will limit interior noise levels to 45 dB CNEL or less.

City of Pittsburg. The Pittsburg city codes contain general limitations on noise but do not quantify levels that are not to be exceeded. However, the Pittsburg General Plan identifies the acceptable exterior noise levels for different land use categories as shown in Table 3.10-4, which is based on the State of California General Plan Guidelines described previously.

In addition, the Pittsburg General Plan specifies that analysis and design of mitigation measures are needed if new noise-sensitive developments are exposed to noise levels greater than 65 dBA CNEL. In such a case and if the development is near a roadway, measures are required to ensure interior noise levels do not exceed 45 CNEL.

According to the Pittsburg General Plan, loud noises from construction activities are limited to normal business hours of 8:00 a.m. to 5:00 p.m.

City of Antioch. Section 9-5.1901 of the Antioch Municipal Code limits noise to proposed outdoor residential living areas adjacent to SR 4, SR 4 Bypass, and BART development to 65 dBA CNEL. Near existing homes that are adjacent to SR 4 and BART development, less than a 5 dBA CNEL increase in noise is allowed. In general, background ambient noise at other locations not adjacent to the SR 4, SR 4 Bypass, and BART development is not allowed to exceed 60 dBA CNEL.

The City also does not allow construction activity during the following periods:

- On weekdays prior to 7:00 a.m. and after 6:00 p.m.;
- On weekdays within 300 feet of occupied dwelling space, prior to 8:00 a.m. and after 5:00 p.m.; and
- On weekends and holidays prior to 9:00 a.m. and after 5:00 p.m.

In addition to the code requirements, the Antioch General Plan specifies objectives for new development as shown on Table 3.10-5. Mitigation is required:

- If a new development results in exceedances of the levels specified in Table 3.10-5; or
- If the increase associated with the proposed development is 3.0 dBA or greater, in areas that already exceed the levels specified in Table 3.10-5 (prior to development).

The Antioch General Plan also specifies that construction near noise-sensitive land for new development should have restrictions on operational hours and should implement a construction-related noise mitigation plan.

Table 3.10-5
City of Antioch General Plan Maximum Noise by Land Use

Land Use	Maximum Sound Levels
Residential Single Family	60 dBA CNEL within rear yards
Residential Multifamily	60 dBA CNEL within interior open space
School Classrooms	65 dBA CNEL
School Play areas	70 dBA CNEL
Hospitals, Libraries	60 dBA CNEL
Commercial/Industrial	70 dBA CNEL at the front setback

Source: City of Antioch, *General Plan*, November 24, 2003.

Oakley. While DMU service would not extend to Oakley as part of the Proposed Project, a maintenance facility is a possibility near the City of Oakley. Similar to Pittsburg, the Oakley Municipal Codes contain general limitations on noise but do not quantify levels that are not to be exceeded. The Oakley General Plan contains the same land compatibility guidelines as shown in Table 3.10-4 (for the City of Pittsburg). In addition, noise levels from non-transportation sources must generally be mitigated to 50 L_{eq} (dBA) during daytime hours (7:00 a.m. to 10:00 p.m.) and to 45 L_{eq} (dBA) during nighttime hours (10:00 p.m. to 7:00 a.m.). On the other hand, exposure to transportation noise sources must be mitigated to levels specified in Table 3.10-6.

Table 3.10-6
Oakley General Plan Noise Level Standards for Exposure to Transportation Noise Sources

	Outdoor	Interior	
Land Use	L_{dn} or CNEL (dBA)	L_{dn} or CNEL (dBA)	Hourly L_{eq} (dBA)
Residence, Transient Lodging, Hospitals, Nursing Homes	65	45	—
Theatres, Auditoriums, Music Halls	—	—	35
Churches, Meeting Halls	65	—	40
Office Buildings and Schools	—	—	45
Libraries, Museum	—	—	45
Playgrounds, Neighborhood Parks	70	—	—

Source: Oakley, *2020 General Plan*, December 16, 2002.

Contra Costa County. Information on Contra Costa County is presented because the existing Pittsburg/Bay Point Station is in the unincorporated community of Bay Point and the County's noise policies and standards would be relevant to this area. The Contra Costa County codes contain general limitations on noise but do not quantify levels that are not to be exceeded. However, the County General Plan contains the same noise and land use compatibility guidelines previously identified in Table 3.10-4 (for the City of Pittsburg). In addition, the County General Plan specifies the noise standards listed in Table 3.10-7. If new residential uses are exposed to an L_{dn} in excess of 65 dB due to single events such as train operation, indoor single-event noise levels shall not exceed 50 dB in bedrooms and 55 dB in other habitable rooms.

Table 3.10-7
Contra Costa County General Plan Noise Standards

	L_{dn} (dB)
Residential (other than from train passbys)	60
Residential if primary noise is train passbys	70

Source: Contra Costa County General Plan, January 2005.

In addition, the County General Plan specifies that construction activities be limited to normal working hours.

Impact Assessment and Mitigation Measures

Standards of Significance

The Proposed Project would pose a significant noise and vibration impact if it were to result in:

- A substantial permanent increase in ambient noise or vibration levels in the project vicinity above levels existing without the project.
- A substantial temporary or periodic increase in ambient noise or vibration levels in the project vicinity above levels existing without the project.

To help quantify substantial increases to ambient conditions, the criteria below are used to define significance for noise and vibration impacts.

Noise Criteria. Noise criteria are based on the FTA guidelines. There are two levels of impact included in the FTA criteria: "Moderate Impact" and "Severe Impact," as shown in Table 3.10-8. The noise levels in this table are the tabular form of the FTA criteria described in Figure 3.10-4. The interpretation of these two levels of impact is summarized below:

Table 3.10-8
Noise Impact Criteria during Operations

Existing Noise Exposure* $L_{eq}(h)$ or L_{dn} (dBA)	Project Noise Impact Exposure,* $L_{eq}(h)$ or L_{dn} (dBA)					
	Category 1 or 2 Sites			Category 3 Sites		
	No Impact	Moderate Impact	Severe Impact	No Impact	Moderate Impact	Severe Impact
<43	< Ambient+10	Ambient + 10 to 15	>Ambient+15	<Ambient+15	Ambient + 15 to 20	>Ambient+20
43	<52	52-58	>58	<57	57-63	>63
44	<52	52-58	>58	<57	57-63	>63
45	<52	52-58	>58	<57	57-63	>63
46	<53	53-59	>59	<58	58-64	>64
47	<53	53-59	>59	<58	58-64	>64
48	<53	53-59	>59	<58	58-64	>64
49	<54	54-59	>59	<59	59-64	>64
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56	<56	56-62	>62	<61	61-67	>67
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71	<66	66-70	>70	<71	71-75	>75
72	<66	66-71	>71	<71	71-76	>76
73	<66	66-71	>71	<71	71-76	>76
74	<66	66-72	>72	<71	71-77	>77
75	<66	66-73	>73	<71	71-78	>78
76	<66	66-74	>74	<71	71-79	>79
77	<66	66-74	>74	<71	71-79	>79
>77	<66	66-75	>75	<71	71-80	>80

* L_{dn} is used for land use where nighttime sensitivity is a factor; L_{eq} during the hour of maximum transit noise exposure is used for land use involving only daytime activities.

Source: FTA, *Transit Noise and Vibration Impact Assessment, Final Report*, May 2006.

Severe Impact. Severe noise impacts are considered "significant" as this term is used in the National Environmental Policy Act (NEPA) and implementing regulations. Noise mitigation will normally be specified for severe impact areas unless there is no practical method of mitigating the noise.

Moderate Impact. In this range of noise impacts, other project-specific factors must be considered to determine the magnitude of the impact and the need for mitigation. These other factors can include the predicted increase over existing noise levels, the types and number of noise-sensitive land uses affected, existing outdoor-indoor sound insulation, and the cost effectiveness of mitigating noise to more acceptable levels.

Noise impact criteria during construction are identified in Table 3.10-9.

Table 3.10-9
Noise Impact Criteria during Construction

Land Use	Acceptable Maximum Daytime Noise Level (dBA)	Acceptable Maximum Nighttime Noise level (dBA)
Residential	90	80
Commercial Areas	100	100
Industrial Areas	100	100

Source: FTA, *Transit Noise and Vibration Impact Assessment, Final Report*, May 2006.

Vibration Criteria. Vibration levels during operations exceeding those in Table 3.10-10 are considered significant. Considering the expected frequency of the Proposed Project (about 160 train trips per day), the criteria under "Frequent Events" would apply. The criteria reported in Table 3.10-11 are used to assess the potential annoyance or interference with vibration sensitive activities due to construction.

Impact Classification. To define noise and vibration impacts to land uses in the project corridor, a level of significance is determined according to established methodology and reported for each identified impact, as specified below. This significance level is presented in the italicized summary impact statement that precedes the analysis of each noise and/or vibration topic. Conclusions of significance are defined as follows: significant (S), potentially significant (PS), less than significant (LTS), no impact (NI), and beneficial (B). If the mitigation measures would not diminish potentially significant or significant impacts to a less-than-significant level, the impacts are classified as "significant and unavoidable effects" (SU). For this section NO, refers to Noise.

Table 3.10-10
Groundborne Vibration (GBV) Impact Criteria during Operations

Land Use Category	GBV Impact Levels (VdB re 1 micro-inch/sec)		
	Frequent Events[a]	Occasional Events[b]	Infrequent Events[c]
Category 1: Buildings where vibration would interfere with interior operations (research facilities, hospitals with vibration sensitive equipment)	65 VdB[d]	65 VdB[d]	65 VdB[d]
Category 2: Residences and buildings where people normally sleep	72 VdB	75 VdB	80 VdB
Category 3: Institutional land uses with primarily daytime uses (schools, churches)	75 VdB	78 VdB	83 VdB

Source: FTA, *Transit Noise and Vibration Impact Assessment, Final Report*, May 2006.

Notes:

a. "Frequent Events" is defined as more than 70 vibration events of the same source per day.

b. "Occasional Events" is defined as between 30 and 70 vibration events of the same source per day.

c. "Infrequent Events" is defined as fewer than 30 vibration events of the same kind per day.

d. This criterion limit is based on levels that are acceptable for most moderately sensitive equipment such as optical microscopes. Vibration-sensitive manufacturing or research will require detailed evaluation to define the acceptable vibration levels. Ensuring lower vibration levels in a building often requires special design of the HVAC systems and stiffened floors.

Table 3.10-11
Vibration Damage Impact Criteria during Construction

Land Use	Acceptable Vibration Levels (VdB)	Acceptable Peak Particle Velocity (in/sec)
Reinforced-concrete, steel or timber (no plaster)	102	0.5
Engineered concrete and masonry (no plaster)	98	0.3
Non-Engineered timber and masonry buildings	94	0.2
Buildings extremely susceptible to vibration damage	90	0.12

Source: FTA, *Transit Noise and Vibration Impact Assessment, Final Report*, May 2006.

Methodology

The following approach was used to assess noise and vibration impacts associated with the Proposed Project.

Existing Noise. Unless otherwise noted, the noise measurements presented in Table 3.10-1 are used to define the existing noise levels at receptors closest to the alignment. Under certain circumstances, where the potential impacts to receptors at a different distance from influential roadway noise sources need to be assessed, the measured noise levels (expressed as L_{dn}) are adjusted for these different distances using equations recommended by the FTA Guidelines.

Future background noise levels are expected to increase as the area grows and traffic increases on the local roads. However, as background noise increases, project noise sources would have less of an effect on resultant total future noise levels. Therefore, future background was assumed to remain at existing levels to maximize the effect of project sources when determining the significance of future project noise impacts.

Operational Noise from Trains and Associated Facilities. Noise (L_{dn}) from the Proposed Project was calculated using the methods and equations contained in the FTA Guidelines. Table 3.10-12 summarizes the key parameters used for calculating noise from the proposed DMU trains.

Noise from special trackwork is also considered in the EIR. When a train crosses special trackwork such as a railroad switch (also known as a cross over), the gap over the switch generates additional noise. The noise from such trackwork can be treated as a stationary source. Wilson, Ihrig & Associates (WIA) conducted field measurements of a similar DMU operating in San Diego County. SEL_{ref} from a DMU traveling over special trackwork are based on these field measurements.[2]

In addition to noise from trains running on tracks, the Proposed Project would also generate noise from other sources such as transit horns which are sounded as vehicles enter station areas, ventilation machinery for tunnels (if required, as it might be if a long tunnel is installed for the Hillcrest Avenue Station option) and activities from the maintenance facilities. The latter two sources were treated as stationary noise sources with the SEL_{ref} below:

- Vent Shaft (assume equivalent to auxiliary equipment) = 101 dBA
- Train Maintenance Facility = 118 dBA (assumes 20 train movements in one hour).

[2] WIA memo to BART dated July 11, 2008.

Table 3.10-12
Summary of Key Parameters for Operational Noise Analysis

Parameter	Year 2015	Year 2030
Reference Sound Exposure Level (SELref) dBA at 50 feet (see note)	91	91
Number of cars per train (N_{pk}) during the peak hour	2	3
Average number of cars per train (N_d) during the daytime (between 7:00 a.m. and 10:00 p.m.)	1.33	1.67
Average number of cars per train (N_n) during the nighttime (between 10:00 p.m. and 7:00 a.m.)	1.2	1.4
Peak hourly volume of trains (V_{pk})	8	8
Average hourly daytime volume of trains (V_d) (between 7:00 a.m. and 10:00 p.m.)	8	8
Average hourly nighttime volume of trains (V_n) (between 10:00 p.m. and 7:00 a.m.)	4.4	4.4
Train speed (S)	75 mph	75 mph
Track type (e.g., welded, jointed)	welded	welded

Source: ERM, 2008.

Note:

DMU SEL_{ref} from Wilson, Ihrig & Associates (WIA) field measurements of a similar DMU operating in San Diego County. Frequency and speed limit based on data from Wilbur Smith and Associates (WSA). Parameters account for trains traveling in both directions.

According to the FTA Guidelines, noise from the maintenance facility may be assumed to, on average, come from the center of the facility.

Noise from trains and associated facilities is initially predicted at 50 feet and then adjusted for distance using equations from the FTA Guidelines.

Noise from Automobiles. Noise levels were also estimated near the proposed Railroad Avenue and Hillcrest Avenue Stations based on the automobile traffic anticipated in the station vicinity. To predict noise levels near roadways, the FHWA Traffic Noise Model (TNM), Version 2.5, was used along with traffic data provided by Wilbur Smith and Associates (WSA), transportation consultants for this EIR. TNM takes into account traffic volumes, types of vehicles, vehicle speeds, signal type at intersections, if any, and roadway configuration. WSA provided traffic volumes, posted speeds limits, and number of lanes. Aerial maps were used to define the roadway configuration. Ninety-five percent of all vehicles were assumed to be passenger cars, vans, and light trucks, while the rest were considered heavy-duty vehicles (as supported by *Transportation Project-Level Carbon Monoxide Protocol*, revised December 1997, Institute of Transportation Studies, UC Davis; and *2006 Annual Average Daily Truck Traffic on the California State Highway System*, December 2007, Caltrans). TNM was used to calculate daytime (7:00 a.m. to 10:00 p.m.) and nighttime (10:00 p.m. to 7:00 a.m.) hourly average noise levels.

Vibration. Vibration from the Proposed Project was evaluated using the general vibration assessment approach described in the FTA Guidelines. The FTA Guidelines provide information on typical groundborne vibration levels for rapid transit, light rail vehicles, and locomotives as a function of distance. According to the Guidelines, DMUs typically have vibration levels between those for rapid transit vehicles and locomotives. Therefore, DMU vibration levels were assumed to be the average of rapid transit vehicles and locomotives.

The Guidelines also include adjustment factors for speed and special trackwork (e.g., track crossings, interlocks). In particular, the FTA Guidelines recommend adding 3.5 VdB for vehicles traveling at 75 mph and 10 VdB for special trackwork. Note, however, that the disruptive effects of vibration from special trackwork decrease with distance because of the rapid fall-off vibration amplitude from this localized vibration source.

Construction Noise. The impacts from construction noise associated with the Proposed Project were estimated using the general assessment approach described in the FTA Guidelines. According to the FTA Guidelines, the impact magnitude should be determined from the two noisiest pieces of equipment operating at the same time. The FTA Guidelines provide reference noise levels for various types of construction equipment at a distance of 50 feet from the source.

The combined noise is adjusted for distance to the nearest sensitive receptor using equations in the FTA Guidelines for stationary project-related sources. The combined noise at the nearest receptor is then compared to the significance criteria.

Construction Vibration. The impact from vibrations during construction activities was determined by looking at vibration magnitude expressed in peak particle velocity (PPV, in inches per second) or VdB. The FTA Guidelines provide reference vibration levels for various construction equipment at a 25-foot distance. These values can be adjusted for distance to a sensitive receptor based on equations in the FTA Guidelines. The predicted vibration levels were then compared to the standards of significance.

Project-Specific Environmental Analysis

Operational Impacts

Impact NO-1 *Noise from the Proposed Project in at-grade segments would have a less-than-significant impact on sensitive receptors at locations far from railroad switches. (LTS)*

As the DMU travels on the tracks, noise would be generated from both the contact between the wheels of the DMU and tracks and from the diesel engines on the DMU. The DMU may also include a horn to announce its arrival at the transfer platform or stations; the sounding of the horn would affect noise levels at receptors in the vicinity of the transfer platform or stations. According to the FTA Guidelines, DMUs are typically louder than light rail vehicles of the same length running on electricity (i.e., without a diesel engine), but quieter than the heavier diesel locomotives. The level of significance is determined by the size of the DMU and horn effects relative to existing noise levels. The quieter the existing noise, the greater the increment of DMU noise needed before the resultant noise level would be significant. Tables 3.10-13 and 3.10-14 show the existing noise levels, the upper limit on acceptable project noise levels under FTA Guidelines, the distance of the closest receptor, and the predicted noise level from the DMU and horn (the latter for receptors near the transfer platform and stations) in 2030. Table 3.10-13 lists predicted noise in residential areas where day-night noise levels are critical because of the nighttime sensitivity of the receptors. Table 3.10-14 shows noise at the two schools closest to the tracks, where peak hourly noise levels are important because of the need for quiet during teaching sessions. Other schools, churches and outdoor recreation areas are also located along the proposed corridor, but none are closer than the closest schools identified in Table 3.10-14.

As shown in Table 3.10-13 and Table 3.10-14, all predicted noise levels for 2030 fall below the significance criteria. For example, at the closest receptors (100 feet from tracks), the acceptable day-night noise level is less than 66 dBA. The predicted day-night noise from the DMU is 61 dBA (including the effect of a horn would raise the noise level to 62 dBA), which is within acceptable levels. This additional noise would increase existing noise levels by 0.2 dBA (0.3 dBA including the horn effect). The peak hourly noise level is predicted to be 59 dBA near the closest school (neither of the two schools modeled would be near the transit platform or stations; thus, there would be no horn effect) and would occur during peak hours of operation (6:00 a.m. to 9 a.m. and 4:00 p.m. to 7:00 p.m.). This peak hourly noise level is below the significance level of 66 dBA. DMU operations in 2015 would generate less noise, because there would be two DMUs per train during peak hours, instead of the three estimated to be needed to serve the ridership in 2030. Therefore, noise from the DMU traveling on at-grade lengths of tracks without railroad switches would have a less-than-significant impact on sensitive receptors in 2015 and 2030.

Table 3.10-13
Predicted Day-Night (L_{dn}) Noise Level from DMU Operations (in at-grade segments with no railroad switches), 2030

Segment	Monitoring Point ID (See Table 3.10-1)	Existing Noise Level (dBA, L_{dn})	Representative Area of Existing Noise (Category 2 Land Uses)	Acceptable Noise (L_{dn}) (Moderate Impact, see Table 3.10-8a)	Distance to Receptor (ft)	Project Generated Noise Level at Receptor (L_{dn})	Increase in Noise Level (L_{dn})	Noise at Sensitive Receptors Exceeding Threshold?
Bailey Road, Pittsburg to Railroad Ave, Pittsburg	Calculated from N18	74	Receptors on either side of SR 4, 100 ft away	<66	100	61 (62)*	0.2 (0.3)*	No
Railroad Ave, Pittsburg to Loveridge Road, Pittsburg	N19	71	Receptors on north side of SR 4, 225 ft away	<66	225	58 (60)*	0.2 (0.3)*	No
Loveridge Road, Pittsburg to Hillcrest, Antioch	Calculated N11	76	Receptors on either side of SR 4, 100 ft away	<66	100	61	0.1	No
Hillcrest, Antioch Area	Calculated from N14	74	Receptors south of SR 4, 190 ft away	<66	190	59 (60)*	0.1 (0.2)*	No

Source: ERM, 2008.

Note:

Analysis conservatively assumes no sound walls are in place.

* The DMUs may include a transit horn, the sounding of which would affect noise levels at receptors in the vicinity of the transfer platform or stations. The numbers in parentheses show the effect of the horn in combination with noise from the DMU engine and tracks, as estimated using FTA methodology.

Table 3.10-14
Predicted Peak Hourly (L_{eq}(hr)) Noise Level at Two Closest Schools from DMU Operations, 2030
(in at-grade segments with no railroad switches)

Facility	Monitoring Point ID (see Table 3.10-4)	Existing Minimum Noise Level during Operations (dBA, L_{eq}(hr))	Acceptable Noise (L_{eq}(hr)) (Moderate Impact, see Table 3.10-8a)	Distance to Receptor (ft)	Project Generated Noise Level at Receptor (L_{eq} (hr))	Increase in Noise Level (L_{eq} (hr))	Noise at Sensitive Receptors Exceeding Threshold?
Parkside Elementary	Calculated from N1	63	<65	150	58	0.9	No
Marsh Elementary	Calculated from N1	64	<66	120	59	1.0	No

Source: ERM, 2008.

Note:

Existing noise level based on minimum between 4 a.m. and midnight. To be conservative in the assessment, the noise monitor adjacent to SR 4 with the lowest hourly noise level was used. Analysis further conservatively assumes no sound walls are in place.

Other facilities to be included as part of the Proposed Project include a staff building and its associated parking lot, and several train control huts to be located at various positions along the project corridor. Neither of these types of facilities is expected to have a significant impact on local noise levels, because they are small in size and level of activity, do not house substantial noise sources, and, except for the parking lot, are enclosed. The employee parking lot would adjoin an existing small parking lot, and the noise characteristics would be expected to be similar to the existing lot.

Impact NO-2 *Noise from the Proposed Project in those segments where there are railroad switches would have a less-than-significant impact on sensitive receptors. (LTS)*

The Proposed Project, as conceptually designed, would have four groups of railroad switches (crossovers) on the main track line. Switches allow trains to cross from one track to another. As the DMU vehicles travel over these railroad switches, the gaps in the rail (at locations called frogs) can result in higher noise levels than rail segments with no gaps. Railroad switches are planned at the following general locations on the main track line: east of the transfer platform, east of Railroad Avenue Station, between Somersville Road and Contra Loma Boulevard, and west of the Median Station (see Figure 3.10-3).

The predicted noise levels at residential receptors near the frogs in 2030 are summarized in Table 3.10-15. The 2015 noise levels would be lower given that at peak hours the train would have only two cars instead of three. The numbers in the table take into account existing and future sound walls along the shoulders and right-of-way of SR 4, where Caltrans predicts noise levels would be reduced from 5 to 7 dBA.[3] For this analysis, the sound walls are assumed to reduce noise level by 5 dBA. The table shows that noise levels for all residential sensitive receptors near all switches are predicted to be less than the moderate impact threshold specified by the FTA Guidelines and so there would be a less than significant impact.

3 Caltrans, Initial Study/Environmental Assessment Route 4 East Project, September 1997; Caltrans, Initial Study/Environmental Assessment on Route 4 in Contra Costa County from Railroad Avenue to Loveridge Road, January 2001; Caltrans, Initial Study/Final Environmental Assessment, State Route 4 (East) Widening Project, Loveridge Road to State Route 160, August 2005.

Table 3.10-15
Predicted Day-Night (L_{dn}) Noise Level from DMU Operations at Railroad Switches (Crossovers)

Location	Monitoring Point ID (see Table 3.10-1)	Existing Noise Level at Closest Receptor (dBA, L_{dn})	Acceptable Noise (L_{dn}) (Moderate Impact, see Table 3.10-8a)	Distance to Receptor (track/1st frog/2nd frog/etc)(ft)	Project Generated Noise Level at Receptor (L_{dn})	Increase in Noise Level (L_{dn})	Noise at Sensitive Receptors Exceeding Threshold?
Frogs East of Transfer Platform	Calculated from N18	73 (no sound wall present)	< 66	130/130	61	0.3	No
	Calculated from N18	66	< 62	125/450/125	57	0.5	No
Frogs east of Railroad Avenue Station	N19	71	< 66	225/225	54 (58)*	0.1 (0.2)*	No
Frogs between Somersville Road and Contra Loma Boulevard	Calculated from N11	66	< 62	125/225/125/175/300	60	0.9	No
Frogs east of Hillcrest Avenue	Calculated from N14	69	< 64	190/190/600	55 (57)*	0.2 (0.3)*	No

Source: ERM, 2008.

Note:

EB refers to eastbound tracks. WB refers to westbound tracks. Highest predicted noise level presented. Predicted noise levels take into account existing and future sound walls along SR 4.

* The DMUs may include a transit horn, the sounding of which would affect noise levels at receptors in the vicinity of the transfer platform or stations. The numbers in parentheses show the effect of the horn in combination with noise from the DMU engine and tracks, as estimated using FTA methodology.

There is also a non-residential noise-sensitive use, Contra Loma Park, located north of SR 4 between Somersville Road and Contra Loma Boulevard, near the easternmost frog. The existing hourly noise level at this location, assuming a 5 dBA reduction in noise from the topography and future sound wall, is conservatively estimated to be 53 dBA. Hourly noise levels would be significant if they were 60 dBA or greater. With the Proposed Project, the hourly noise level at this location is predicted to be 52 dBA. Therefore, the noise impact at the park is less than significant.

Impact NO-3 *Noise from the proposed maintenance facility to support the Proposed Project operations would be less than significant. (LTS)*

The Proposed Project would have a maintenance facility where the movement of DMUs and maintenance activities would generate noise at nearby receptors. Maintenance operations would take place both in the SR 4 median, immediately east of the median Station platform, and outside the median at a 2.8-acre DMU maintenance annex on the north side of SR 4. The FTA Guidelines specify a source reference level for yards and shops of 118 dBA. To be conservative, this analysis combines the noise from the "yards and shops" with noise from trains traveling over railroad switches. The total DMU active fleet would consist of nine DMUs in 2030. The analysis conservatively assumes all nine DMUs are moved in the maintenance yard at night. The sensitive receptors most impacted by the maintenance yard are the homes located south of SR 4 about 190 feet from the maintenance yard. At these homes, existing noise levels are about 74 dBA. The maintenance facility is predicted to generate a noise level of 65 dBA there, which is less that the 66 dBA significance criterion. As a result, noise from the maintenance facility would have a less-than-significant impact.

Impact NO-4 *Traffic around the Railroad Avenue and Hillcrest Avenue Stations associated with the Proposed Project would have a less-than-significant noise impact on sensitive receptors. (LTS)*

The Proposed Project would change traffic conditions near the Railroad Avenue and Hillcrest Avenue Stations. The traffic analysis (see Section 3.2, Transportation) shows that many of roadways near Railroad Avenue and Hillcrest Avenue would experience a drop in traffic volumes in 2015 and 2030 as a result of the Proposed Project. For example, overall traffic along Railroad Avenue would decrease as a result of the Proposed Project. Traffic, however, is projected to increase along Bliss Avenue near the Railroad Avenue Station where the existing park-and-ride lot is located. Similarly, traffic is projected to increase along Hillcrest Avenue near Sunset Drive.

Roadways that would experience an appreciable increase in traffic and have adjacent sensitive receptors were modeled using TNM. The traffic threshold for modeling was taken to be daytime (i.e., 7:00 a.m. to 10:00 p.m.) traffic volume increases of 500 cars or more and nighttime (i.e., 10:00 p.m. to 7:00 a.m.) traffic volume increases of 75 cars or more.

In the vicinity of the proposed Railroad Avenue Station, traffic would increase appreciably along Bliss Avenue between Railroad Avenue and Harbor Street. However, existing land uses along Bliss Avenue are predominantly commercial, which are not considered sensitive receptors. For other roadways, their traffic increases would either be below the traffic threshold or they do not have adjacent sensitive receptors. Accordingly, the change in project-related noise levels along local streets near the proposed Railroad Avenue Station would have a less-than-significant impact on sensitive receptors.

In the vicinity of the proposed Hillcrest Avenue Station, in contrast, roadways having adjacent sensitive receptors would experience appreciable increases in traffic, as a result of the Proposed Project, mainly from passengers arriving at and departing from the station. These roadways include Hillcrest Avenue near Sunset Drive and segments of Oakley Road. Table 3.10-16 presents the predicted noise levels at receptors near these roadways for the no-build and build conditions in 2015 and 2030. The analysis demonstrates that traffic noise increases associated with the Proposed Project for receptors near the Hillcrest Avenue Station would have less-than-significant impacts.

Impact NO-5 *Vibration from the Proposed Project would have a less-than-significant vibration impact on sensitive receptors. (LTS)*

The Proposed Project would generate groundborne vibration that can cause annoyance to nearby sensitive receptors. In particular, locations where the DMU crosses a track switch can result in relatively high vibration levels. Track switches allow trains to cross from one track to another, and they have gaps that increase vibration levels as a vehicle crosses over the gaps. For the Proposed Project, railroad switches are planned at the following general locations on the main track line: east of the transfer platform, east of Railroad Avenue Station, between Somersville Road and Contra Loma Boulevard, and west of the Median Station (see Figure 3.10-3).

Table 3.10-16
Predicted Day-Night (L_{dn}) Noise Level from Project-Related Traffic (Years 2015 & 2030)

Intersection	Year	Approximate Distance to Receptor from Edge of Road (ft)	Predicted No-Build Noise at Closest Receptor (dBA)	Predicted Build Noise Level at Closest Receptor (dBA)	Predicted Increase (dBA)	Allowable Increase[1] (dBA)
Hillcrest/Sunset	2015	100	57.8	58.4	0.6	2.1
	2030	100	59.1	59.2	0.1	2.1
Oakley/Willow	2015	30	65.2	65.3	0.1	1.2
	2030	30	69.3	69.4	0.1	1.0
Oakley/Phillips	2015	30	66.2	66.3	0.1	1.2
	2030	30	63.5	64.4	0.9	1.5
Oakley/Neroly	2015	35	65.9	66.1	0.2	1.2
	2030	35	64.4	64.5	0.1	1.5

Source: ERM, 2008.

Note:

The "allowable increase" is the minimum increase in noise level required to reach the FTA criterion for "moderate impact." The significance of the noise impacts at each receptor location depend upon the specific existing noise level and the modeled project noise level at each location. The range of project noise levels that would lead to a conclusion of significance varies with the existing noise level at each location, as shown in Table 3.10-8a.

The FTA Guidelines state that DMU-generated vibration levels would typically fall between rapid transit and locomotive sources. However, depending on the suspension system, vibration levels from a DMU can be equivalent to rapid transit or light rail vehicles. The Proposed Project is expected to use European-style DMUs that have suspensions, loads, and vibration characteristics similar to light rail vehicles. Table 3.10-17 shows the predicted vibration levels at various distances from tracks and switches, and compares them to the maximum acceptable groundborne vibration allowed for residential uses (i.e., 72 VdB, as reported in Table 3.10-9).

The table shows that receptors greater than 90 feet from the tracks alone or greater than 125 feet from railroad switches would not be significantly impacted by groundborne vibration. The closest sensitive receptor in the project corridor would be about 100 feet from the tracks and 125 feet or more from switches. Therefore, groundborne vibration from the Proposed Project is expected to have a less-than-significant impact on nearby receptors.

Table 3.10-17
Predicted Vibration Levels from DMU Operations

Type of Impact	Location	Acceptable Level (VdB)	Distance from Centerline of Track				
			80 ft	90 ft	100 ft	125 ft	150 ft
Ground-borne Vibration (VdB)	Away from Switches	= < 72	**74**	72	71	70	68
	At Switches	= < 72	**79**	**76**	**74**	72	68

Source: ERM, 2008.

Note:

Numbers in bold exceed criteria. Acceptable levels are from Table 3.10-9 for residences and buildings where people normally sleep. Institutional land uses have higher acceptable levels.

Construction Impacts

Impact NO-6 *Noise from construction equipment could significantly impact sensitive noise receptors along the project corridor. (PS)*

Construction for the Proposed Project would last from 2011 to 2014 and would occur along the median of SR 4, near the existing Pittsburg/Bay Point BART Station, and at the locations proposed for the transfer platform, the Railroad Avenue Station, the Hillcrest Avenue Station, the associated parking lots and maintenance facilities, and the staging areas. Construction would require a range of noise-generating equipment including dump trucks, scrapers, water trucks, bulldozers, graders, truck-mounted cranes, loaders, excavators, rollers, concrete mix trucks, lubrication/fueling service trucks, concrete pumps, diesel generators, and compressed air units. In addition, haul trucks would bring in sub-ballast and structural concrete. Pile drivers would also be used as part of the Proposed Project, and typically generate the most noise. However, pile driving would not be generally necessary at most locations in the project corridor. It would only occur where the more massive project structures (e.g., aerial crossings) require additional support at their foundations, which would not typically be the case along much of the at-grade portions of the track.

The project corridor contains residential, commercial, and industrial areas. The most stringent significance criterion is for residential areas. Table 3.10-18 shows the predicted distance within which the significance criteria identified in Table 3.10-10 would be exceeded for the following scenarios: (1) one pile driver; (2) the two noisiest equipment types (excluding pile drivers); (3) the one noisiest equipment type (excluding pile drivers); and (4) the two equipment types with average noise levels. Some commercial and residential areas are as close as 100 feet from primary construction activities, and industrial areas are as close as 250 feet from primary construction activities. While impacts are expected to be less than significant along commercial and industrial areas along SR 4, significant noise impacts are expected during construction in/near residential areas. The exact locations of the impact would depend on number and type of equipment used in each segment at any particular time. The most significant impacts would occur if night construction took place near residential areas.

Table 3.10-18
Distance of Significant Noise Impact during Proposed Project Construction for Residential, Commercial, and Industrial Receptors

	Acceptable Hourly Noise (dBA)	Distance of Significant Impact (ft)			
		Pile Driver	Noisiest Two (excluding pile drives): Drill and Scraper	Noisiest One: Drill	Two "Average": Scraper & Water Truck
Residential					
Daytime	=<90	170	130	120	60
Nighttime	=<80	530	400	375	180
Commercial					
Daytime	=<100	55	40	40	20
Nighttime	=<100	55	40	40	20
Industrial					
Daytime	=<100	55	40	40	20
Nighttime	=<100	55	40	40	20

Source: ERM, 2008. Calculated using FTA Guidelines.

In addition to construction activities along the tracks, stations, and maintenance facility, activities at staging areas would also generate noise. Four staging areas are currently proposed: (1) immediately east of the Pittsburg/Bay Point Station between SR 4 and Leland, (2) north of SR 4 on Canal Road between Franklin Avenue and Emerald Cove near the proposed transfer platform, (3) south of SR 4 near Railroad Avenue on Bliss Avenue, and (4) north of SR 4 near the existing BART park-and-ride lot east of Hillcrest Avenue. The staging area east of the Pittsburg/Bay Point BART Station would be more than 100 feet from the nearest residential receptors. The staging area near the transfer platform would be located about 50 feet from residential receptors to the north. The staging area near the Railroad Avenue Station would be located more than 400 feet from the nearest residential receptor but about 100 feet from the nearest commercial property. The staging area near the Hillcrest Avenue is more than 700 feet from the nearest residential receptor and more than 100 feet from the nearest commercial property. While noise from activities in these staging areas would be typically less than in other areas of construction, depending on the equipment being brought in and out of the staging area, impacts from the staging area near the transfer platform may be significant given its close proximity to residential receptors. In addition, depending on the routes for haul trucks carrying material to the site, noise generated by these haul trucks may have significant impacts on residential receptors. For example, haul trucks may generate a noise level of more than 90 dBA at a distance of 35 feet, which would be significant for residential receptors during daytime operations.

MITIGATION MEASURES. The following measures would reduce the potentially significant, although temporary, construction noise impact. However, given the uncertainty in the equipment to be used at the same time and the potential proximity to sensitive receptors, temporary impacts may be significant and unavoidable even with these mitigation measures. (SU)

NO-6.1 *Employ noise-reducing construction practices.* BART shall ensure that the construction contractor implements noise-reducing practices. The construction supervisor or other entity appointed by BART shall measure noise levels at nearest sensitive receptors before beginning construction and periodically thereafter to ensure these noise levels are not exceeded. Measurements shall be taken during periods when noisy, heavy equipment is operating. Noise-reducing measures that could be implemented to attain the noise levels include:

- Minimize nighttime construction in residential areas. Restrict high noise-generating equipment such as drills (which produce 98 dBA at 50 feet) and scrapers (which produce 89 dBA at 50 feet) to daytime hours (7:00 a.m. to 6:00 p.m.).
- Use quieter methods of pile driving including sonic pile drivers where feasible.
- Use equipment with enclosures and high-performance mufflers.
- Locate equipment as far as possible from residential areas.
- Install noise barriers between equipment and residential areas.
- Select haul truck routes to minimize impact to residential areas.

NO-6.2 *Designate a noise-disturbance coordinator, disseminate information to residences and businesses, and implement a response/tracking program.* BART shall ensure that a noise-disturbance coordinator is identified and be responsible for receiving noise complaints, determining the cause of the complaints, and ensuring reasonable measures are taken to address the complaints. Residences and businesses within at least 500 feet and 50 feet of construction area, respectively, shall be notified in writing prior to construction. In addition, contact information for the coordinator shall be posted at the construction site and provided to the residences and businesses located within 500 feet and 50 feet, respectively.

Impact NO-7 *Vibration from construction equipment could significantly impact sensitive receptors along the project corridor. (PS)*

Groundborne vibration from construction activities can result in both human annoyance (as measured in VdB) and damage to fragile structures (as measured in Peak Particle Velocity or PPV in inches/second). During construction, the greatest concern is potential structural damage from the use of equipment, such as pile drivers, vibratory rollers, and tracked equipment (e.g., bulldozers). Using FTA Guidelines, Table 3.10-19 provides the most conservative vibration criteria and the predicted distances vibration levels may be significant from the operation of pile drivers, vibratory rollers, bulldozers, and caisson drilling. The closest residential receptors are about 100 feet from expected construction areas that would require the use of these types of equipment. Based on the distances identified in Table 3.10-19, pile drivers may result in significant vibration impacts where vibration-sensitive equipment is used (e.g., dentist office), where fragile buildings are located, and in areas where other vibration-sensitive residential and institutional receptors are common. However, the use of pile drivers would not be common throughout the project corridor. They would only be used where the more massive project structures (e.g., aerial crossings) require additional support at their foundations, which would not typically be the case along most of the at-grade portions of the track. Other equipment may also have significant vibration impacts depending on where it used. For example, fully loaded haul trucks that drive within 20 feet of fragile buildings have the potential to cause structural damage.

MITIGATION MEASURE. The following measure would reduce vibration impacts. However, primarily because pile drivers would be used, vibration impacts are expected to remain significant and unavoidable. (SU)

Table 3.10-19
Distance of Significant Vibration Impact during Proposed Project Construction (feet)

		Distance of Significant Impact (ft)			
	Acceptable Vibration	**Impact Pile Drivers**	**Roller**	**Caisson Drilling/Large Bulldozer**	**Loaded Trucks**
Annoyance: Sensitive Equipment	= <65 VdB	900	225	130	125
Annoyance: Residence	= <72 VdB	525	130	80	75
Annoyance: Institutional	= <75 VdB	425	105	65	60
Damage to fragile buildings	= <0.12 in/sec	135	40	20	20
	=<90 VdA	125	35	20	20

Source: ERM, 2008.
Note:
Acceptable vibration related to “annoyance” based on “frequent events” defined as equivalent to more than 70 vibration events per day.

NO-7.1 *Employ vibration-reducing construction practices. BART shall ensure that the construction contractor implements vibration-reducing practices including but not limited to those listed below:*

- minimize nighttime construction in residential areas
- restrict high vibration-generating equipment such as rollers, drills, and tracked equipment to daytime hours (7:00 a.m. to 6:00 p.m.)
- use sonic pile drivers where feasible
- locate vibration-generating equipment as far as possible from sensitive receptors including homes, schools, churches, and dental offices
- select haul truck routes so that trucks do not come within 20 feet of sensitive receptors.

Hillcrest Avenue Station Options Analysis

In addition to the Median Station of the Proposed Project, a Northside West Station option, a Northside East Station option, and a Median Station East option are being considered. The Northside West Station option would be located north of SR 4 and would be connected with the tracks in the median of SR 4 by a short or long tunnel under SR 4. The maintenance facility for this station option would be located either just east of the Northside West Station option or east of SR 160. The Northside East Station option would be located north of SR 4 and east of the Northside West Station option. As with the Northside West Station option, the Northside East Station option would connect with the tracks in the median of SR 4 by a short or long tunnel. The maintenance facility would be located east of SR 160. The Median Station East option would consist of a station in the median of SR 4, similar to the Proposed Project, but 950 feet further east, and a maintenance facility north of SR 4, at a site similar to the maintenance facility immediately east of the Northside West Station option. Generally, noise and vibration impacts of the three station options are identical. The following discussion identifies differences among the noise and vibration impacts of the Median Station and the other options.

Operational Impacts

Impact NO-8 *Noise from the proposed DMU with the Northside West Station, Northside East Station, and Median Station East options in those segments where the vehicles would operate at grade far from railroad switches would have a less-than-significant impact on sensitive receptors. (LTS)*

The Northside West and Northside East Station options would be located north of SR 4 and east of the Median Station. Both of these options would be located further away from the closest sensitive receptors to the south of SR 4 than the Median Station (which had less-than-significant DMU and horn noise impacts). Therefore, impacts to those receptors would be even less than that of the Median Station, and less than significant as well. Impacts to receptors under the Median Station East option would be identical to those of the Proposed Project and be less than significant.

Impact NO-9 *Noise from the ventilation machinery necessary for the tunnel that would connect the Northside West Station, Northside East Station, or the Median Station East to the tracks in the SR 4 median would have a less-than-significant impact on nearby sensitive receptors. (LTS)*

The Northside West and Northside East Station options would require a tunnel to connect the stations to the tracks in the median of SR 4; the tunnel may be long or short. A long tunnel would require ventilation machinery that would generate noise. At 50 feet, the day-night noise level from the ventilation machinery may reach 72 dBA. While the exact location of the vent shaft is not known at this time, its closest distance to residences south of SR 4 would be 190 feet (assuming that the shaft would be located immediately north of the SR 4 right-of-way). These homes have an existing noise level of about 74 dBA. Project-related noise at this location would be significant if the noise from the ventilation machinery were 66 dBA or greater. However, ventilation noise is predicted to be 60 dBA and thus is less than significant. A short tunnel would not require ventilation machinery, and, therefore, would not generate noise. The Median Station East option would require a short tunnel to connect to the proposed maintenance facility north of SR 4 and east of the station. Because this station option would require a short tunnel, there would be no need for ventilation machinery. Therefore, ventilation noise impacts would be less than significant. To be conservative, the analysis ignores the benefit of the sound wall that would be placed south of SR 4 as part of the SR 4 widening project, which would make the ventilation noise levels even less than estimated above.

Impact NO-10 Noise from the proposed maintenance facilities that support DMU maintenance operations would be less than significant for all station options. (LTS)

The Northside West Station option could have a maintenance facility located at either of two alternative sites: one just east of the station, the other east of SR 160. Under the Northside East Station option, this facility would have only one location, which is east of SR 160, the same as the second location for the Northside West Station option. Either location would be further from the sensitive residential receptors located south of SR 4; thus, impacting those receptors less than the maintenance facility under the Median Station of the Proposed Project. The site east of SR 160, however, is about 300 feet from the residential area located east of Neroly Road. With an existing noise level near Neroly Road of about 66 dBA, project-generated noise would be significant if it reached 62 dBA at the residences. However, the maintenance facility would generate a noise level of about 61 dBA at this location. The maintenance facility of the Median Station East option would be located north of SR 4 and east of the station, allowing for a distance of several hundred feet between it and the nearest sensitive receptor. Therefore, noise from the maintenance facility associated with any of the station options would have a less-than-significant impact on nearby sensitive receptors.

Impact NO-11 Traffic associated with the Northside West Station or Median Station East operations would have a less-than-significant noise impact on sensitive receptors along their access routes. However, because of additional residential development associated with the Northside East Station option, traffic may result in significant noise impact on sensitive receptors along its access routes. (PS)

Compared to the Northside West Station or Median Station East options, the traffic analysis performed for the Median Station was found to be the worst case in terms of traffic volumes at intersections. Therefore, the traffic noise levels under the Northside West option are expected to be no worse than under the Median Station option, and virtually identical to those under the Median

Station East option. Thus, noise impacts from traffic associated with the Northside West Station and Median Station East options are expected to be less than significant.

In contrast, the Northside East Station option would include more residential development in its vicinity compared to local residential development under the other options. This would result in higher traffic volumes on some streets than predicted for the Median Station. As a result, noise impacts to sensitive receptors along access routes near the Northside East Station may be significant, particularly along Oakley Road.

MITIGATION MEASURE. Feasible mitigation measures are not available to ensure traffic-related noise impacts are reduced to less-than-significant levels. For example, the installation of sound walls along local streets to reduce noise levels for existing sensitive receptors would not be practical because many of the homes face the roadway. As a result, this impact is considered significant and unavoidable. (SU)

Construction Impacts

Impact NO-12 Noise from construction equipment could significantly impact sensitive noise receptors along the project corridor for the all station options. (PS)

The locus of activity associated with construction of the station and maintenance facilities under either the Northside West or the Northside East Station options would be farther from the residential receptors to the south than it would under the Median Station East option (i.e., 190 feet). Additionally, the maintenance facility site east of SR 160 would be about 300 feet away from residences on Neroly Road. Construction activity associated with all station options would be relatively close to existing residential areas under all station options. Thus, temporary impacts from noise during construction may still be significant.

MITIGATION MEASURES. Mitigation Measure NO-6.1 and NO-6.2, identified for the Proposed Project, would also reduce the potentially significant, although temporary, construction noise impact for the Northside West, Northside East, and Median Station East options. However, given the uncertainty in the equipment to be used at the same time and the potential proximity to sensitive receptors, temporary impacts may be significant and unavoidable even with these mitigation measures. (SU)

Cumulative Analysis

For the cumulative noise analysis, the areas of concern, given the localized impact of noise, are areas near the staging areas, project corridor, and stations. However, development in the vicinity of the proposed corridor can affect noise along the project corridor by increasing traffic on SR 4 or along roadways that provide access to the proposed stations. Consequently, the cumulative noise analysis considered the Proposed Project in combination with the contribution of vehicular traffic noise increases on SR 4 as a result of the mixed used development fostered by the Ridership Development Plans (as prepared by each city for its station area) and the regional growth forecasts of Association of Bay Area Governments (ABAG)[4] as amended by the County's regional traffic model. The Ridership Development Plans would account for the potential development of 1,845 new residential units and 1,004,000 square feet of commercial space near the Railroad Avenue Station area and up to 2,500 new residential units and 2,150,000 square feet of commercial space near the Hillcrest Avenue Station area. Finally, the Union Pacific Railroad may introduce rail freight service, which could eventually be as high as 40 trains per day, to its rail line in the project corridor. Overall, the cumulative noise impacts identified below would be worse at locations where noise from Union Pacific trains would raise future noise background levels and decrease the FTA incremental significance thresholds applicable at each location.

Operational Impacts

Impact NO-CU-13 *Cumulative noise, which includes the Proposed Project's contribution from the DMU vehicles operating at grade far from railroad switches in combination with traffic from station operations, future development in the vicinity of the stations and other foreseeable future development in the project corridor, would have a potentially significant impact on sensitive receptors in the project corridor. (PS)*

The project-level noise analysis above showed that the operation of the DMU for the Proposed Project at locations away from railroad switches would have less-than-significant noise impacts. However, traffic growth in the project corridor would also increase noise between now and 2030. Since DMU noise would be regarded as a potentially cumulatively considerable influence on the future noise environment of the project corridor, this would introduce a potential for cumulative noise impacts that is evaluated below.

Between Bailey Road and Railroad Avenue. The expected increase in daily traffic in the stretch between Bailey Road and Railroad Avenue would be between 30 and 35 percent. A 35 percent increase in traffic would increase noise levels by about 1.3 dBA (assuming that other influential factors affecting

4 Association of Bay Area Governments, *Projections 2007,* December 2006.

noise, such as average speed, would remain unchanged). The closest residential receptors in this segment are about 100 feet from the tracks and have an existing L_{dn} of about 72 dBA (with existing sound walls). The total cumulative increase in noise associated with future traffic and operations of the DMU would be about 1.4 dBA (and slightly higher for receptors near the transfer platform or station where horn noise may also contribute to the total) at the closest residences. This would exceed the incremental significance criteria for noise impact (i.e., just under 1 dBA at this existing noise level), a significant cumulative impact. In fact, there would be significant cumulative noise impacts for all residential receptors within 225 feet of the tracks, which includes the majority of residential uses in this segment.

Between Railroad Avenue and Loveridge Road. The expected increase in daily traffic in this segment would be between 50 and 60 percent. A 60 percent increase in traffic would increase noise levels by about 2 dBA (assuming that other influential factors affecting noise, such as average speed, would remain unchanged). The closest residential receptors are located north of SR 4 along this segment about 225 to 250 feet away from the tracks. The existing L_{dn} at these locations is about 71 dBA. The total cumulative increase in noise associated with future traffic and operations of the DMU would be about 2 dBA at the closest residences (and slightly higher for receptors near the station where horn noise may also contribute to the total). This cumulative increase would exceed the incremental significance criteria for noise impact (i.e., about 1 dBA at this existing noise level), a significant cumulative impact.

Cumulative noise impacts at institutional receptors (e.g., churches and schools) in this segment of the project corridor would be less than significant. The closest institutional land use not protected by a sound wall is the Martin Luther King Preschool, located west of Loveridge Road and about 225 feet north from the tracks. The existing peak hour L_{eq} at this location is 66 dBA. The total cumulative increase in peak-hour noise associated with future traffic and operations of the DMU at this location would be about 3 dBA. This would not exceed the incremental significance criteria (i.e., greater than 3 dBA at this existing noise level). Thus, the cumulative noise impact at the Martin Luther King Preschool and other institutional receptors would be less than significant.

Between Loveridge Road and Hillcrest Avenue. Traffic noise in this segment is expected to increase over time as SR 4 would be widened and realigned. TNM was used to model the increased noise from traffic and geometric changes. Sound walls would also be placed on the shoulder or right-of-way of SR 4 between Loveridge Road and Hillcrest Avenue. Since Caltrans requires that sound walls provide at least a 5 dBA reduction in noise to be considered feasible, this analysis assumes these walls will achieve a 5 dBA reduction in noise. The cumulative increase in L_{dn} from traffic (based on TNM modeling) and the Proposed Project are expected to range between 1 and 8 dBA at the closest residential receptors. This cumulative increase would exceed the incremental significance criteria for noise impact (i.e., about 1 dBA at the existing noise levels found in this segment), a significant cumulative impact. Therefore, the noise impacts would be cumulatively significant for the closest residential receptors facing SR 4 between Loveridge Road and Hillcrest Avenue.

In contrast, cumulative noise impacts to the closest institutional receptors in this segment would be less than significant. The Caltrans Initial Study/Environmental Assessment[5] for the SR 4 widening project identified existing and projected 2030 peak-hour L_{eq} at the closest institutional receptors along SR 4 including churches, schools, and parks. Peak hour noise levels from the Caltrans study were added to the predicted peak hour noise levels that would be generated from the Proposed Project to estimate the total cumulative increase. For example, the closest school along this segment is the Marsh Elementary School, located west of G Street about 120 feet from the proposed tracks. The Caltrans assessment shows that the existing and projected peak hour noise levels at the school would be 63 dBA and 71 dBA, respectively. After including a 5 dBA reduction from the future sound wall, the cumulative peak hour noise increase would be about 3 dBA. This cumulative increase would not exceed the incremental significance criteria for noise impact (i.e., about 4 dBA at the existing noise level).

East of Hillcrest Avenue. Cumulative increases in noise levels for the closest residential receptors would not exceed 1 dBA with the installation of the sound walls on the south side of SR 4. This increase would not exceed the incremental significance criteria for noise impact in this segment. Thus, cumulative noise impacts at residential receptors east of Hillcrest Avenue would be less than significant.

Although the Northside West Station or the Northside East Station would be located farther from the closest sensitive receptors located near the Median Station and south of SR 4, and thus contribute less to cumulative noise levels there, there are other sensitive receptors closer to these alternative station locations, between the UP right-of-way and Oakley Road. Residential receptors in this area, particularly along Sunset Drive, Hillcrest Avenue, and Oakley Road, would be subject to potentially significant cumulative noise

[5] Caltrans, Initial Study/Final Environmental Assessment, State Route 4 (East) Widening Project, Loveridge Road to State Route 160, August 2005.

impacts from DMU operations and traffic generated by future station area development being planned by the City of Antioch. For example, the area near the Oakley and Willow intersection is estimated to have an existing noise level of about 64 dBA, based on a nearby noise measurement. The predicted noise level in 2030 at this intersection would be 69 dBA, a 5 dBA increase from existing, which would exceed the significance threshold. Since the Proposed Project's contribution to this increase would be cumulatively considerable, noise impacts from increased traffic on local roadways the Hillcrest Avenue Station area would be cumulatively significant.

The cumulative noise impacts of the Median Station East option would be similar to those of the Median Station option.

MITIGATION MEASURE. Sound walls are already planned for installation along the SR 4 right-of-way as part of the SR 4 widening project. Additional feasible mitigation measures may become available as project plans evolve to further reduce DMU noise to the point where its effects would not be considered cumulatively considerable. In addition, sound walls could be constructed along those segments of SR 4 near residential receptors where such features are not included as part of the SR 4 widening project. However, SR 4 vehicular traffic would be the primary source of cumulative traffic noise, to which the Proposed Project would add only a minor contribution. Accordingly, additional sound walls are not included as part of the Project or as a mitigation measure, especially since Impacts NO-1 and NO-2 identified less-than-significant impacts for the DMU operations. Since there is no conclusive evidence at this time that less-than-cumulatively-considerable project noise increments would be achieved at all locations far from railroad switches, noise impacts are conservatively considered cumulatively significant and unavoidable. (SU)

Impact NO-CU-14

Cumulative noise, which includes the Proposed Project's contribution from the DMU vehicles operating near railroad switches in combination with traffic from station operations, future development in the vicinity of the stations and other foreseeable future development in the project corridor, would have a potentially significant impact on sensitive receptors in the project corridor. (PS)

Groups of railroad switches are planned at the following general locations on the main track line: east of the transfer platform, east of Railroad Avenue Station, between Somersville Road and Contra Loma Boulevard, and west of the Hillcrest Avenue Station. The project-level noise analysis above (see Impact NO-2) has shown that noise from the operation of these railroad switches would have less-than-significant noise impacts. However, traffic growth in the project corridor would also increase noise between now and 2030. Since railroad switch noise would have to be regarded as a potentially cumulatively considerable influence on the future noise environment in their vicinity, this would introduce a potential for cumulative noise impacts that is evaluated below.

Between Bailey Road and Loveridge Road. The cumulative noise from the switches and increased traffic associated with foreseeable development would increase the L_{dn} between 1 and 2 dBA at the residential uses closest to the switches (and slightly higher for receptors near the station where horn noise may also contribute to the total). This would exceed the incremental significance criterion for noise impact (i.e., about 1 dBA at existing noise levels in this segment). Therefore, the cumulative noise impacts would be significant.

East of Somersville Road. The cumulative noise from the switches and increased traffic noise would increase the L_{dn} by about 4 dBA at the residential uses closest to the switches. This would exceed the incremental significance criterion for noise impact (i.e., about 1 dBA at existing noise levels in this segment). Therefore, the cumulative noise impacts would be significant.

Hillcrest Avenue Vicinity. After taking into account the effects of the sound wall to the south of SR 4, the cumulative noise from switches and increased traffic would increase the L_{dn} by less than 1 dBA at the residential uses closest to the switches (and slightly higher for receptors near the station where horn noise may also contribute to the total). This would not exceed the incremental significance criteria for noise impact (i.e., less than 1 dBA for this area with an existing noise level of 74 dBA). Therefore, the cumulative noise impacts would be less than significant.

Although the Northside West Station, Northside East Station, Median Station East options could affect placement of the switches, their noise would still contribute considerably to the total impact, which would be cumulatively significant. As described for Impact NO-CU-13, the combination of DMU operations near the switches under the Northside East and Northside West Station options with the development (and traffic) associated with the Ridership Development Plans under consideration by the City of Antioch could result in significant cumulative noise impacts for sensitive receptors north of the UP right-of-way.

The cumulative noise impacts of the Median Station East option would be similar to those of the Median Station option.

MITIGATION MEASURE. For the same reasons cited for Impact NO-CU-13, it is not clear that mitigation measures would be sufficient to reduce cumulative noise increases in the vicinity of switches for the Proposed Project operations. As a result, cumulative noise impacts in the vicinity of the switches from DMU operations and traffic-related noise associated with the proposed Ridership Development Plans could remain significant and unavoidable. (SU)

Impact NO-CU-15 *Cumulative noise from the ventilation machinery necessary for the underground (tunnel) options to connect the Northside West and Northside East Station options at Hillcrest Avenue, combined with noise from other foreseeable development, would have a less than significant impact on nearby sensitive receptors. (LTS)*

Long tunnels require mechanical ventilation and such equipment that could generate noise that would have a potential for cumulative impacts. Since there are no long tunnels proposed for the Median Station and Median Station East, there would be no potential for cumulative noise impacts under these options.

The closest the ventilation machinery could be placed with respect to existing residences (south of SR 4) is about 190 feet. These residences will be shielded from ventilation and traffic noise by a sound wall to be constructed as part of the SR 4 widening project. They currently experience noise levels of about 74 dBA. The incremental significance criterion is about 1 dBA. Ventilation noise under the Northside West and Northside East Station options on its own would have a less-than-significant impact on these sensitive receptors. The sound wall would reduce the cumulative noise increase to less than 1 dBA. Thus, the cumulative noise impact would be less than significant.

Impact NO-CU-16 *Cumulative noise from the proposed maintenance facility to support the Proposed Project operations combined with noise from foreseeable development may be cumulatively significant. (PS)*

Median Station and Median Station East Options. Impact NO-3 specified that impacts from the proposed maintenance facility would be less than significant on nearby homes located to the south of SR 4. At these sensitive receptors, given their existing noise background level, a cumulative noise increase from facility activities and traffic of more than 1 dBA would be cumulatively significant. However, with the sound wall expected to be located south of SR 4 as part of the SR 4 widening project, increases of this magnitude are not expected. Thus, cumulative noise impacts at the closest sensitive receptors would be less than significant.

Northside West and Northside East Station Options. Two sites for the maintenance facility are being considered under the Northside West Station option: either an area just east of the station or an area east of SR 160. The noise impacts associated with the maintenance facility located just east of the station would be less than those of the Median Station and the Median Station East option because of the greater distance to the residential areas to the south. Therefore, the potential for cumulative noise impacts from this maintenance facility would be less than that of the Median Station and therefore, cumulatively less than significant.

For the maintenance facility site east of SR 160, the nearest residential development would be about 300 feet east of Neroly Road, which currently experiences an L_{dn} of about 66 dBA. At this existing noise level, an increase limited to about 1 dBA would be considered less than significant. The combined level from the maintenance facility and from the new SR 4 Bypass would be 68 dBA, a 2 dBA increase over existing levels. The incremental significance criterion would be about 1 dBA. Thus, the cumulative noise impacts from the maintenance facility at this site would be significant.

MITIGATION MEASURE. The following mitigation measure would reduce the potential, cumulatively significant noise impact from the maintenance facility located at the site east of SR 160. However, given the uncertainty of the location and design of future development, the necessary reduction to project-related noise could not be assured and the impacts would remain cumulatively significant and unavoidable. (SU)

NO-CU-16.1 *Install sound walls around the remote maintenance facility adjacent to sensitive receptors.* Sound walls placed along the maintenance facility periphery facing the residential development to the east could reduce the noise contribution from the remote maintenance facility to less than cumulatively considerable if they could reduce noise levels at the closest residential area by 5 dBA.

Impact NO-CU-17 *Vibration from the Proposed Project in combination with other foreseeable projects would have a less-than-significant cumulative vibration impact on nearby sensitive receptors. (LTS)*

Growth along the proposed corridor would primarily increase the number of passenger vehicles in the area. While heavy-duty trucks with rubber tires can increase vibration levels on roadways, rubber-tire vehicles alone do not typically contribute significantly to vibration of residences located along roadways. Impact NO-5 demonstrates that the DMU traveling on steel tracks are not expected to have significant vibration impacts to nearby receptors without mitigation. The small increase in vibration levels associated with heavy-duty trucks on the freeway, combined with the vibration associated with the DMU, are not expected to have cumulatively significant vibration impacts under the Median, Median East, Northside West or Northside East Station options.

Construction Impacts

Impact NO-CU-18 *Cumulative noise from construction equipment associated with the Proposed Project in combination with other foreseeable development could significantly impact nearly sensitive receptors. (PS)*

Construction of the Proposed Project may occur concurrently with other nearby construction activities associated with new development and roadways along the proposed corridor. This would include construction associated with residential and commercial development near the Railroad Avenue Station and Hillcrest Avenue Station areas. However, the construction associated with widening of SR 4 would be of particular concern because it may involve the use of pile drivers in certain areas. The Proposed Project on its own is expected to have significant noise impact to nearby receptors, particularly with the use of pile drivers. The construction of the Proposed Project in conjunction with construction of SR 4 and development along the corridor, particularly at the station areas, would result in cumulatively significant noise impacts under the Median, Median East, Northside West, or Northside East Station options

MITIGATION MEASURES. Mitigation Measures NO-6.1 and NO-6.2, which call for the Proposed Project contractors to employ noise-reducing construction practices or other equivalent measures and designate a noise-disturbance coordinator, would minimize noise associated with the project, but not to less-than-significant levels. Nearby construction projects would also apply similar mitigation measures to reduce their impacts. Non-BART development near the Railroad Avenue and Hillcrest Avenue Stations would be required to comply with local ordinances to limit noise during construction. However, even with the mitigation measures in place, the Proposed Project together with nearby projects is expected to remain cumulatively significant and unavoidable. (SU)

Impact NO-CU-19 *Cumulative vibration from construction equipment associated with the Proposed Project in combination with other foreseeable development could have a significant impact on nearby sensitive receptors. (PS)*

Other construction projects in the project corridor may use construction equipment generating high levels of vibration. For example, the widening of

SR 4 may require the use of pile drivers, which generate high levels of vibration. The Proposed Project on its own is expected to result in significant vibration impacts, particularly if pile drivers are used, and may contribute to the vibration levels from other construction projects, depending on their proximity. The Proposed Project combined with nearby projects could result in short-term, significant cumulative vibration impacts. These short-term vibration impacts during construction would be cumulatively significant under the Median Station, as well as under the Median Station East, Northside West, or Northside East Station options.

MITIGATION MEASURE. With Mitigation Measure NO-7.1, which calls for the Proposed Project contractors to employ vibration-reducing construction practices, and similar mitigation measures for other projects that are expected to be in place, the short-term, cumulative vibration impacts would be reduced. However, the short-term cumulative impacts, particularly where pile driving is involved, may not be reduced to less-than-significant levels. As a result, construction related cumulative vibration impacts would remain significant and unavoidable. (SU)