3.4 Noise and Vibration

3.4.1 Introduction

This section describes the regulatory setting, affected environment, impacts, and mitigation measures for noise and vibration resulting from the project. Noise and vibration are key elements of the environmental impact analysis because their increases over existing levels near the California High-Speed Train (HST) project are a potentially significant impact.

The 2005 and 2010 HST Program EIR/EIS documents identified project engineering and design elements to reduce or avoid potential noise and vibration impacts (Authority and FRA 2005, [2008] 2010). During the period between the scoping meetings and preparation of this Project EIR/EIS, the alternative analysis process identified those alignments and design options that would avoid or minimize potential impacts to noise- and vibration-sensitive receivers. One important noise and vibration design choice was for the HST System to use distributed power electric motor unit (EMU) trainsets that will have lower noise emissions than the locomotive-hauled electric trainsets according to the Federal Railroad Administration (FRA) noise and vibration guidance manual (FRA 2005).

The noise and vibration limits chosen for construction and operation of the HST System satisfy the federal guidelines of the FRA and Federal Transit Administration (FTA) for train and HST facility operations and Federal Highway Administration (FHWA) as defined for California application by the California Department of Transportation (Caltrans) for traffic noise.

3.4.2 Laws, Regulations, and Orders

Noise and vibration impacts from major transportation projects are an important federal and state environmental concern and review requirements. In order to aid in compliance with environmental regulations and guidelines related to noise and vibration, FRA and FTA have developed guidance for assessing noise and vibration impacts from major rail projects like HST. FRA and FTA guidance is intended to satisfy environmental review requirements and assist project sponsors in addressing predicted construction and operation noise and vibration during the design process.

A. FEDERAL

Federal Noise Emission Compliance Regulation

FRA has a regulation governing compliance of noise emissions from interstate railroads. The FRA's Railroad Noise Emission Compliance Regulation (49 CFR Part 210) prescribes compliance requirements for enforcing railroad noise emission standards adopted by the EPA (40 CFR Part 201).

FHWA Procedures for Abatement of Highway Traffic Noise and Construction Noise, as provided in 23 CFR Subchapter H, Section 772

The criteria for highway noise impacts (relevant to the extent HST causes changes in traffic patterns) are included in the FHWA Procedures for Abatement of Highway Traffic Noise and Construction Noise (23 CFR Part 772).

B. STATE

California Noise Control Act

At the state level, the California Noise Control Act, enacted in 1973 (Health and Safety Code Section 46010 et seq.), requires the Office of Noise Control in the Department of Health Services to provide assistance to local communities developing local noise control programs and works with the Office of Planning and Research to provide guidance for preparing required noise elements in city and county general plans, pursuant to Government Code Section 65302(f). In preparing the noise element, a city or county must identify local noise sources, and analyze and quantify, to the extent practicable, current and projected noise levels for various sources, including highways and freeways, passenger and freight railroad operations, ground rapid transit systems, commercial, general, and military aviation and airport operations, and other ground stationary noise sources. These would include HST alignments. The California Noise Control Act stipulates the mapping of noise-level contours for these sources, using community noise metrics appropriate for environmental impact assessment as defined in Section 3.4.3. Cities and counties use these as guides to making land use decisions to minimize the community residents' exposure to excessive noise.

C. REGIONAL AND LOCAL

Counties and cities in California prepare general plans with noise policies and ordinances (outlined above in the discussion of state regulations). These noise elements often incorporate specific allowable noise levels to achieve a quality environment. Many noise elements reviewed for cities and counties in the Fresno to Bakersfield Section include restrictions on construction hours; none have noise level limits on construction. Where airports exist, the general plans include a section on airport land use compatibility plans with respect to noise so that new noise-sensitive uses are not located near or do not encroach on the area. The general plans do not address ground-borne vibration. The *Fresno to Bakersfield Section: Noise and Vibration Technical Report* (Authority and FRA 2011) summarizes the noise-related information from the city and county general plans for the Fresno to Bakersfield Section. These local plans and policies were identified and considered in the preparation of this analysis.

3.4.3 Methods for Evaluating Impacts

The analysis of noise and vibration impacts used design information for the proposed alignment and field noise and vibration measurements. The FRA (2005) guidance manual, *High-Speed Ground Transportation Noise and Vibration Impact Assessment*, was the primary source of guidance for analyzing HST noise and vibration impacts and mitigation, which was supplemented by FTA (2006) guidance, *Transit Noise and Vibration Impact Assessment,* for non-HST noise. FRA manual provides guidelines for establishing the extent of the study area to be used for the noise and vibration impact analyses. It also provides guidance for identifying noise-sensitive locations where increased annoyance (the startle effect) can occur from HST pass-bys. The methodology followed by the noise and vibration analysts is described below.

- For HST noise sources, analysts used the FRA guidance manual (FRA 2005, Chapter 5 – Detailed Noise Analysis, Chapter 9 - Detailed Vibration Assessment). Analysts also used the FTA guidance manual for the detailed vibration impact analysis (FTA 2006, Chapter 11 – Detailed Vibration Analysis).
- For non-HST noise sources, such as stations, maintenance facilities and construction, analysts followed the methods described in the FTA guidance manual (FTA 2006).
- For traffic noise sources, analysts followed the methods described in the *FHWA Highway Traffic Noise: Analysis and Abatement Guidance* (FHWA 2010).

The following thresholds were used for the impact analyses:

- FRA Severe Noise Impact Criteria for HST Operations.
- FRA Increased Annoyance from Rapid Onset Rates of HST Pass-bys.
- FRA Interim Criteria for Noise Impacts on Animals.
- FRA Vibration Impact Criteria for HST Operations
- FTA Detailed Vibration Impact Criteria.
- Caltrans Noise Abatement Criteria for Traffic.
- FTA Noise Impact Criteria for Ancillary and Non-HST Noise Sources, such as stations and maintenance facilities.

Additional details regarding evaluation methods are provided in the following sections and in the *Fresno to Bakersfield Section: Noise and Vibration Technical Report* (Authority and FRA 2011).

A. WHAT IS NOISE?

Noise from an HST system is expressed in terms of a "source-path-receiver" framework. The "source" generates noise levels that depend on the type of source (e.g., a high-speed train) and its operating characteristics (e.g., speed). The "receiver" is the noise-sensitive land use (e.g., residence, hospital, or school) exposed to noise from the source. In between the source and the receiver is the "path" where the noise is reduced by distance, intervening buildings, and topography. Environmental noise impacts are assessed at the receiver. Noise criteria are established for the various types of receivers because not all receivers have the same noise-sensitivity.

Analysts use three primary noise measurement descriptors to assess noise impacts from traffic and transit projects. They are the equivalent sound level (L_{eq}), the day-night sound level (L_{dn}), and the sound exposure level (SEL):

- **L_{eq}**: The level of a constant sound for a specified period of time that has the same sound energy as an actual fluctuating noise over the same period of time. The peak-hour L_{eq} is used for all traffic and rail noise analyses at locations with daytime use, such as schools and libraries.

- **L_{dn}**: The L_{eq} over a 24-hour period, with 10 dB added to nighttime sound levels (between 10 p.m. and 7 a.m.) as a penalty to account for the greater sensitivity and lower background sound levels during this time. The L_{dn} is the primary noise-level descriptor for rail noise in residential land uses. Figure 3.4-1 shows typical L_{dn} noise levels. The *Fresno to Bakersfield Section: Noise and Vibration Technical Report* provides details regarding noise and noise descriptors.

Measuring Noise Levels

Noise is unwanted sound. Sound is measured in terms of sound pressure level and is usually expressed in decibels (dB). The human ear is less sensitive to higher and lower frequencies than it is to mid-range frequencies. All noise ordinances, and this noise analysis, use the A-weighting system, which measures what humans hear in a more meaningful way because it reduces the sound levels of higher and lower frequency sounds—similar to what humans hear. Measurements taken with this A-weighted filter are referred to as dBA readings.

- **SEL**: The sound exposure level (SEL) during a single noise event is the primary descriptor of a single noise event, and is used to describe noise from a HST passing a location along the track. SEL is an intermediate value in the calculation of both L_{eq} and L_{dn}. It represents a receiver's cumulative noise exposure from an event (train pass-by) and represents the total A-weighted sound during the event normalized to a 1-second interval.

In addition to the L_{eq}, L_{dn}, and SEL, there is another descriptor used to describe noise. The loudest 1 second of noise over a measurement period (L_{max}) is used in many local and state ordinances for noise coming from private land uses and for construction impact evaluations.

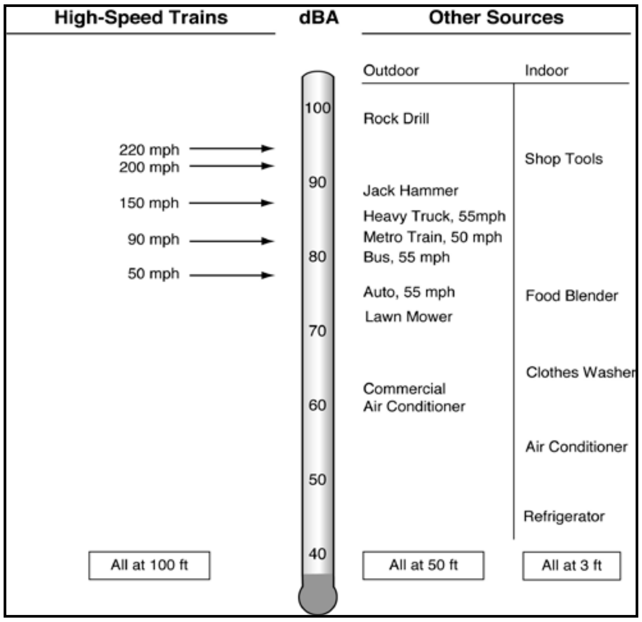


Figure 3.4-1
Typical 24-hour L_{dn} noise levels

B. WHAT IS VIBRATION?

Vibration from an HST system is also expressed in terms of a “source-path-receiver” framework. The “source” is the train rolling on the tracks, which generates vibration energy transmitted through the supporting structure under the tracks and into the ground. Once the vibration gets into the ground, it propagates through the various soil and rock strata—the “path”—to the foundations of nearby buildings, the “receivers.” Ground-borne vibrations generally reduce in levels with distance depending on the local geological conditions. A “receiver” is a vibration-sensitive building (e.g., residence, hospital, or school) where the vibrations may cause perceptible shaking of the floors, walls, and ceilings and a rumbling sound inside rooms. Not all receivers have the same vibration-sensitivity. Consequently, criteria are established for the various types of receivers. Ground-borne vibration can be described in terms of displacement, velocity, or acceleration for evaluating impacts from transit projects. Ground-borne noise occurs as a perceptible rumble and is caused by the noise radiated from the vibration of room surfaces. Vibration above certain levels can damage buildings, disrupt sensitive operations, and cause annoyance to humans within buildings.

Figure 3.4-2 illustrates typical ground-borne vibration velocity levels for common sources and thresholds for human and structural response to ground-borne vibration. As shown, the range of interest is from approximately 50 to 100 VdB (i.e., from imperceptible background vibration to the threshold of damage). Although the threshold of human perception to vibration is approximately 65 VdB, annoyance does not usually occur unless the vibration exceeds 70 VdB.

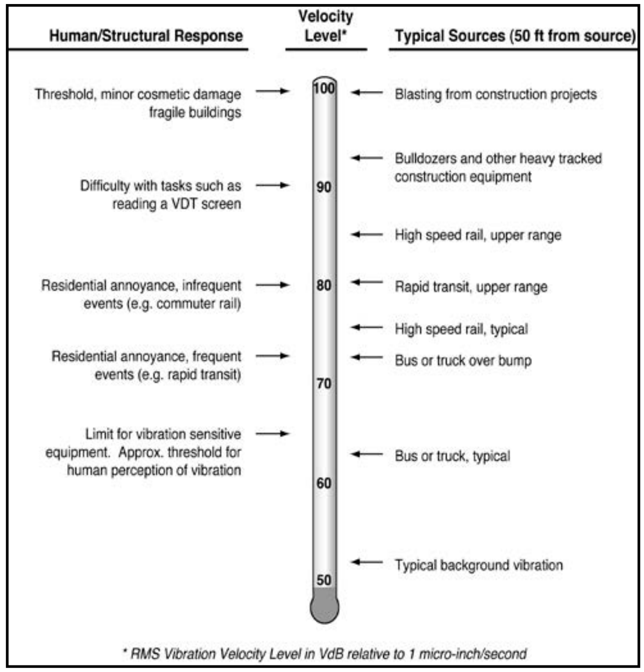


Figure 3.4-2
Typical levels of ground-borne vibration
Source: FRA (2005)

C. IMPACT ASSESSEMENT GUIDANCE

For the impact assessment for noise and vibration, two different guidance documents are used. For construction impacts, the FTA (2006) assessment document is used to assess impacts while for project impacts the FRA (2005) assessment document is used. The reason for using both documents is that the FTA (2006) guidance is a more recent and complete addition to the measurement of noise and vibration impacts; however, it does not specifically discuss impacts from the operation of a HST while the FRA guidance does. Accordingly, for construction impacts that do not differ by transportation type the more recent and complete FTA (2006) guidance is used, while for project operations the FRA (2005) guidance is used.

Construction Thresholds

Construction activities associated with a large transportation project often generate noise and vibration complaints even though they take place over a limited period. For the impact assessment from construction noise and vibration, the threshold is the exposure of noise- and vibration-sensitive receivers to construction-related noise or vibration at levels exceeding standards established by FTA and established thresholds for architectural and structural building damage (FTA 2006).

Construction Noise

Table 3.4-1 shows the FTA noise assessment criteria for construction. The last column applies to construction activities that extend over 30 days near any given receiver. Day-night sound level, L_{dn}, is used to assess impacts in residential areas and 24-hr L_{eq} is used in commercial and industrial areas. The 8-hr L_{eq} and the 30-day average L_{dn} noise exposure from construction noise calculations use the noise emission levels of the construction equipment, their location, and operating hours. The construction noise limits are normally assessed at the noise-sensitive receiver property line edge.

Construction Vibration

The FTA guidance manual (FTA 2006) provides the basis for the construction vibration assessment.

FTA provides construction vibration criteria designed primarily to prevent building damage, and to assess whether vibration might interfere with vibration-sensitive building activities or temporarily annoy building occupants during the construction period. The FTA criteria include two ways to express vibration levels: (1) root-mean-square (RMS) vibration velocity level (VdB) for annoyance and activity interference and (2) peak particle velocity (PPV), which is the maximum instantaneous peak of a vibration signal used for assessments of damage potential.

Measuring Vibration Levels

Ground-borne noise occurs as a perceptible rumble and is caused by the noise radiated from the vibration of room surfaces. Vibration above certain levels can damage buildings, disrupt sensitive operations, and cause annoyance to humans within buildings.

The response of humans, buildings, and equipment to vibration is most accurately described using velocity or acceleration. In this analysis, vibration velocity is expressed in terms of VdB as the primary measurement to evaluate the effects of vibration. The frequency distribution of vibration energy is important for detailed impact analyses. Analysts break the frequency range into segments called 1/3-octave bands for detailed analyses.

Table 3.4-1
FTA Construction Noise Assessment Criteria

Land Use	8-hour L_{eq}, dBA		Noise Exposure, L_{dn}, dBA
	Day	Night	30-day Average
Residential	80	70	75[a]
Commercial	85	85	80[b]
Industrial	90	90	85[b]

Source: FTA 2006.

[a] In urban areas with very high ambient noise levels (L_{dn} greater than 65 dB), L_{dn} from construction operations should not exceed existing ambient + 10 dB.

[b] Twenty-four-hour L_{eq}, not L_{dn}.

Acronyms:
dBA A-weighted decibel(s)
L_{dn} day-night sound level
L_{eq} equivalent sound level

To avoid temporary annoyance to building occupants during construction or construction interference with vibration-sensitive equipment inside special-use buildings, such as a magnetic resonance imaging (MRI) machine, FTA recommends using the long-term operational vibration criteria provided below in the Vibration Criteria – HST Operations section.

Table 3.4-2 shows the FTA building damage criteria for construction activity; the table lists PPV limits for four building categories. These limits are used to estimate potential problems that should be addressed during final design. See the *Fresno to Bakersfield Section: Noise and Vibration Technical Report* (Authority and FRA 2011) for a description of the metrics.

Table 3.4-2
Construction Vibration Damage Criteria

Building Category	PPV (inch/sec)	Approximate L_v[a]
I. Reinforced concrete, steel, or timber (no plaster)	0.5	102
II. Engineered concrete and masonry (no plaster)	0.3	98
III. Non-engineered timber and masonry buildings	0.2	94
IV. Buildings extremely susceptible to vibration damage	0.12	90

Source: FTA 2006.

[a] RMS vibration velocity level in VdB relative to 1 micro-inch/second.

Acronym:
PPV peak particle velocity

Project Thresholds

Noise Criteria — HST Operations

The descriptors and criteria for assessing noise impact vary according to land use categories adjacent to the track. For land uses where people live and sleep (e.g., residential neighborhoods, hospitals, and hotels), the day-night average sound level (L_{dn}) is the assessment parameter. For other land use types where there are noise-sensitive uses (e.g., outdoor concert areas, schools, and libraries), the equivalent noise level (L_{eq}[h]) for an hour of noise sensitivity that coincides with train activity is the assessment parameter. Table 3.4-3 summarizes the three land use categories.

Specific types of impacts use other noise descriptors. For disturbance of wildlife and domestic animals, the noise exposure from an individual train passage, called the SEL, is determined. The potential for startle effects for people in the near the HST is addressed in terms of a combination of train speed and distance from the track.

Table 3.4-3
FRA Noise-Sensitive Land Uses

Land Use Category	Noise Metric dBA[a]	Land Use Category
1	Outdoor $L_{eq}(h)$[b]	Tracts of land where quiet is an essential element in their intended purpose. This category includes lands set aside for serenity and quiet, such as outdoor amphitheaters, concert pavilions, and National Historic Landmarks with significant outdoor use.
2	Outdoor L_{dn}	Residences and buildings where people normally sleep. This category includes homes and hospitals, where nighttime sensitivity to noise is of utmost importance.
3	Outdoor $L_{eq}(h)$[b]	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. Buildings with interior spaces where quiet is important, such as medical offices, conference rooms, recording studios, concert halls fall into this category, as well as places for meditation or study associated with cemeteries, monuments, and museums. Certain historical sites, parks, and recreational facilities are also included.

Source: FRA 2005.

Notes:
[a] Onset-rate adjusted sound levels (L_{eq} and L_{dn}) are to be used where applicable.
[b] L_{eq} for the noisiest hour of transit-related activity during hours of noise sensitivity.

Acronyms:
dBA A-weighted decibel(s)
L_{eq} equivalent sound level, dBA

The noise impact criteria used by the FRA and FTA are ambient-based; the increase in future noise (future noise levels with the project compared to existing noise levels) is assessed rather than the noise caused by each passing train. The criteria specify a comparison of future project noise with existing levels because comparison with an existing condition is more accurate (FRA 2005). Figure 3.4-3 shows the FRA noise impact criteria for human annoyance. Depending on the magnitude of the cumulative noise increases, FTA and FRA categorize impacts as (1) no impact, (2) moderate impact, or (3) severe impact. Severe impact is where a significant percentage of people would be highly annoyed by the project's noise. Moderate impact

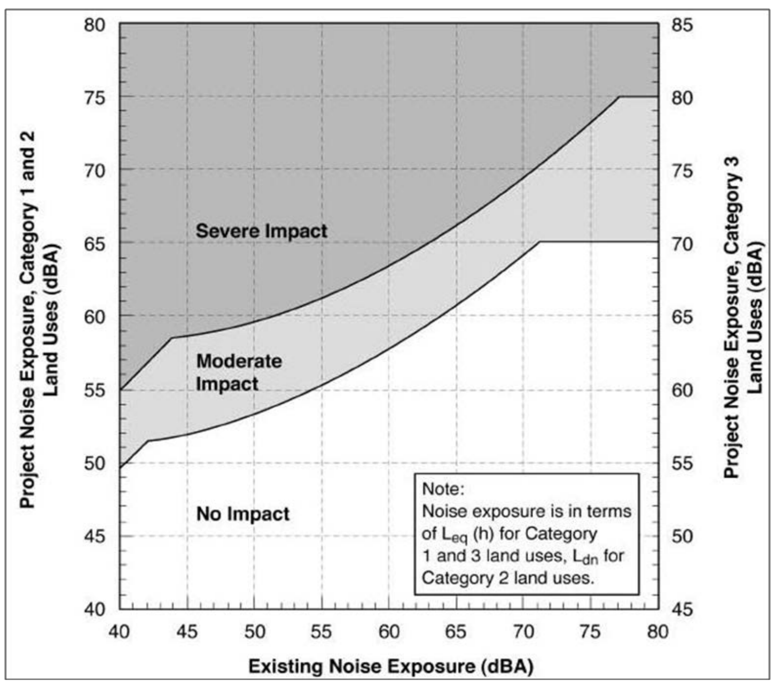


Figure 3.4-3
FRA noise impact criteria

Source: FRA (2005)

is where the change in cumulative noise level would be noticeable to most people, but may not be sufficient to generate strong, adverse reactions.

Noise Criteria – Traffic

The criteria for highway noise impacts (relevant to the extent HST causes changes in traffic patterns) are from the FHWA Procedures for Abatement of Highway Traffic Noise and Construction Noise, as provided in 23 CFR Subchapter H, Section 772. Table 3.4-4 summarizes the traffic noise abatement criteria. A noise impact occurs if projected noise levels approach the levels for specific land use categories listed in Table 3.4-4 or substantially exceed existing noise levels, as defined by Caltrans. In accordance with the regulations, a traffic noise analysis is required only for projects that include: (1) construction of a new highway, (2) reconstruction of an existing highway with a substantial change in the horizontal alignment or vertical profile or an increase in the number of through traffic lanes. If impacts are identified, noise abatement must be considered. In addition, FHWA guidance regarding the physical alteration of an existing highway states “changes in the horizontal alignment that reduce the distance between the source and the receiver by half or more result in a Type 1 project” (FHWA 2010). A Type 1 project is defined in 23 CFR 772 as a proposed federal or federal-aid highway project for the construction of a highway at new location or the physical alteration of an existing highway that significantly changes either the horizontal or vertical alignment or increases the number of through-traffic lanes. FHWA requires identifying highway traffic noise impacts and examining potential abatement measures for all Type 1 projects receiving federal funds.

Caltrans is responsible for implementing the FHWA regulations in California. Under Caltrans policy, a traffic-noise impact occurs if projected noise levels are within 1 dB of the FHWA criteria shown in Table 3.4-4; therefore, a residential impact occurs at 66 dBA L_{eq}, and a commercial impact occurs at 71 dBA L_{eq}. Caltrans also considers a 12-dB increase in noise a substantial impact, regardless of the original noise level.

Table 3.4-4
FHWA Traffic Noise Abatement Criteria

Land Use Category		Hourly L_{eq}
Type A	Land where serenity and quiet are of extraordinary significance and serve an important public need and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose	57 dBA (exterior)
Type B	Picnic areas, recreation areas, playgrounds, active sports areas, parks, residences, motels, hotels, schools, churches, libraries, and hospitals.	67 dBA (exterior)
Type C	Developed lands, properties or activities not included in the above categories	72 dBA (exterior)
Type D	Undeveloped land	—
Type E	Residences, motels, hotels, public meeting rooms, schools, churches, libraries, hospitals and auditoriums	52 dBA (interior)

Source: FHWA Procedures for Abatement of Highway Traffic Noise and Construction Noise (23 CFR 772).

Acronyms:
dBA A-weighted decibel(s)
FHWA Federal Highway Administration
L_{eq} equivalent sound level

Noise Effects on Wildlife and Domestic Animals

FRA also addresses impacts on wildlife (mammals and birds) and domestic animals (livestock and poultry). Noise exposure limits for each are an SEL of 100 dBA from passing trains as shown in Table 3.4-5.

Table 3.4-5
Interim Criteria for High-Speed Train Noise Effects on Animals

Animal Category	Class	Noise Metric	Noise Level (dBA)
Domestic	Mammals (Livestock)	SEL	100
	Birds (Poultry)	SEL	100
Wild	Mammals	SEL	100
	Birds	SEL	100

Source: FRA 2005.
Acronym:
dBA A-weighted decibel(s)

Vibration Criteria – HST Operations

Ground-borne vibration impacts from HST operations inside vibration-sensitive buildings are defined by the vibration velocity level, expressed in terms of VdB, and the number of vibration events per day of the same kind of source. Table 3.4-6 summarizes vibration-sensitivity in terms of the three land use categories and the criteria for acceptable ground-borne vibrations and acceptable ground-borne noise. Ground-borne noise is a low-frequency rumbling sound inside buildings, caused by vibrations of floors, walls, and ceilings. Ground-borne noise is generally not a problem for buildings near railroad tracks at- or above-grade, because the airborne noise from trains typically overshadows effects of ground-borne noise. Ground-borne noise becomes an issue in cases where airborne noise cannot be heard, such as for buildings near tunnels.

The FRA provides guidelines to assess the human response to different levels of ground-borne noise and vibration, as shown in Table 3.4-6. These levels represent the maximum vibration level of an individual train pass-by. A vibration event occurs each time a train passes the building or property and causes discernible vibration. “Frequent Events” are more than 70 vibration events per day, and “Infrequent Events” are fewer than 70 vibration events per day. The guidelines also provide criteria for special buildings very sensitive to ground-borne noise and vibration, such as concert halls, recording studios, and theatres. Table 3.4-7 shows the impact criteria for special buildings.

Tables 3.4-6 and 3.4-7 include separate FRA criteria for ground-borne noise (the "rumble" that radiates from the motion of room surfaces in buildings from ground-borne vibration). Although the criteria are expressed in dBA, which emphasizes the more audible middle and high frequencies, the criteria are significantly lower than airborne noise criteria to account for the annoying low-frequency character of ground-borne noise. Because airborne noise often masks ground-borne noise for aboveground (i.e., at-grade or elevated) high-speed trains, ground-borne noise criteria apply primarily to operations in a tunnel, where airborne noise is not a factor. The Fresno to Bakersfield alignment is planned be above ground. As a result for the Fresno to Bakersfield corridor, ground-borne noise criteria apply only to buildings with sensitive interior spaces that are well insulated from exterior noise.

Table 3.4-6
FRA Ground-Borne Vibration and Ground-Borne Noise Impact Criteria

Land Use Category	Ground-Borne Vibration Impact Criteria (VdB relative to 1 micro inch/second)		Ground-Borne Noise Impact Criteria (dB re 20 micro Pascals)	
	Frequent Events[a]	Infrequent Events[b]	Frequent Events[a]	Infrequent Events[b]
Category 1: Buildings where vibration would interfere with interior operations	65 VdB[c]	65 VdB[c]	NA[d]	NA[d]
Category 2: Residences and buildings where people normally sleep	72 VdB	80 VdB	35 dBA	43 dBA
Category 3: Institutional land uses with primarily daytime use	75 VdB	83 VdB	40 dBA	48 dBA

Source: FRA 2005.

Notes:
[a] Frequent Events is defined as more than 70 vibration events per day.

[b] Infrequent Events is defined as fewer than 70 vibration events per day.

[c] 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 heating, ventilating and air conditioning systems, and stiffened floors.

[d] Vibration-sensitive equipment is not sensitive to ground-borne noise.

Acronyms:
dB decibel(s)
FRA Federal Railroad Administration
VdB vibration velocity level

Table 3.4-7
FRA Ground-Borne Vibration and Ground-Borne Noise Impact Criteria for Special Buildings

Type of Building or Room	Ground-Borne Vibration Impact Criteria (VdB relative to 1 micro-inch/second)		Ground-Borne Noise Impact Criteria (dB relative to 20 micro-Pascals)	
	Frequent Events[a]	Infrequent Events[b]	Frequent Events	Infrequent Events[b]
Concert Hall	65 VdB	65 VdB	25 dBA	25 dBA
TV Studio	65 VdB	65 VdB	25 dBA	25 dBA
Recording Studio	65 VdB	65 VdB	25 dBA	25 dBA
Auditorium	72 VdB	80 VdB	30 dBA	38 dBA
Theater	72 VdB	80 VdB	35 dBA	43 dBA

Table 3.4-7
FRA Ground-Borne Vibration and Ground-Borne Noise Impact Criteria for Special Buildings

Type of Building or Room	Ground-Borne Vibration Impact Criteria (VdB relative to 1 micro-inch/second)		Ground-Borne Noise Impact Criteria (dB relative to 20 micro-Pascals)	
	Frequent Events[a]	Infrequent Events[b]	Frequent Events	Infrequent Events[b]

Source: FRA 2005.

Notes:
[a] *Frequent Events* is defined as more than 70 vibration events per day.
[b] *Infrequent Events* is defined as fewer than 70 vibration events per day.

Acronyms:
dB decibel(s)
dBA A-weighted decibel(s)
VdB vibration velocity level

In order to determine the actual transmission characteristics of vibration through the soils along the project right-of-way, transfer mobility testing must be conducted. Transfer mobility is a measure of the relationship between the exciting force and the response at each accelerometer position. Eighteen vibration propagation measurements were taken to estimate the vibration transfer mobility along the proposed alignment between Fresno and Bakersfield. This testing showed that all residential structures within a distance of 86 feet and all 4(f) site structures within a distance of 190 feet from the centerline of any proposed at grade alignment have the potential to be impacted by vibration levels from the HST project. Additional information regarding the transfer mobility testing can be found in the *Fresno to Bakersfield Section: Noise and Vibration Technical Report* (Authority and FRA 2011).

Construction Noise Impact Methodology

The construction noise impact assessment used the methodology described in the FTA guidance manual (FTA 2006). The contractor and the Authority will make decisions regarding procedures and equipment. For this analysis construction scenarios for typical railroad construction projects are used to predict noise impacts. The construction noise and vibration methodology includes the following:

- Noise emissions from equipment expected to be used by contractors.
- Construction methods using the equipment identified above.
- Usage scenarios for how the equipment will be operated.
- Estimated site layouts of equipment along the right-of-way.
- Relationship of the construction operations to nearby noise-sensitive receivers.

Table 3.4-1 above lists FTA criteria for the maximum acceptable 8-hour noise levels (L_{eq}) for daytime and nighttime. It also shows the 30-day average L_{dn} values for long-term construction projects.

Criteria for Construction Noise Impact Assessment

The construction noise assessment is based on guidelines included in the FTA guidance manual (FTA 2006), as well as consideration of local noise ordinances, which are presented in the *Fresno to Bakersfield Section: Noise and Vibration Technical Report*. The Authority applies uniform noise and vibration criteria for construction based on FTA and FRA guidance.

Table 3.4-1 shows FTA assessment criteria for construction noise. An 8-hour L_{eq} and a 30-day average noise exposure are used to assess impacts. A 30-day average L_{dn} is used to assess impacts in residential areas, and a 30-day average 24-hour L_{eq} is used to assess impacts in commercial and industrial areas. The noise emission levels of the construction equipment, utilization factor, hours of operation, and location of equipment are used to calculate 8-hour and 30-day average noise exposures.

Construction Vibration Impact Methodology

The FTA guidance manual (FTA 2006) provides the methodology for the assessment of construction vibration impact. Estimated construction scenarios have been developed for typical railroad construction projects allowing a quantitative construction vibration assessment to be conducted. Construction vibration is assessed quantitatively where a potential for blasting, pile-driving, vibratory compaction, demolition, or excavation close to vibration-sensitive structures exists. Criteria for annoyance (see Tables 3.4-6 and 3.4-7) and damage (see Table 3.4-2) were applied to determine construction vibration impacts. The methodology included the following:

- Vibration source levels from equipment expected to be used by contractors.
- Estimated site layouts of equipment along the right-of-way.
- Relationship of the construction operations to nearby vibration-sensitive receivers.

Train Operation Noise and Vibration Methodology

HST operation noise and vibration levels were projected using current HST System operation plans and the prediction models provided in the FRA guidance manual (FRA 2005). Potential noise and vibration impacts also were evaluated in accordance with the FRA guidance manual. Section 3.4.3 Part C describes the applicable criteria; this section, as well as the Noise and Vibration Technical Report, provide further detail about the assessment methodology, including modeling assumptions. The assumptions for train operation are listed below followed by the methodologies:

- Noise modeling projections assumed atmospheric absorption of sound based on the International Standard ISO 9613-2.

- The noise analysis used source reference levels for the VHS Electric vehicle type listed in Table 5-2 of the FRA Guidance Manual (FRA 2005). These adjustments assumed that trainsets would be distributed-power EMU vehicles with 10 cars and a maximum speed of 220 mph. The assumption of a 10-car trainset differs from that of the 8-car trainset in the project description. A sensitivity analysis was conducted that showed an 8-car trainset would be approximately 0.1 dBA noisier than a 10-car trainset, which is an imperceptible increase.

- The noise sources included the wheel/rail interface at one foot above top of rail, the propulsion noise at 10 feet above top of rail, and the aerodynamic noises from the train nose (at 10 feet above top of rail), the wheel region (at 5 feet above top of rail), and the pantograph (at 15 feet above top of rail).

- HST track was assumed to be continuous welded rail.

- Modeling used the full system schedule of train operations as outlined in Chapter 2 of this document and detailed in the Noise and Vibration Technical Report.

- Maximum speed was assumed to be 220 mph along the corridor depending upon speed profiles provided by Project Design files and interpreted by Parsons Brinckerhoff, Inc. in July 2010.

- Top of rail elevations are based on 15% preliminary design as available March 2011.
- The track was assumed to be on aerial structure wherever top-of-rail elevations are more than 20 feet above existing grade.
- All aerial structure sections of the corridor were assumed to be as described in the Technical Memorandum "TM 1.1.21 Typical Cross Section 15% R0 090404 TM Excerpt.pdf."
- Noise and vibration projections assumed that any buildings within 50 feet of the track centerline would be within the right-of-way and therefore were not included in the impact assessment.
- There would be several closures of existing roadway/freight train/Amtrak train at-grade crossings along the corridor on the BNSF Alternative. A road overcrossing would separate both the HST and the BNSF freight line. Trains passing through the existing at-grade crossings between roadways and freight/Amtrak railroad tracks currently are required to blow their horns as a warning to oncoming traffic and pedestrians. Noise modeling projections assumed no change to any of the existing at-grade crossings and, therefore, no change to locations where the freight and Amtrak trains will blow their horns. There would be no at-grade crossings for HSTs.
- No adjustments were made to projected noise levels to account for increases in localized noise due to special trackwork, such as crossovers and turnouts, since the project will use special trackwork which will not have gaps associated with crossovers.
- No noise exposure effects were assumed associated with changes in freight rail or Amtrak operations due to the implementation of the HST project.

Project analysts tabulated projected noise and existing ambient noise exposures at the identified receivers or clusters of receivers. The analysts found the levels of impact (no impact, moderate impact, or severe impact) by comparing the existing and project noise exposure based on the impact criteria shown in Figure 3.4-3.

Station Noise

Project analysts assessed the noise impacts associated with HST stations in the cities of Fresno and Bakersfield and in Kings County at each noise-sensitive receiver by using the FTA methodology in the guidance manual (FTA 2006, Section 6.7). The detailed noise analysis included a measurement program at representative clusters of receivers to determine existing ambient noise conditions and a noise prediction method to determine future noise conditions. The noise predictions at these receivers were based on the following information:

- Type of train equipment to be used.
- Train schedules (number of stopping trains and number of through trains during daytime and nighttime hours).
- Train consists (number of cars).
- Speed profiles of stopping trains and through trains.
- Plans and profiles of elevated station structures.
- Landform topography such as buildings in the immediate vicinity of the station.

Project analysts tabulated the projected noise and existing ambient noise exposures at the identified receivers or clusters of receivers. The analysts then determined the levels of impact (no impact, moderate impact, or severe impact) by comparing the existing and project noise exposure with the impact criteria shown in Figure 3.4-3.

Traffic Noise at Stations, Parking Facilities, and Grade-Separations

In addition to noise from HST operations, project analysts assessed changes in traffic volume, primarily near the proposed HST station sites. Traffic on local roads provides only a minor contribution to overall noise levels. In addition, because the dominant noise source at stations would be the HST through trains moving at 220 mph, any changes in traffic near the stations would provide only a minor contribution to the project noise at stations.

Stationary HST-Related Noise Sources

Noise from other railroad noise sources than HSTs includes noise from the three types of maintenance facilities (heavy maintenance, maintenance-of-way, and overnight servicing) and electrical power substations.

The noise analysis used FTA (2006) methodology to analyze noise from the HST traction power substations, maintenance facilities, and activities associated with maintenance, repair, and storage of HSTs. Source noise included wheel squeal as the trains pass through the curved sections at the ends of the storage tracks, shop activities, railcar washes, and warning horns.

D. METHODS FOR EVALUATING EFFECTS UNDER NEPA

Pursuant to NEPA regulations (40 CFR 1500-1508), project effects are evaluated based on the criteria of context and intensity. Context means the affected environment in which a proposed project occurs. Intensity refers to the severity of the effect, which is examined in terms of the type, quality, and sensitivity of the resource involved, location and extent of the effect, duration of the effect (short- or long-term), and other consideration of context. Beneficial effects are identified and described. When there is no measurable effect, impact is found not to occur. Intensity of adverse effects is summarized as the degree or magnitude of a potential adverse effect where the adverse effect is thus determined to be negligible, moderate, or substantial. It is possible that a significant adverse effect may still exist when on balance the impact is negligible or even beneficial. For Noise and Vibration, the terms are defined as follows:

If the project results in an increase in noise that is measurable, but not perceptible to the human ear, the impact is defined as negligible. If the project results in a change in the cumulative noise level that would be noticeable to most people, but may not be sufficient to generate strong, adverse reactions, the impact is defined as moderate. If the project results in a change in the cumulative noise level that would cause a significant percentage of people to be highly annoyed by the project’s noise, the impact is defined as substantial.

E. CEQA SIGNIFICANCE CRITERIA

The FRA noise and vibration criteria for evaluating effects under NEPA may be used as the CEQA significance criteria. In addition to these criteria, CEQA guidelines also define an impact pertaining to noise and vibration as considered significant if it would result in any of the following environmental effects:

- Exposure of persons to or generation of noise levels in excess of standards for a severe impact established by the FRA for high-speed ground transportation and by the FTA for transit projects. These standards cover both permanent and temporary/periodic increases in ambient noise levels in the project vicinity above levels existing without the project.
- Exposure of persons to or generation of excessive ground-borne vibration or ground-borne noise levels.

F. STUDY AREA FOR ANALYSIS

Noise Study Area

The study area is the noise environment around the HST alternatives at the screening distances shown in Table 3.4-8. This table, which groups screening distances by the type of corridor the project would occupy, takes into account when the HST alignment follows along an existing rail line or highway or along a new transportation corridor. Screening distances indicate whether any noise-sensitive receivers are near enough to the proposed alignment for a noise impact to be possible. If receivers fall beyond these screening distances, FRA guidance has determined that impacts would be unlikely. The FRA has three speed ranges in its screening methodology; the highest speed range category (Regime III – 170 mph or greater) was used to define the Fresno to Bakersfield HST alignment screening distance (see Table 3.4-8). Consistent with FRA methodology, screening distances were adjusted to match project conditions such as speeds up to 220 mph and project schedules.

Table 3.4-8
Screening Distances for High-Speed Rail Speed Regime III[a]

Corridor Type	Existing Noise Environment	Screening Distance for Train Type and Speed Regime[b]
Railroad	Urban/noisy suburban – unobstructed	700 feet
	Urban/noisy suburban – intervening buildings[c]	300 feet
	Quiet suburban/rural	1,200 feet
Highway	Urban/noisy suburban – unobstructed	600 feet
	Urban/noisy suburban – intervening buildings[c]	350 feet
	Quiet suburban/rural	1,100 feet
New	Urban/noisy suburban – unobstructed	700 feet
	Urban/noisy suburban – intervening buildings[c]	350 feet
	Quiet suburban/rural	1,300 feet

Source: FRA 2005.
[a] 170 mph or greater.
[b] Measured from centerline of alignment. Minimum distance is assumed to be 50 feet.
[c] Rows of buildings are assumed to be at 200, 400, 600, 800, and 1,000 feet away, parallel to the alignment.

Vibration Study Area

For the proposed project, the study area for vibration is as follows:

- HST station study area: 150 feet from the station boundary.
- HST alignment study areas, including existing railroads: up to 275 feet from the edge of the right-of-way.
- Highway study areas: 50 feet from the roadway centerline.

The vibration impact assessment uses the FRA screening procedure. Screening distances indicate the potential for vibration impact on vibration-sensitive receivers. FRA guidance has determined that receivers located beyond the screening distances are not likely to be affected by the HST. Table 3.4-9 presents the screening distances for vibration assessment.

Table 3.4-9
FRA Screening Distances for Vibration Assessment

Land Use	Train Frequency[a]	Screening Distance (feet)	
		Train Speed of 100 to 200 mph	Train Speed of 200 to 300 mph
Residential	Frequent	220	275
	Infrequent	100	140
Institutional	Frequent	160	220
	Infrequent	70	100

Source: FRA 2005.
Note:
[a] Frequent = greater than 70 pass-bys per day; Infrequent = less than 70 pass-bys per day.
Acronym:
mph mile(s) per hour

The study areas for the vibration impact assessment analysis generally follow the HST corridor between Fresno and Bakersfield. Most of the study area along the north-south alignment lies along active railroad and highway rights-of-way. Vibration study areas are defined within the FRA vibration screening distances as ranging from 220 feet for institutional land uses to 275 feet for residential land uses (see Table 3.4-9).

3.4.4 Affected Environment

The affected environment follows the Fresno to Bakersfield HST corridor along the BNSF Railway (BNSF) tracks from the downtown area of the city of Fresno to the downtown area of the city of Bakersfield. This region includes areas and communities within the incorporated boundaries of the cities of Fresno, Hanford, Corcoran, Wasco, Shafter, and Bakersfield. This region also includes unincorporated communities within the counties of Fresno, Kings, Tulare, and Kern. The areas within the cities of Fresno, Corcoran, Wasco, Shafter, and Bakersfield are considered urban or suburban, and most of the unincorporated areas between these cities are considered rural. The proposed station locations fall within the urban areas of the cities of Fresno and Bakersfield, except the potential Kings/Tulare Regional Station is in a rural area east of Hanford. Most of the project areas described above as urban or suburban are also along active rail corridors, as are most of the rural areas.

There are no applicable regional plans or policies pertaining to noise and vibration within the Fresno to Bakersfield Section study area.

A. EXISTING NOISE LEVELS

To establish a base for existing environmental noise levels for the project noise impact assessment, a comprehensive series of noise measurements were made within the study area. A combination of 196 long-term (24 hours in duration) and 207 short-term (generally 60 minutes in duration) noise measurements were taken at noise-sensitive receivers. Multiple measurements were made at some measurement sites. The ambient noise level measurement locations were selected to be representative of the noise environment most likely to be impacted by train noise. Measurements were completed at single-family and multi-family residences for long-term measurements. Short-term measurements were completed at residential and institutional sites (e.g., hospitals, libraries, schools, churches).

The noise measurement locations are shown graphically on Figures 3.4-4 through 3.4-8. Summaries of the long- and short-term noise measurements are presented in Appendix 3.4-A NV Table 1 (long–term measurements) and Appendix 3.4-A NV Table 2 (short-term measurements). Each measurement site listed in these tables consists of the measurement location identification number, location address, a summary of noise sources, additional notes, and the resulting noise level.

The short-term noise measurements in Appendix 3.4-A NV Table 2 include the actual measured short-term L_{eq} values and the estimated L_{dn} values. These values were estimated by comparing the short-term measured values to the corresponding L_{eq} values at a nearby long-term measurement location that is subjected to a similar noise environment using the following method:

A. Note the L_{eq} value for the short-term measurement (60 minutes).

B. Compare the monitored short-term (ST) L_{eq} value from step A to the monitored L_{eq} value for the nearby long-term (LT) measurement location for the same measurement period used for the short-term (ST) L_{eq} value.

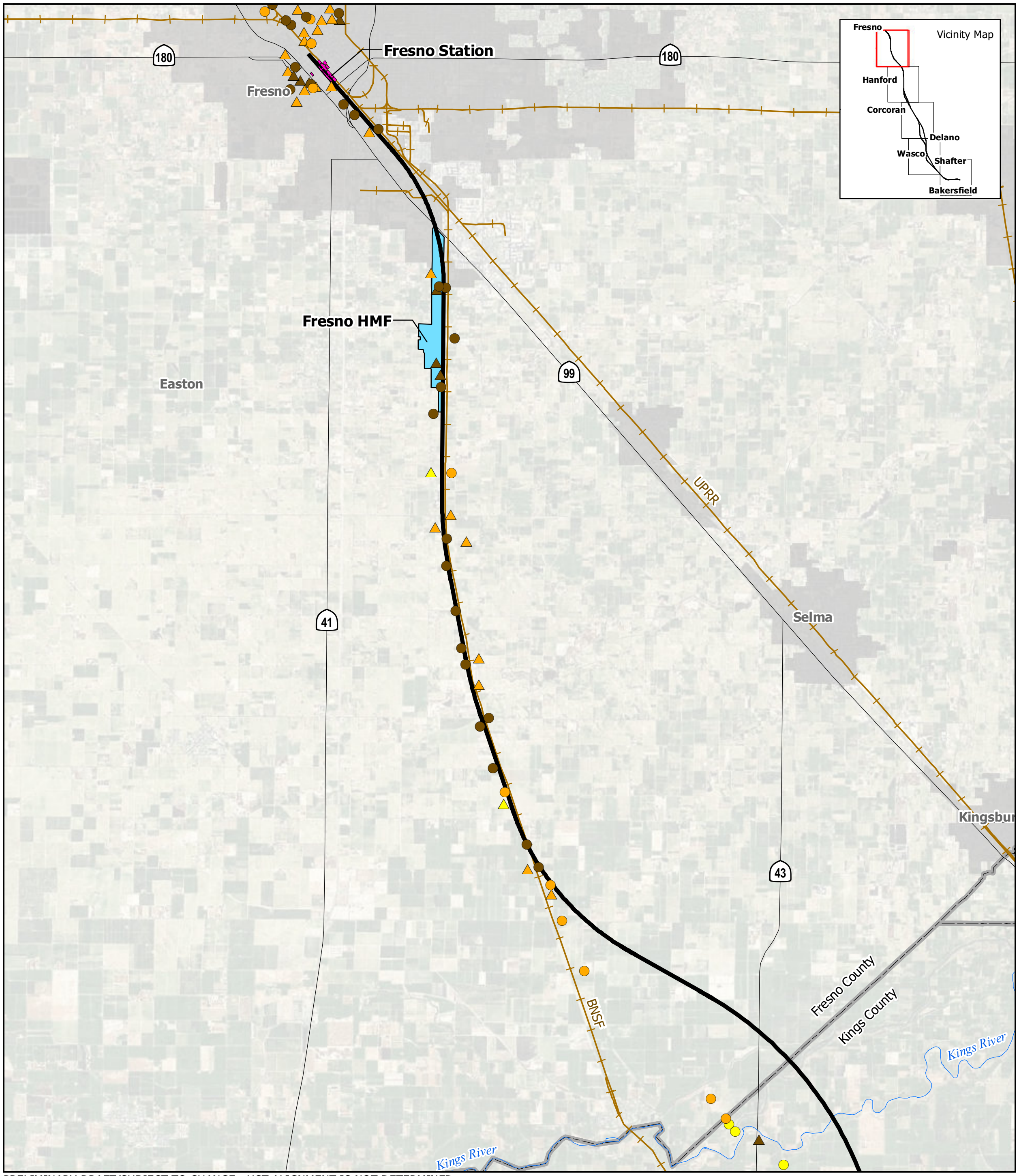
Then

L_{eq} (ST) – $L_{eq(simultaneous)}$ (LT) = delta

and

L_{dn} (ST) = L_{dn} (LT) + delta

The area around the proposed station in Fresno is developed primarily with commercial and industrial land uses, with some residential land uses mixed in. The noise environment in this area is dominated by traffic on the local streets, traffic on the freeways that surround the downtown area, and noise from train operations along the Union Pacific Railroad mainline. Noise levels were measured at the noise-sensitive land uses throughout the area, as indicated in Section 3.4.3, and the measured noise levels ranged from 61 dBA L_{dn} along one of the quieter streets to 72 dBA L_{dn} near the railroad. These noise levels are typical for urban settings dominated by vehicular traffic and railroad operations. The alternative alignment would proceed southeast from the Fresno station, pass State Route (SR) 41 and approach the BNSF rail yard. The sensitive land uses in this area are subject to more roadway and railroad noise; the noise levels measured here range from 68 to 75 dBA L_{dn}.



PRELIMINARY DRAFT/SUBJECT TO CHANGE - HST ALIGNMENT IS NOT DETERMINED

May 10, 2011

Data source: URS, 2011

Base map source: USGS National Elevation Dataset, 90-m hillshade

N

0 1 2 Miles

0 2 4 Kilometers

- BNSF Alternative (Bypasses labeled)
- Existing rail line
- Steam/River
- Highway
- Community/Urban area
- County boundary
- Potential heavy maintenance facility

Long-term noise monitoring site

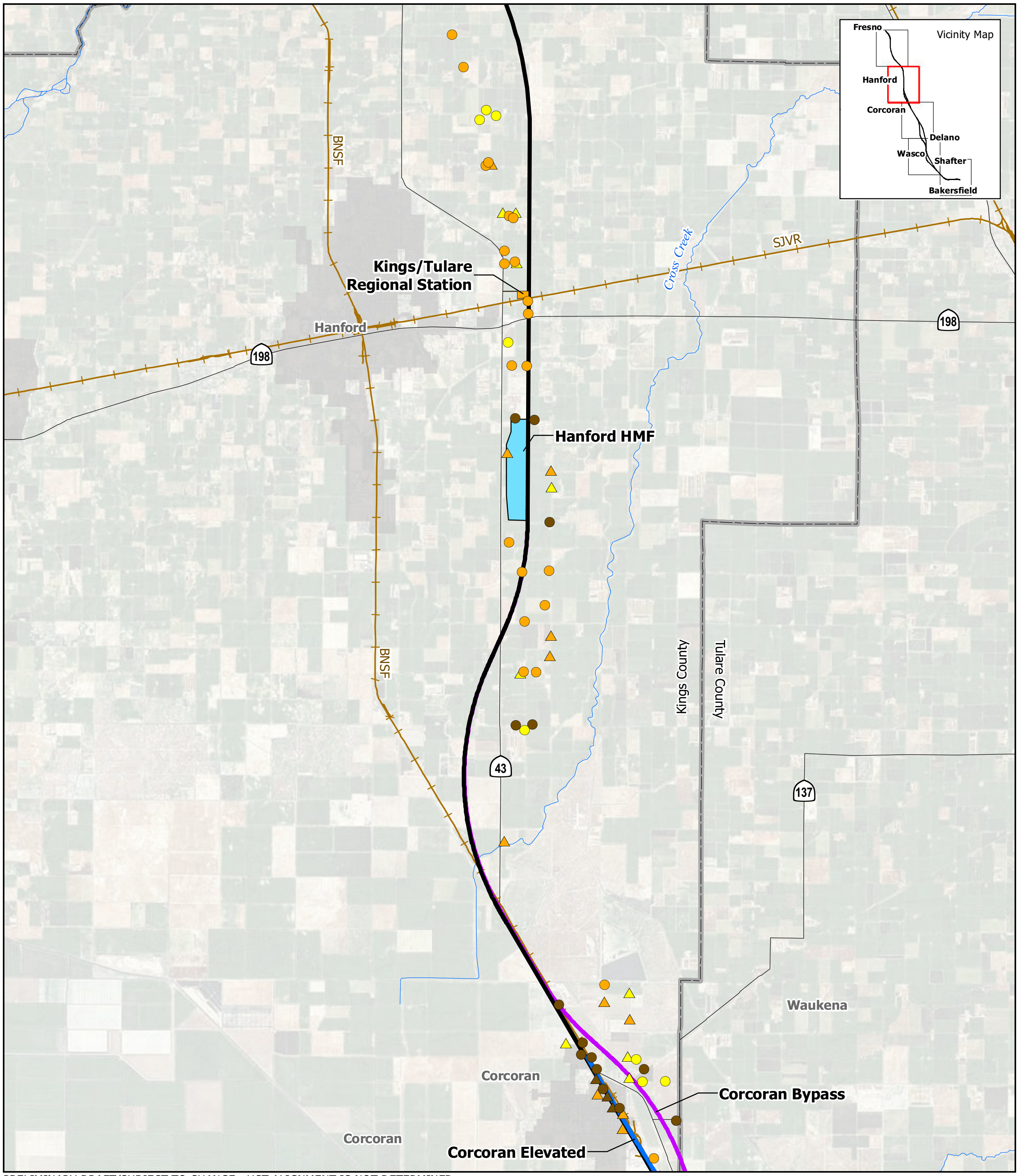
- Between 40 and 55 dBA
- Between 55.1 and 64 dBA
- Above 64 dBA

Short-term noise monitoring site

- Between 40 and 55 dBA
- Between 55.1 and 64 dBA
- Above 64 dBA

- Vibration measurement site
- Proposed station
- Potential Kings/Tulare Regional Station

Figure 3.4-4
Fresno area:
Noise and vibration
measurement sites



PRELIMINARY DRAFT/SUBJECT TO CHANGE - HST ALIGNMENT IS NOT DETERMINED

May 10, 2011

Data source: URS, 2011

Base map source: USGS National Elevation Dataset, 90-m hillshade

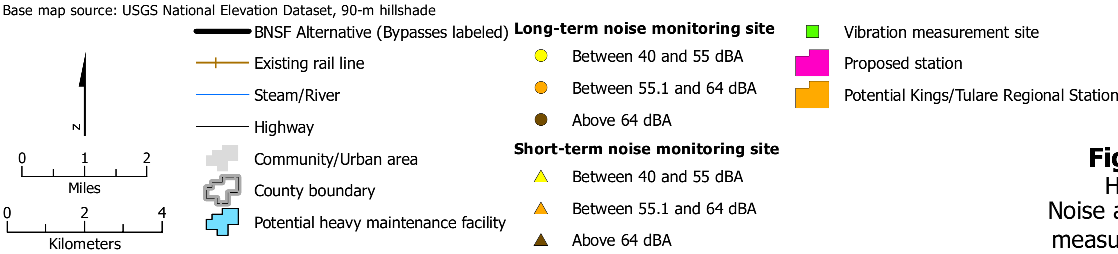
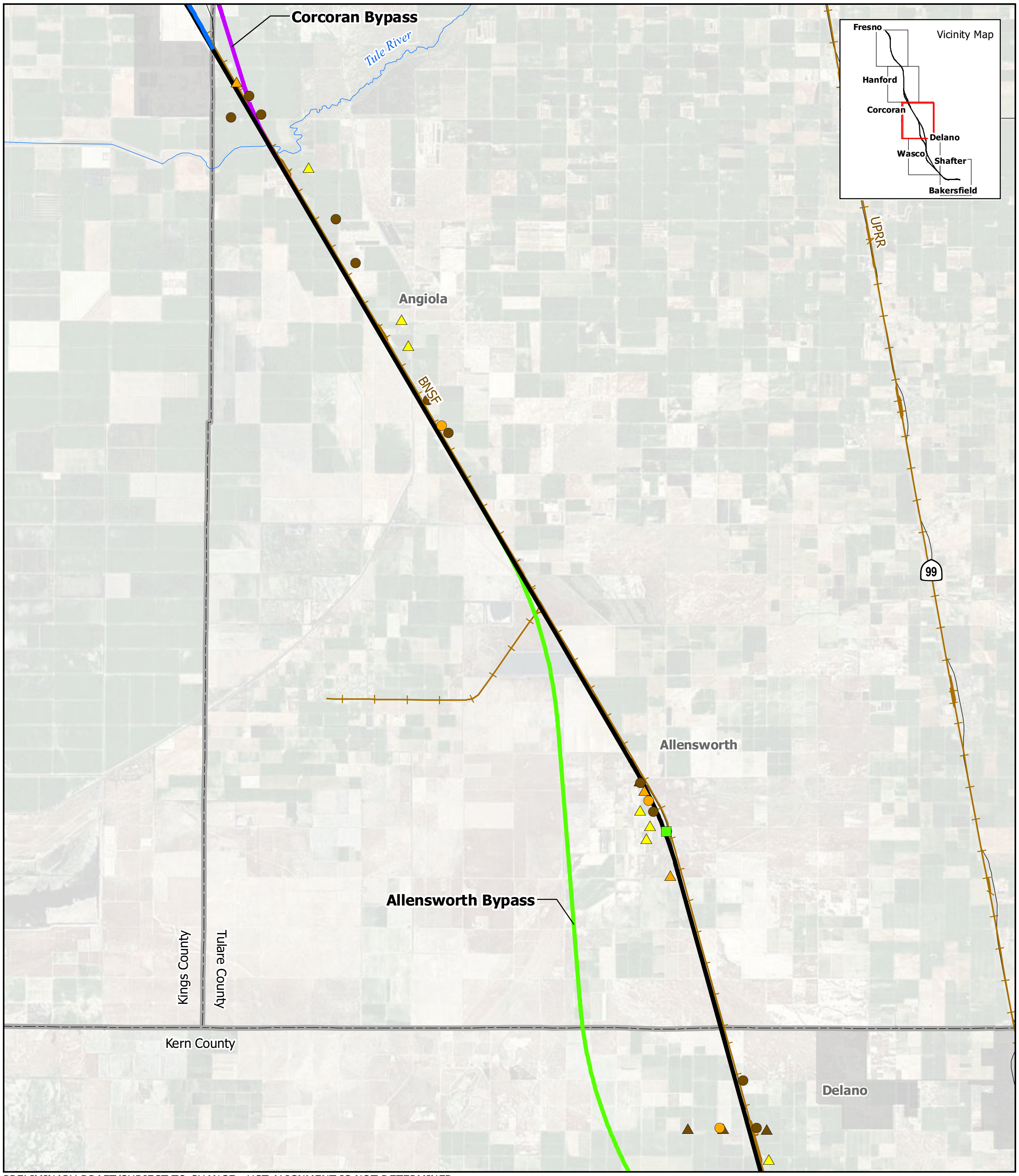


Figure 3.4-5
Hanford area:
Noise and vibration
measurement sites



PRELIMINARY DRAFT/SUBJECT TO CHANGE - HST ALIGNMENT IS NOT DETERMINED

May 10, 2011

Data source: URS, 2011

Base map source: USGS National Elevation Dataset, 90-m hillshade

- BNSF Alternative (Bypasses labeled)
- Existing rail line
- Steam/River
- Highway
- Community/Urban area
- County boundary
- Potential heavy maintenance facility

Long-term noise monitoring site

- Between 40 and 55 dBA
- Between 55.1 and 64 dBA
- Above 64 dBA

Short-term noise monitoring site

- Between 40 and 55 dBA
- Between 55.1 and 64 dBA
- Above 64 dBA

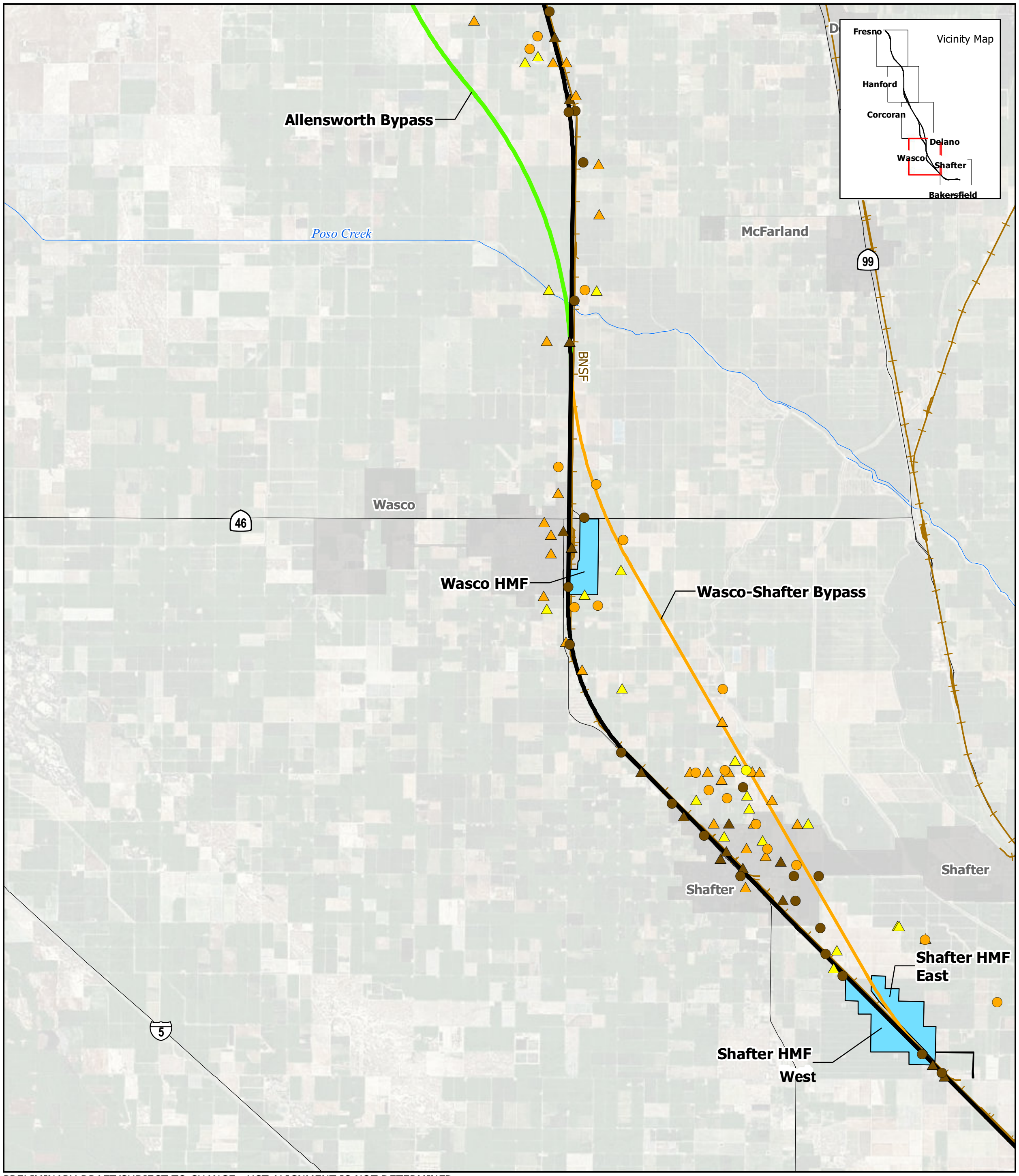
- Vibration measurement site
- Proposed station
- Potential Kings/Tulare Regional Station

N

0 1 2 Miles

0 2 4 Kilometers

Figure 3.4-6
Corcoran area: Noise and vibration measurement sites



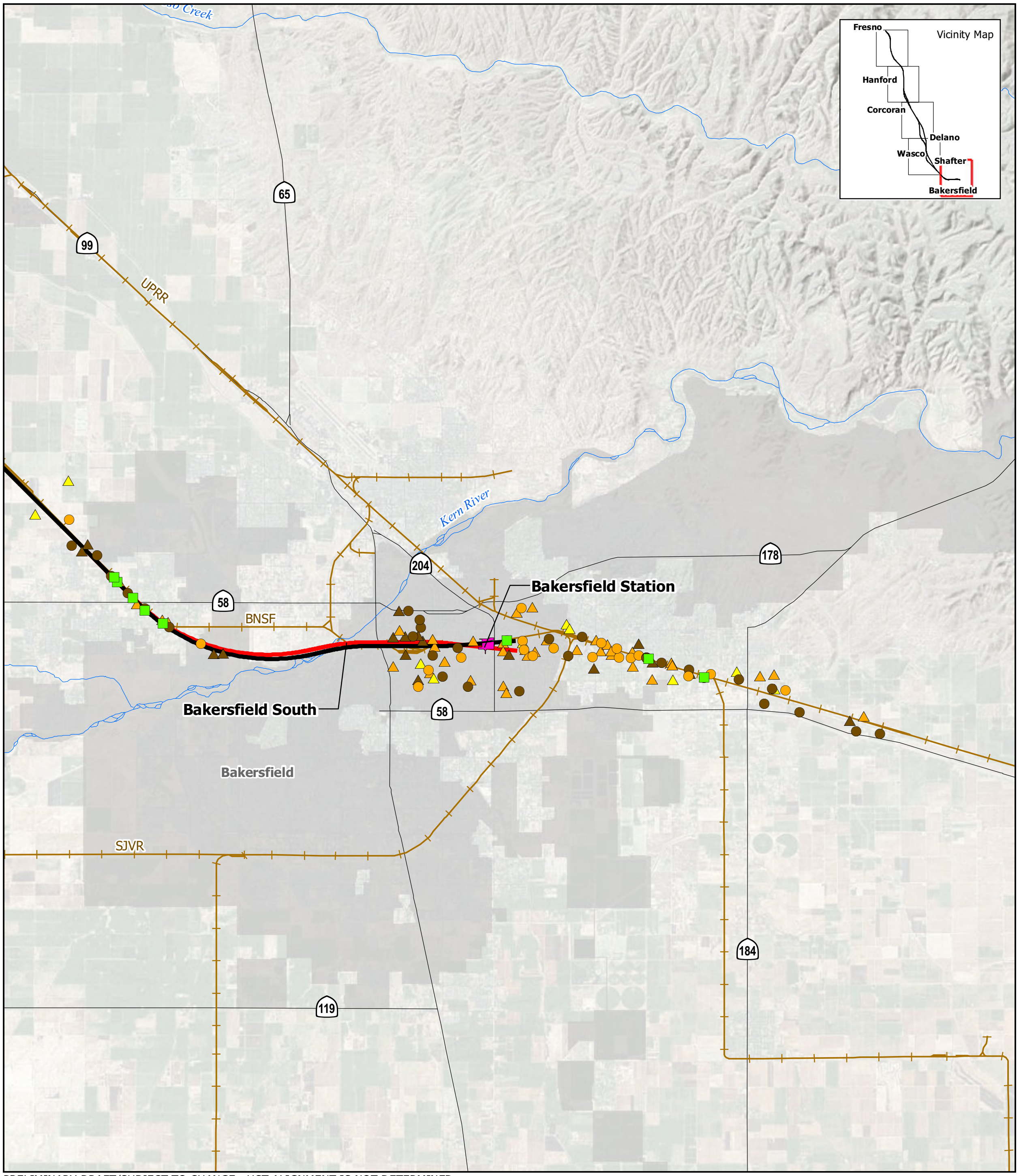
PRELIMINARY DRAFT/SUBJECT TO CHANGE - HST ALIGNMENT IS NOT DETERMINED

May 10, 2011

Data source: URS, 2011

Base map source: USGS National Elevation Dataset, 90-m hillshade

Figure 3.4-7
Wasco-Shafter area: Noise and vibration measurement sites



PRELIMINARY DRAFT/SUBJECT TO CHANGE - HST ALIGNMENT IS NOT DETERMINED

May 10, 2011

Data source: URS, 2011

Base map source: USGS National Elevation Dataset, 90-m hillshade

BNSF Alternative (Bypasses labeled)

Existing rail line

Steam/River

Highway

Community/Urban area

County boundary

Potential heavy maintenance facility

Long-term noise monitoring site

Between 40 and 55 dBA

Between 55.1 and 64 dBA

Above 64 dBA

Short-term noise monitoring site

Between 40 and 55 dBA

Between 55.1 and 64 dBA

Above 64 dBA

Vibration measurement site

Proposed station

Potential Kings/Tulare Regional Station

N

0 1 2 Miles

0 2 4 Kilometers

Figure 3.4-8

Bakersfield area: Noise and vibration measurement sites

After the alignment passes Jensen Avenue, it turns to the south to follow the BNSF alignment, passing over SR 99. South of Malaga Street, the alignment runs along the west side of the BNSF right-of-way, between Cedar Avenue to the west and Maple Avenue to the east. The land uses in this area are primarily agricultural, with homes mostly along Cedar Avenue and Maple Avenue. One of the homes adjacent to the existing railroad line experienced a noise level of 79 dBA L_{dn}. This site was dominated by train noise, with a total of 44 trains passing this location in a 24-hour period. Another home farther south that is approximately 900 feet (274 meters) from the existing railroad experienced a noise level of 58 dBA L_{dn}, which is significantly quieter.

From this point, the project alignment follows the BNSF for approximately 12 miles (19 kilometers) through primarily agricultural lands. Along this portion of the alternative alignments, the measured ambient noise levels ranged from 64 to 77 dBA L_{dn}. These noise levels are to be expected in areas near freight and passenger train operations. The median measured noise level for these same sites without train operations ranged from 36 to 44 dBA L_{dn}; these noise levels are comparable to the inside of a house during a quiet evening.

After crossing Clarkson Avenue, the project alignment turns to the southeast, away from the BNSF right-of-way, to bypass the community of Laton and to run around the east side of Hanford where the Kings/Tulare Regional Station is proposed. The land uses in the area continue to be primarily agricultural. The measured ambient noise levels between Laton and SR 198 ranged from 47 to 63 dBA L_{dn}. These noise levels are consistent with a rural environment with some vehicular traffic. The project alignment runs on the east side of SR 43 as it turns south toward Corcoran. It runs halfway between 7th Street and 8th Street. The land uses along the alignment between SR 198 and Corcoran are primarily dairy farms and fields of alfalfa. The measured ambient noise levels in this area range from 52 dBA L_{dn} at the homes away from busy roadways to 72 dBA L_{dn} for the homes adjacent to the main arterials.

Just south of Idaho Avenue, the project alignment curves to the southwest, crosses SR 43, then curves to the left in order to meet up with the BNSF alignment on the north side of Corcoran. South of Nevada Avenue, the Corcoran Bypass Alternative curves toward the east to bypass Corcoran around the east side. Noise measurements made along the alignment through the city of Corcoran ranged from 64 to 81 dBA L_{dn}. These noise levels are consistent with homes adjacent to commercial and industrial sites that are exposed to highway traffic and railroad operations. Around the east side of Corcoran, noise levels measured at homes away from SR 43 and other major roads ranged from 48 to 61 dBA L_{dn}.

South of Corcoran, the BNSF Alternative Alignment and the Corcoran Bypass Alternative rejoin at between Avenue 144 and Avenue 136, and run along the west side of SR 43. The land use in the area is agricultural, with a mix of orchards, alfalfa, and dairy. The noise levels measured in this area ranged from 59 to 70 dBA L_{dn}. These noise levels are consistent with expectations for homes along a two-lane highway and an active rail line.

In the vicinity of Allensworth, the measured noise levels for the homes near the BNSF right-of-way ranged from 62 to 76 dBA L_{dn}. For homes farther from the tracks, the measured noise levels were from 47 to 63 dBA L_{eq}, levels that would be expected for a reasonably quiet neighborhood. For the homes near both SR 43 and the BNSF right-of-way, the measured noise levels ranged from 71 to 74 dBA L_{dn}.

South of Avenue 84, the Allensworth Bypass Alignment curves to the south in order to go around the Allensworth Historic Park and the Pixley Wildlife Refuge to the west. The Allensworth Bypass Alignment rejoins the BNSF Alternative at Whisler Road, just north of the city of Wasco. The Wasco-Shafter Bypass alignment curves to the southeast to avoid the cities of Wasco and Shafter, while the BNSF Alternative goes through the downtown areas of the cities of Wasco and Shafter, following the BNSF right-of-way as much as is practicable. The noise levels measured along the BNSF Alternative Alignment through these cities generally ranged from 70 to 79 dBA L_{dn}. These levels are very loud and reflect the proximity to an active freight rail line.

The Wasco-Shafter Bypass Alternative Alignment goes through agricultural land and through some of the least-populated areas along the alternative alignment. Noise levels measured along this alternative ranged from 54 to 61 dBA L_{dn}, which are levels to be expected in a quiet, rural environment. For the homes next to the well-traveled roadways, the noise levels ranged from 67 to 71 dBA L_{dn}.

South of Reina Road, the land uses transition from agricultural to residential, with several neighborhoods of single-family dwellings. Along this portion of the alternative alignments, noise measurements were conducted in the rear yards of homes that back up to the existing BNSF right-of-way. The noise levels measured at these homes ranged from 65 to 77 dBA L_{dn}. These levels are very high and are reflective of homes directly adjacent to a busy railroad line. Beyond this point, the BNSF line and the project alternatives turn east toward the freight yard and station at Bakersfield. The land uses here are urban: roadways, freeways, and rail lines dominate the noise environment. The noise measurements conducted near the alternative alignments and the proposed downtown Bakersfield station alternatives in this area ranged from 59 to 70 dBA $L_{dn,}$ which are consistent with an urban environment.

<u>Heavy Maintenance Facility Alternatives</u>

- Fresno Works – Fresno: The land uses in this area are primarily agricultural, with scattered housing units in the area. One of the homes adjacent to the existing railroad line experienced a noise level of 79 dBA L_{dn}. This site was dominated by train noise, with a total of 44 trains passing this location in a 24-hour period. Another home farther south that is approximately 900 feet from the existing railroad experienced a noise level of 58 dBA L_{dn}.
- Kings County – Hanford: The land uses in the area continue to be primarily agricultural with adjacent rural community. The measured ambient noise levels ranged from 47 to 63 dBA L_{dn}. These noise levels are consistent with a rural environment with some vehicular traffic.
- Kern Council of Governments – Wasco: The noise levels measured were generally ranged from 70 to 79 dBA L_{dn}. These levels are very loud and reflect the urban environment and the proximity to an active freight rail line.
- Kern Council of Governments – Shafter East: Noise levels generally ranged from 54 to 61 dBA L_{dn}, which are levels to be expected in a quiet, rural environment. For the homes next to the well-traveled roadways, the noise levels ranged from 67 to 71 dBA L_{dn}.
- Kern Council of Governments – Shafter West: Noise levels generally ranged from 54 to 61 dBA L_{dn}, which are levels to be expected in a quiet, rural environment. For the homes next to the well-traveled roadways, the noise levels ranged from 67 to 71 dBA L_{dn}.

B. EXISTING VIBRATION LEVELS

Project analysts identified vibration sensitive areas (VSAs) within the study area by locating the vibration-sensitive land use categories listed in Table 3.4-6 (i.e., residential and institutional) within an appropriate screening distance from the proposed HST alternatives. The screening distances used to identify VSAs are based on FRA guidance, as listed in Table 3.4-9. Some of these VSAs are exposed to existing sources of ground-borne vibration. The existing levels were measured by placing vibration sensors at representative vibration-sensitive locations throughout the corridor along the UPRR and BNSF tracks.

Vibration measurements were conducted at 9 locations representative of actual potentially impacted areas that were within 220 feet of a HST alternative alignment and within approximately 250 feet of an existing active rail line. The field vibration data were processed in an appropriate fashion for comparison with established FTA/FRA impact criteria (i.e., maximum event vibration level) and then compared with the value generated by the FTA general vibration assessment procedure (using the Generalized Ground Surface Vibration Curve for “locomotive powered passenger or freight”). The values calculated using this FTA method are described as representing the “upper range of measurement data for a well-maintained system,” so it is expected that the majority of the field measurements collected for this project would be at or below the FTA-predicted value.

Appendix 3.4-A NV Table 3 presents a summary of the vibration measurements, including measured vibration levels for various train-related vibration events and a comparison with predicted values using the FTA prediction method. Appendix D of the *Fresno to Bakersfield Section: Noise and Vibration Technical Report* (Authority and FRA 2011) provides additional detail on the field vibration measurements, including a sample of the field documentation procedures.

Appendix 3.4-A NV Table 3 shows the measured vibration levels were generally equal to or less than the levels predicted by the (conservative) FTA method (generally within about 0 to -8 VdB). Two of the nine measured locations (Vib-02 and Vib-07) displayed some vibration levels higher than those predicted by the FTA method. The apparently efficient vibration propagation characteristics at these two locations were taken into account during the impact assessment. Several events were more than 10 VdB lower than the predicted values. These results may have been due to either less efficient soil propagation characterizations at these locations or simply lower-than-predicted isolated events. The predicted levels included the expectation of flat spots on the wheels, which are common on mixed freight trains and much less so on Amtrak trains. Perhaps the lower levels were due to lower actual train speeds than those estimated in the field.

Overall, a majority of the measurements were between 70 and 80 VdB with the highest measured vibration level being 91.7 VdB and the lowest measurement being 59.1 VdB. Specific vibration measurements were not taken at the proposed station locations as none of the stations had sensitive receivers within the FRA screening distances. It is estimated that none of station alternatives are expected to have vibration levels above residential standards.

Heavy Maintenance Facility (HMF) Alternatives

Similar to the proposed station alternatives, none of the HMF alternative sites had sensitive receivers within the FRA screening distances. Therefore, it is estimated that none of HMF alternatives are expected to have vibration levels be above residential standards.

3.4.5 Environmental Consequences

A. OVERVIEW OF PROJECT IMPACTS

Operation of the HST along the Fresno to Bakersfield Section would increase noise levels above the ambient noise environment by as much as 22 dBA L_{dn} (Authority and FRA 2011). The results of the analysis showed potential for moderate to severe noise impacts for many of the receivers along the alternative alignments, according to the FRA impact criteria. For this analysis, a moderate impact according to the FRA impact criteria is considered to be a moderate effect under NEPA and a less than significant impact under CEQA. Severe impacts according to the FRA impact criteria are considered to be substantial effects under NEPA and significant impacts under CEQA. Operation impacts associated with (1) exposure of persons to noise levels in excess of standards established by the FRA and the FTA and (2) creation of a substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project would be substantial under NEPA and significant under CEQA. Tables 3.4-10 and 3.4-11 summarize the number of impacts by project alternative from HST and HMF operations.

Some land use sensitive receivers within 175 feet of the rail centerline would be adversely affected by vibration impacts during operation of the HST. The vibration impacts associated with exposure of persons to excessive ground-borne vibration levels are considered substantial under NEPA and significant under CEQA.

Table 3.4-10
Summary of Noise Impacts by Project Alternative from HST Operations

HST Alternative	Total Number of Impacts before Mitigation	
	Moderate	Severe
BNSF Alternative	11,194 residences, 44 churches, 32 schools, 2 hospitals, 9 parks	5,471 residences, 27 churches, 10 schools, 1 hospitals, 4 parks
Corcoran Elevated	1,763 residences, 4 churches, 4 school, 2 hospitals, 1 park	737 residences, 2 churches, 1 school, 1 park
Corcoran Bypass	331 residences, 2 schools,	231 residences, 2 schools
Allensworth Bypass	2 residences	None
Wasco-Shafter Bypass	330 residences, 3 churches, 1 school	192 residences
Bakersfield South Alternative	5,932 residences, 20 churches, 15 schools, 2 parks	2,470 residences, 11 churches, 4 schools, 1 hospital, 1 park
Source: Authority and FRA 2011.		

Table 3.4-11
Sensitive Noise Receivers Surrounding HMF Sites

Heavy Maintenance Facility	Within 900 feet
Fresno Works-Fresno	100
Kings County–Hanford	6
Kern Council of Governments–Wasco	327
Kern Council of Governments–Shafter East	6
Kern Council of Governments–Shafter West	8
Source: Authority and FRA 2011.	

There would be vibration effects on sensitive receivers from many of the alternatives during operation; however, none of the HMF sites would result in vibration impacts during operation. The numbers of sensitive receivers impacted by vibration are listed below.

- BNSF Alternative – 39 receivers.
- Corcoran Elevated Alternative – 0 receivers.
- Corcoran Bypass Alternative – 20 receivers.
- Allensworth Bypass Alternative – 1 receiver.

- Wasco-Shafter Bypass Alternative – 2 receivers.
- Bakersfield South Alternative – 14 receivers.

B. NO PROJECT ALTERNATIVE

Currently, many sources of noise and vibration exist throughout the HST corridor, as described in Section 3.4.4, Affected Environment. These sources, including the UPRR, BNSF, and San Joaquin Valley Railroad will continue to generate noise and vibration.

Freight trains currently operating along the BNSF between Fresno and Bakersfield would continue to operate without the HST System. According to the FRA Office of Safety (2010), BNSF has maintained 20 to 24 trains per day for the past 10 years; 12 of these trains have been Amtrak trains. The number of trains is not anticipated to vary from this amount in the 20-year planning horizon. While there may be increases in freight volume, a 100% increase in volume would be required for a 3 dB increase in future freight noise levels. Since the increases in freight volumes would likely be substantially below 100%, the noise increases would be minimal.

People would continue to experience noise and vibrations throughout the study area; however, exposure of people to or the generation of significant noise or vibration levels would not change because local general plans and noise and vibration ordinances are in place to ensure that standards are met.

C. HIGH-SPEED TRAIN ALTERNATIVES

Construction Period Impacts

Common Construction Noise Impacts

Alternative Alignments: By using the FTA criteria provided in Table 3.4-1 and the noise projections in Table 3.4-12, and assuming that construction noise reduces by 6 dB for each doubling of distance from the center of the site, it is possible to estimate the screening distances for potential construction noise impacts. These estimates suggest that the potential for construction noise impact will be minimal for commercial and industrial land use, with impacts screening distances of 79 feet and 45 feet, respectively. For residential land use, the potential for temporary construction noise impacts would be limited to locations within approximately 141 feet of the alignment. However, the potential for noise impacts from nighttime construction could extend to residences as far as 446 feet. These impacts are temporary during construction (see Chapter 2, Alternatives). Under these conditions potential effects would be moderate under NEPA and impacts would be significant under CEQA.

HMF Sites: By using the criteria provided in Table 3.4-1 and the noise projections in Table 3.4-12, and assuming that construction noise reduces by 6 dB for each doubling of distance from the center of the site, it is possible to estimate screening distances for potential construction noise impact. There are no construction noise impacts projected for any of the HMF sites.

Table 3.4-12
Typical Equipment Noise for Rail Construction

Equipment Item	Typical Maximum Sound Level at 50 feet (dBA)	Equipment Utilization Factor (%)	L_{eq} (dBA)
Air compressor	81	50	78
Backhoe	80	40	76
Crane, derrick	88	10	78
Bulldozer	85	40	81
Generator	81	80	80
Loader	85	40	81
Jackhammer	88	4	74
Shovel	82	40	78
Dump truck	88	16	80
Total Workday L_{eq} at 50 feet (8-hour workday)			**89**

Source: Authority and FRA 2011.
Acronyms:
dBA A-weighted decibel(s)
L_{eq} equivalent sound level

Common Construction Vibration Impacts

Alternative Alignments: During construction, some equipment may cause ground-borne vibrations, most notably pile-driving equipment. Construction equipment can produce vibration levels at 25 feet that range from 58 VdB for a small bulldozer to 112 VdB for a pile driver. Table 3.4-13 provides the approximate distances within which receivers could experience construction-related vibration effects.

Table 3.4-13
Approximate Distances to Vibration Criterion-Level Contours – Construction

Land Use Category	Vibration Criterion Level (VdB)	Approximate Vibration Contour Distance (feet)
Category 1[a]	65	175
Category 2	72	130
Category 3	75	70

Source: Authority and FRA 2011.
Note:
[a] See Table 3.4-4 for a description of the categories.
Acronym:
VdB vibration velocity level

Because there are receivers present within the distances identified in Table 3.4-13, the potential for vibration impacts during construction exists. These effects would be moderate under NEPA and impacts would be significant under CEQA.

HMF Sites: There would be no vibration impacts from construction at any of the proposed HMF sites.

Project Impacts

Moderate and Severe Noise Impacts

Project analysts assessed HST noise impacts for noise-sensitive land uses based on a comparison of existing noise levels with future noise levels from the project. The areas around the proposed stations in Fresno and Bakersfield are developed primarily with commercial and industrial land uses, with some residential land uses mixed in. The noise environments in these areas are dominated by traffic on the local streets, traffic on the freeways that surround the downtown areas, and train operations along rail lines.

Beginning in Fresno, the BNSF Alternative follows the BNSF right-of-way for approximately 12 miles through primarily agricultural lands. Along this portion of the BNSF Alternative, the measured ambient noise levels ranged from 64 to 77 dBA L_{dn}. These noise levels are what would be expected in areas near freight and passenger train operations. Noise measurements made along the alignment through Corcoran ranged from 64 to 81 dBA L_{dn}. These noise levels are consistent with what is expected for homes adjacent to commercial and industrial sites that are exposed to highway traffic and railroad operations.

The HST along the BNSF Alternative would result in substantial effects and significant impacts because a large number of sensitive receivers in the communities would be subjected to HST operational noise. Although the Corcoran, Allensworth, and Wasco-Shafter Bypasses would avoid most of the sensitive receivers in those areas, there would still be some substantial effects under NEPA and significant impacts under CEQA. Therefore, all alternatives would have noise impacts.

This evaluation is based on the information currently available. Project elements, such as the specific vehicle type, track structure, and other elements, may change during engineering and design, resulting in changes to the noise assumptions and the results of the impact assessment. As project elements affecting noise either change or are refined, additional analyses will be conducted to reflect these changes.

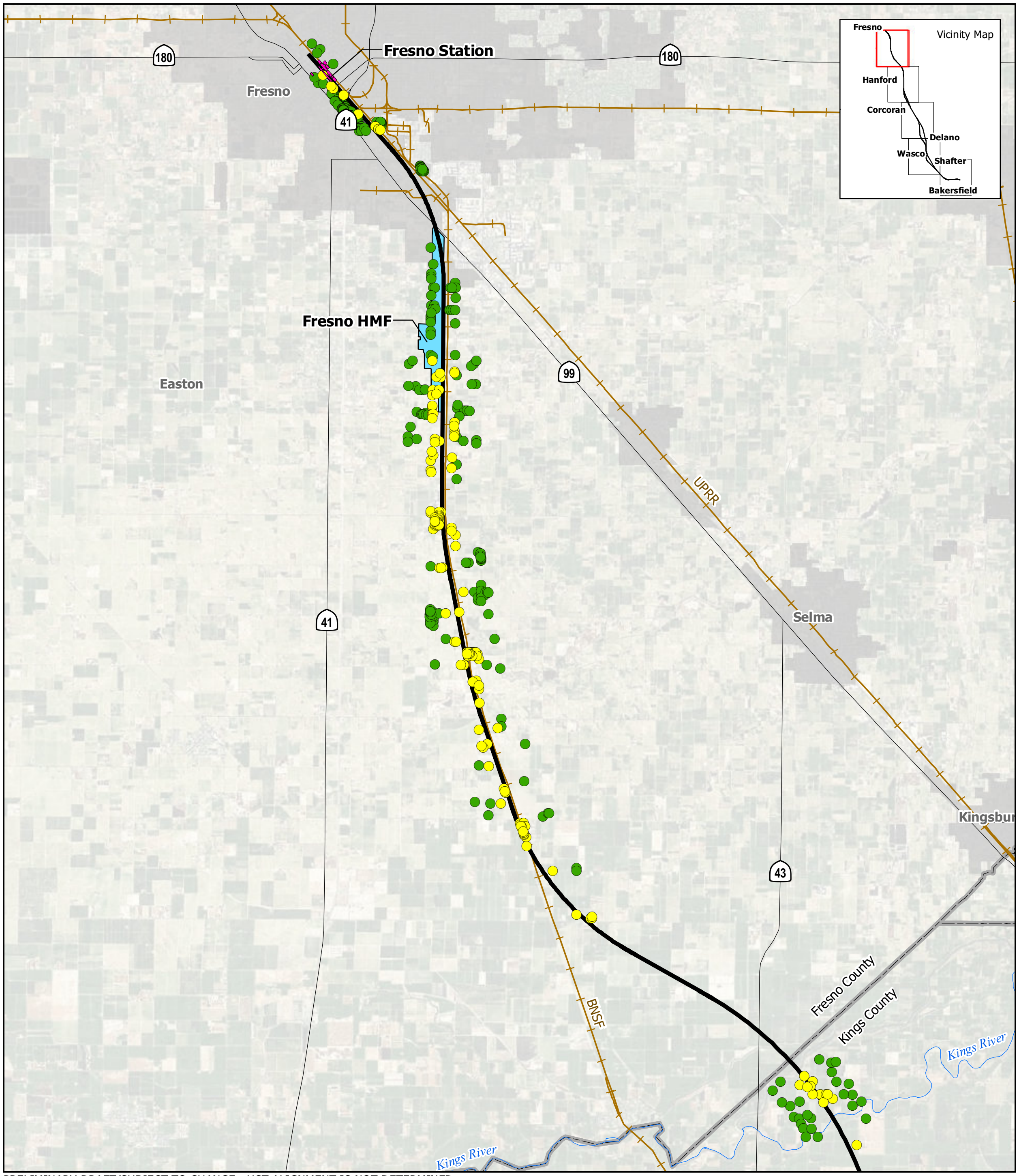
The following sections summarize the potential noise impacts from the operation of the HST System. The *Fresno to Bakersfield Section: Noise and Vibration Technical Report* provides more details regarding impacts (Authority and FRA 2011).

BNSF Alternative Alignment. Table 3.4-14 summarizes potential direct noise impacts related to operation of HSTs under the BNSF Alternative without mitigation during the design year (2035). Figures 3.4-9 through 3.4-13 show the locations of noise impacts under all HST alternative alignments without mitigation during the design year (2035). HST noise impacts are assessed for noise-sensitive land uses based on a comparison of existing noise levels with future noise levels from the project.

There would be substantial effects under NEPA and significant impacts under CEQA for many receivers along the BNSF Alternative Alignment, before consideration of mitigation. Table 3.4-14 lists the number of sensitive receivers along the BNSF Alternative Alignment that may receive noise impacts from operation of the proposed project.

Table 3.4-14
Impacted Sensitive Noise Receivers along the BNSF Alternative Alignment

BNSF Alternative Alignment	Total Number of Impacts	
	Moderate Impacts	**Severe Impacts**
Impacts by Alignment Segment		
Fresno (Distance for Moderate Impact = 500 to 1,325 feet), (Distance for Severe Impact = within 500 feet)	171 residences, 7 churches, 2 parks	20 residences
Hanford (Distance for Moderate Impact = 1,400 to 3,600 feet), (Distance for Severe Impact = within 1,400 feet)	420 residences, 1 church, 4 schools	329 residences, 1 church, 3 schools
Through Corcoran (Distance for Moderate Impact = 1,450 to 3,200 feet), (Distance for Severe Impact = within 1,450 feet)	1,632 residences, 4 churches, 4 schools, 2 hospitals, 1 parks	536 residences, 2 churches, 1 school, 1 park
Pixley (Distance for Moderate Impact = 1,000 to 2,300 feet), (Distance for Severe Impact = within 1,000 feet)	4 residences	2 residences
Through Allensworth (Distance for Moderate Impact = 900 to 1,700 feet), (Distance for Severe Impact = within 900 feet)	33 residences, 1 school, 1 park	30 residences, 1 park
Through Wasco-Shafter (Distance for Moderate Impact = 1,400 to 3,000 feet), (Distance for Severe Impact = within 1,400 feet)	2,624 residences, 10 churches, 8 schools, 1 park	1,831 residences, 13 churches, 2 schools, 1 park
Bakersfield (Distance for Moderate Impact = 1,300 to 2,700 feet), (Distance for Severe Impact = within 1,300 feet)	6,310 residences, 22 churches, 15 schools, 4 parks	2,723 residences, 11 churches, 4 schools, 1 hospital, 1 park
Total Impacts under the BNSF Alternative Alignment	**11,194 residences, 44 churches, 32 schools, 2 hospitals, 9 parks**	**5,471 residences, 27 churches, 10 schools, 1 hospital, 4 parks**
Source: Authority and FRA 2011.		



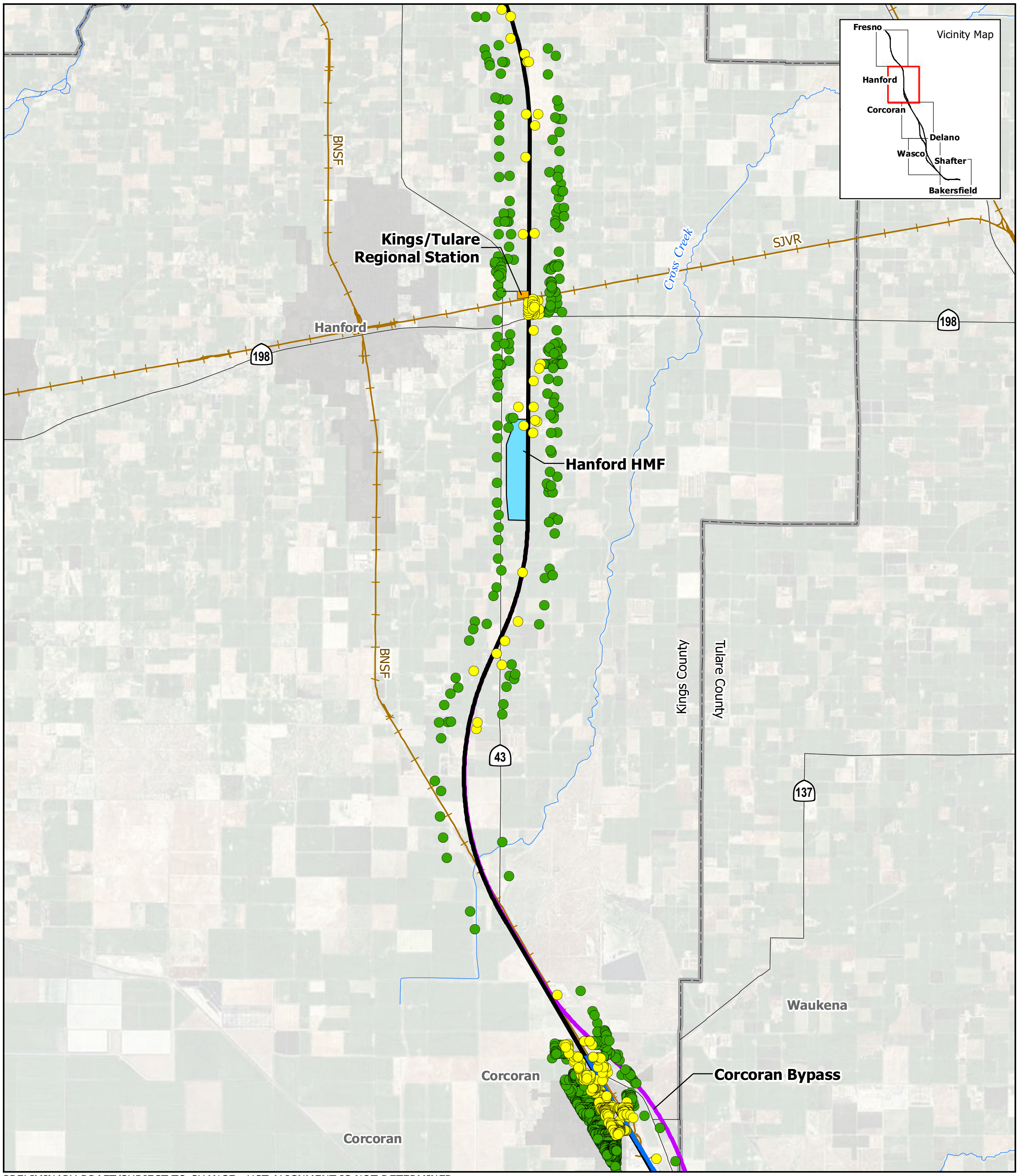
PRELIMINARY DRAFT/SUBJECT TO CHANGE - HST ALIGNMENT IS NOT DETERMINED

May 10, 2011

Data source: URS, 2011

Base map source: USGS National Elevation Dataset, 90-m hillshade

Figure 3.4-9
Fresno area:
Noise impacts

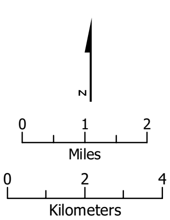


PRELIMINARY DRAFT/SUBJECT TO CHANGE - HST ALIGNMENT IS NOT DETERMINED

May 10, 2011

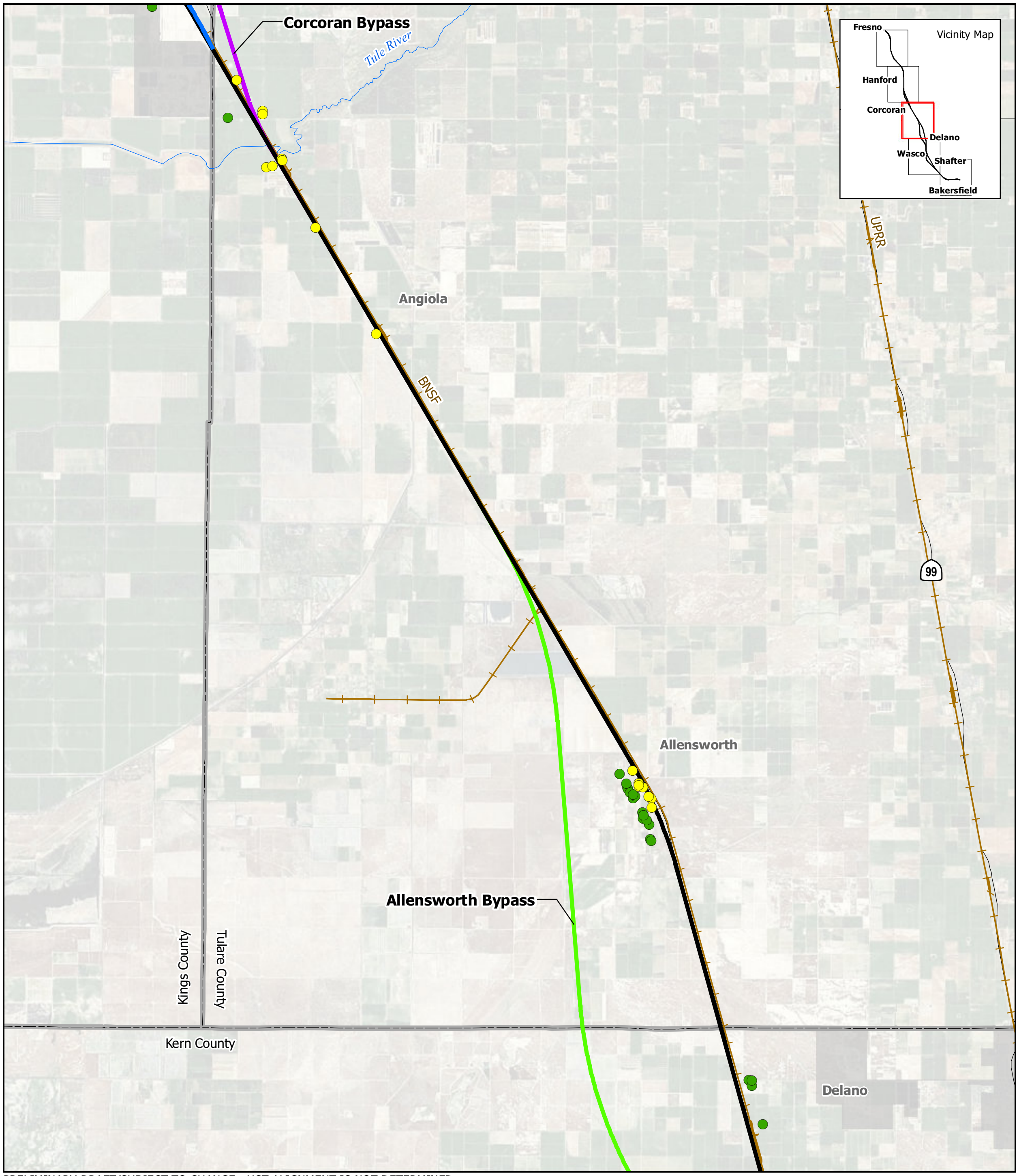
Data source: URS, 2011

Base map source: USGS National Elevation Dataset, 90-m hillshade



- BNSF Alternative (Bypasses labeled)
- Existing rail line
- Steam/River
- Highway
- Community/Urban area
- County boundary
- Potential heavy maintenance facility
- Proposed station
- Potential Kings/Tulare Regional Station
- Moderate noise impact location
- Severe noise impact location

Figure 3.4-10
Hanford area:
Noise impacts



PRELIMINARY DRAFT/SUBJECT TO CHANGE - HST ALIGNMENT IS NOT DETERMINED
Data source: URS, 2011
Base map source: USGS National Elevation Dataset, 90-m hillshade

May 10, 2011

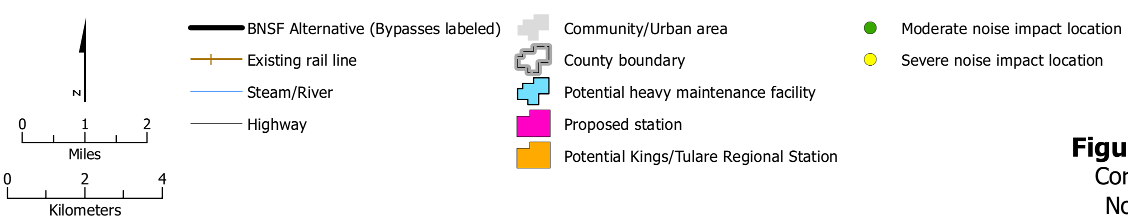
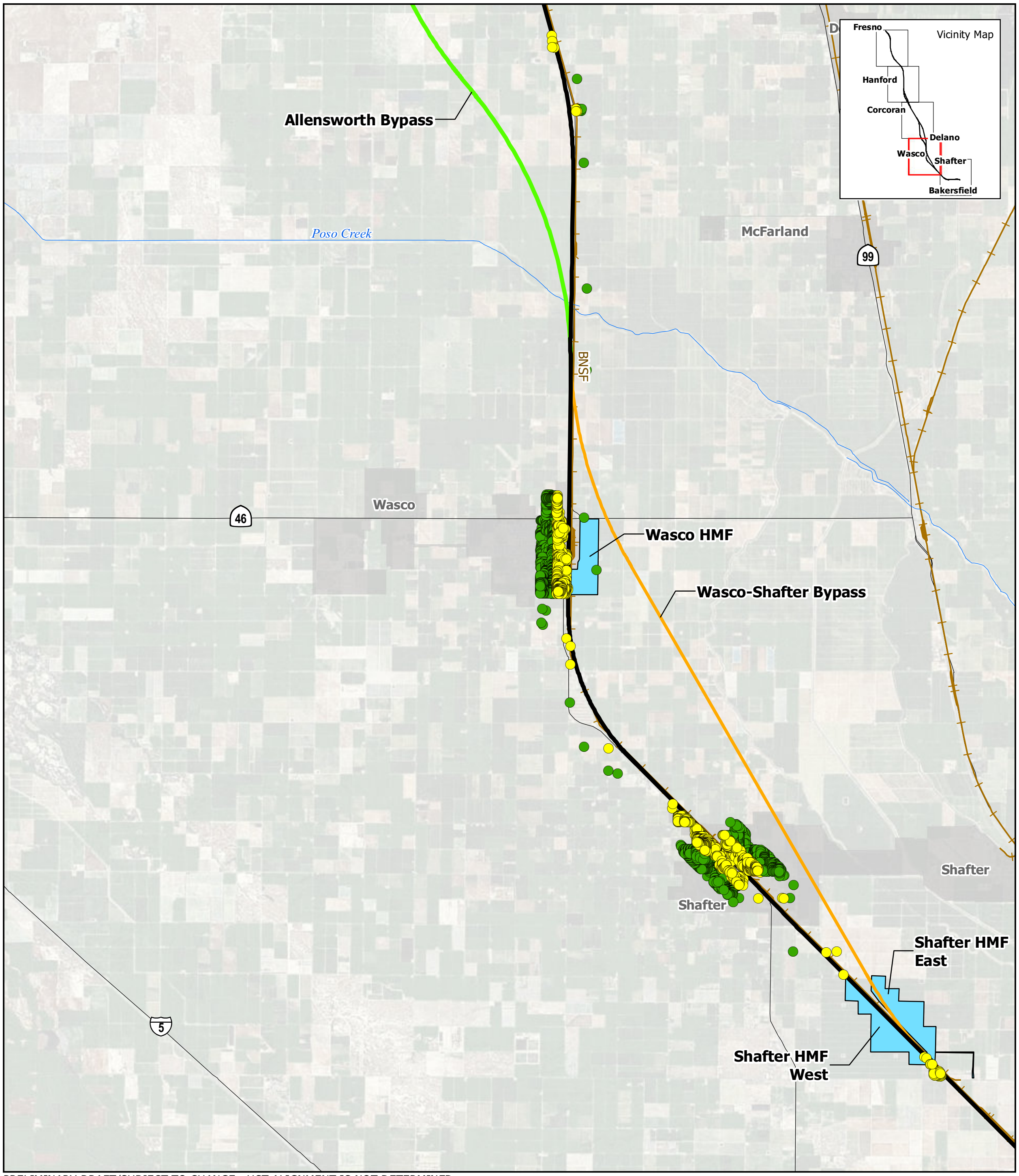


Figure 3.4-11
Corcoran area:
Noise impacts



PRELIMINARY DRAFT/SUBJECT TO CHANGE - HST ALIGNMENT IS NOT DETERMINED

May 10, 2011

Data source: URS, 2011

Base map source: USGS National Elevation Dataset, 90-m hillshade

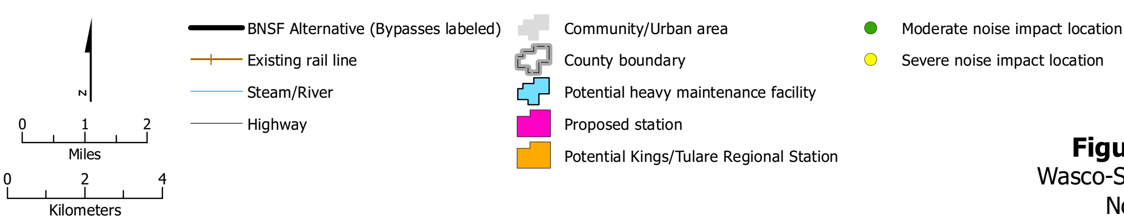
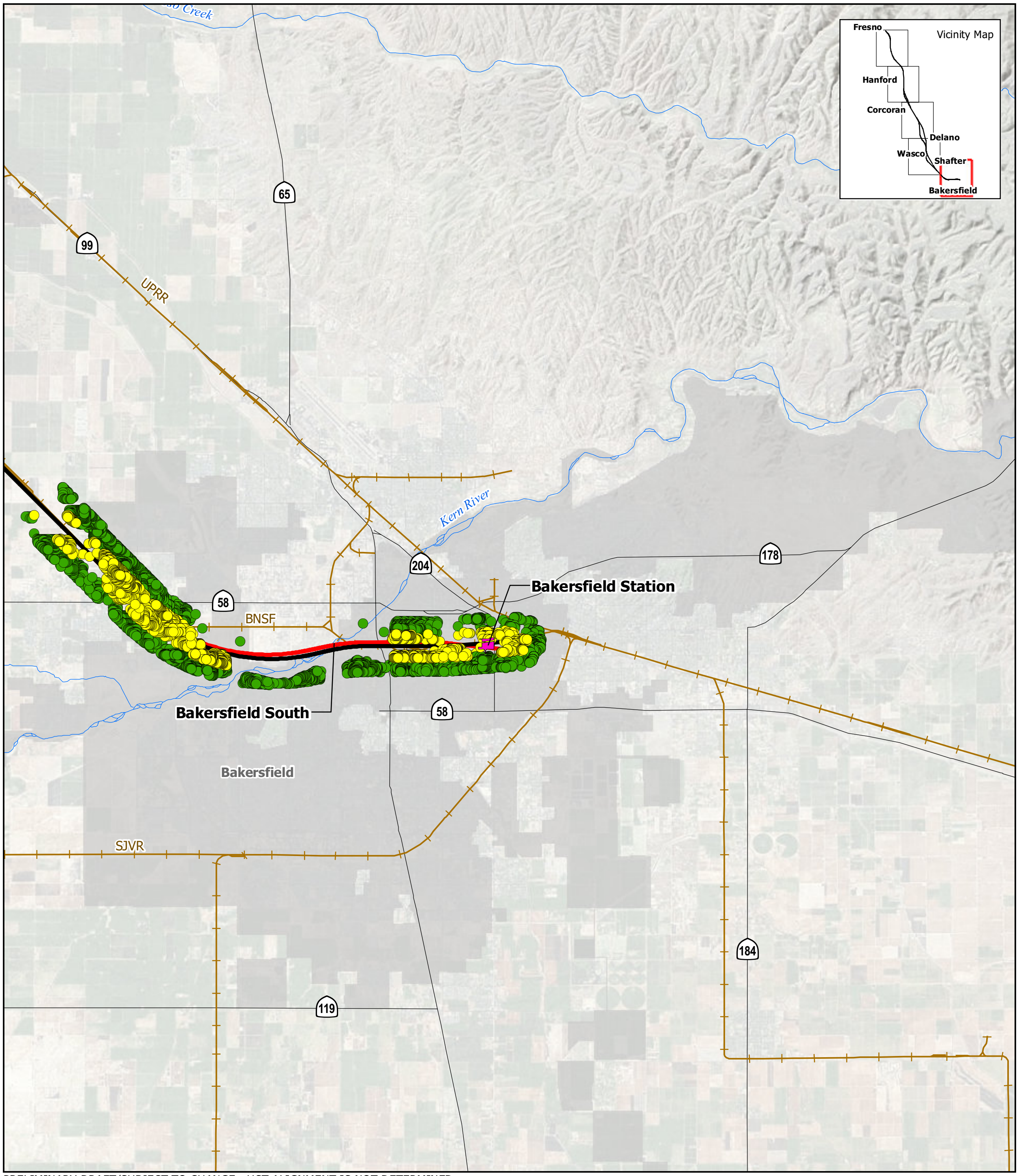


Figure 3.4-12
Wasco-Shafter area:
Noise impacts



PRELIMINARY DRAFT/SUBJECT TO CHANGE - HST ALIGNMENT IS NOT DETERMINED

May 10, 2011

Data source: URS, 2011

Base map source: USGS National Elevation Dataset, 90-m hillshade

BNSF Alternative (Bypasses labeled)
Existing rail line
Steam/River
Highway
Community/Urban area
County boundary
Potential heavy maintenance facility
Proposed station
Potential Kings/Tulare Regional Station
Moderate noise impact location
Severe noise impact location

N

0 1 2 Miles

0 2 4 Kilometers

Figure 3.4-13
Bakersfield area:
Noise impacts

Appendix 3.4-A NV Tables 4 and 5 show the potential noise impacts from the BNSF Alternative without mitigation for the design year (2035) at each of the locations where existing noise measurements were conducted. These two tables show the measurement sites and the distance from the receiver to the BNSF Alternative. These two tables also show the source height, land use type, measured existing noise level, projected HST noise level, and the moderate and severe impact criteria. The projected HST noise level is compared with the impact criteria to determine the locations with impacts. Finally, the two tables show the total noise level with the project, the projected noise level increase with the project, and whether there is no impact, moderate impact or severe impact due to the HST project.

Corcoran Elevated Alternative Alignment. There would be substantial effects under NEPA and significant impacts under CEQA for many of the receivers along the Corcoran Elevated Alternative Alignment, before consideration of mitigation. Table 3.4-15 lists the number of sensitive receivers along the Corcoran Elevated Alternative that may receive moderate or severe noise impacts from operation of the proposed project. There are 201 additional severe noise impact receivers and 131 additional moderate noise impact receivers with this alternative, compared with those of the corresponding portion of the BNSF Alternative. Appendix 3.4-A NV Tables 6 and 7 list the potential noise impacts under the Corcoran Elevated Alternative Alignment without mitigation for the design year (2035) at each of the locations where existing noise measurements were conducted.

Table 3.4-15
Sensitive Noise Receivers along the Corcoran Elevated Alternative Alignment

Section	Moderate Impacts	Severe Impacts
Corcoran Bypass Elevated Alternative (Distance for Moderate Impact = 1,800 to 3,600 feet); (Distance for Severe Impact = within 1,800 feet)	1,763 residences, 4 churches, 4 schools, 2 hospitals, 1 park	737 residences, 2 churches, 1 school, 1 park
Source: Authority and FRA 2011.		

Corcoran Bypass Alternative Alignment. There would be substantial effects under NEPA and significant impacts under CEQA for many of the receivers along the Corcoran Bypass Alternative Alignment, before consideration of mitigation. Table 3.4-16 lists the number of sensitive receivers along the Corcoran Bypass Alternative that may receive moderate or severe noise impacts from operation of the proposed project. There are 307 fewer severe noise impact receivers and 1,310 fewer moderate noise impact receivers with this alternative, compared with those of the corresponding portion of the BNSF Alternative. Appendix 3.4-A NV Tables 8 and 9 list the potential noise impacts under the Corcoran Bypass Alternative Alignment without mitigation for the design year (2035) at each of the locations where existing noise measurements were conducted.

Table 3.4-16
Sensitive Noise Receivers along the Corcoran Bypass Alternative Alignment

Section	Moderate Impacts	Severe Impacts
Corcoran Bypass Alternative (Distance for Moderate Impact = 1,450 to 3,200 feet); (Distance for Severe Impact = within 1,450 feet)	331 residences, 2 schools	231 residences, 2 schools
Source: Authority and FRA 2011.		

Allensworth Bypass Alternative Alignment. There would be negligible effects under NEPA and less-than-significant impacts under CEQA for two receivers along the Allensworth Bypass Alternative Alignment, according to the FRA impact criteria. Table 3.4-17 lists the number of sensitive receivers along the Allensworth Bypass Alternative that may receive moderate noise impacts from operation of the proposed project. There are 31 fewer severe noise impact receivers and 33 fewer moderate noise impact receivers with this alternative, compared with those of the corresponding portion of the BNSF Alternative. Appendix 3.4-A NV Tables 10 and 11 list the potential noise impacts under the Allensworth Bypass Alternative Alignment without mitigation for the design year (2035) at each of the locations where existing noise measurements were conducted.

Table 3.4-17
Sensitive Noise Receivers along the Allensworth Bypass Alternative Alignment

Section	Moderate Impacts	Severe Impacts
Allensworth Bypass Alternative (Distance for Moderate Impact = 900 to 1,700 feet); (Distance for Severe Impact = within 900 feet)	2 residences	None
Source: Authority and FRA 2011.		

Wasco-Shafter Bypass Alternative Alignment. There would be substantial effects under NEPA and significant impacts under CEQA for many of the receivers along the Wasco-Shafter Bypass Alternative Alignment, before consideration of mitigation. Table 3.4-18 lists the number of sensitive receivers along the Wasco-Shafter Bypass Alternative that may receive moderate or severe noise impacts from operation of the proposed project. There are 1,655 fewer severe noise impact receivers and 2,309 fewer moderate noise impact receivers with this alternative, compared with those of the corresponding portion of the BNSF Alternative. Appendix 3.4-A NV Tables 12 and 13 list the potential noise impacts under the Wasco-Shafter Bypass Alternative Alignment without mitigation for the design year (2035) at each of the locations where existing noise measurements were conducted.

Table 3.4-18
Sensitive Noise Receivers along the Wasco-Shafter Alternative Alignment

Section	Moderate Impacts	Severe Impacts
Wasco-Shafter Bypass Alternative (Distance for Moderate Impact = 1,400 to 2,700 feet); (Distance for Severe Impact = within 1,400 feet)	330 residences, 3 churches, 1 school	192 residences
Source: Authority and FRA 2011.		

Bakersfield South Alternative Alignment. There would be substantial effects under NEPA and significant impacts under CEQA for many of the receivers along the Bakersfield South Alternative Alignment, before consideration of mitigation. Table 3.4-19 lists the number of sensitive receivers along the Bakersfield South Alternative that may receive moderate or severe noise impacts from operation of the proposed project. There are no additional severe noise impact receivers and 382 fewer moderate noise impact receivers with this alternative, compared with those of the corresponding portion of the BNSF Alternative. Appendix 3.4-A NV Tables 14 and 15 list the potential noise impacts under the Bakersfield South Alternative Alignment without mitigation for the design year (2035) at each of the locations where existing noise measurements were conducted.

Table 3.4-19
Sensitive Noise Receivers along the Bakersfield South Alternative Alignment

Section	Moderate Impacts	Severe Impacts
Bakersfield South Alternative (Distance for Moderate Impact = 1,300 to 2,700 feet); (Distance for Severe Impact = within 1,300 feet)	5,932 residences, 20 churches, 15 schools, 2 parks	2,723 residences, 11 churches, 4 schools, 1 hospital, 1 park
Source: Authority and FRA 2011.		

HMF Sites. According to the noise standards listed in the California Noise and Land Use Capability Matrix, it is typical for industrial land uses to generate noise levels as high as 75 dBA at 50 feet from the noise source. As shown on Figure 3.4-3, any noise level above 50 dBA would result in a moderate or severe impact on sensitive receivers for Category 1 and 2 land uses (e.g., residences and buildings where people normally sleep). For noise levels to be below 50 dBA, a receiver would need to be at least 900 feet from the noise source. Table 3.4-11 (above) lists the number of sensitive receivers within 900 feet of each proposed heavy maintenance facility site that would have severe impacts according to the FRA impact criteria. Each HMF has residences within the 900-foot contour line and therefore all HMFs have substantial effects under NEPA and significant impacts under CEQA.

Annoyance from Onset of HST Pass-bys

There is considerable evidence that increased annoyance is likely to occur for train noise events with rapid onset rates. The relationship between speed and distance defines the locations where the onset rate for HST operations can cause annoyance or surprise according to the FRA guidance manual (FRA 2005). For the most part, the potential for increased annoyance for is confined to an area very close to the tracks. In the Fresno to Bakersfield Section, the maximum train speeds would be 220 mph. At this speed, the distance from the centerline of the tracks within which annoyance or surprise can occur would be 45 feet, which is within the project right-of-way where people and animals will be excluded with fencing. For these reasons, rapid onset noise events are considered to be negligible effects under NEPA and less than significant impacts under CEQA.

Noise Effects on Wildlife and Domestic Animals

FRA also addresses the impacts of the HST on wildlife (mammals and birds) and domestic animals (livestock and poultry). The noise exposure limit for each type of animal is an SEL of 100 dBA from passing trains. The SEL represents a receiver's cumulative noise exposure from an event and represents the total A-weighted sound during the event normalized to a 1-second interval.

A screening assessment determined typical and maximum distances from the HST tracks at which this limit may be exceeded. Project analysts computed train pass-by SELs for two conditions: at-grade and on a 60-foot-high elevated guideway. To provide a conservative estimate, in each case the HST maximum operating speed of 220 mph was used, and no shielding from intervening structures or terrain was assumed.

Table 3.4-20 indicates that along at-grade sections, the screening distance (i.e., distance from trackway centerline within which an impact could result) for a single-train pass-by SEL of 100 dBA would be approximately 100 feet from the track centerline. In elevated guideway locations, a single-train pass-by SEL of 100 dBA would not occur beyond the edge of the structure, approximately 15 feet from the track centerline. This assumes the presence of a safety barrier on the edge of the guideways that is 3 feet above the top of the rail height, as detailed in typical cross sections.

For reference, Table 3.4-20 also shows the screening distances for potential wildlife/domestic animal impacts from freight trains that currently use the UPRR and BNSF tracks. The distance to an impact for a freight train is 75 feet when the warning horn is not sounded and 400 feet when the crossing is at–grade and the horn is sounded. These screening distances assume a freight train consisting of two locomotives and 100 railcars traveling at 50 mph, which is typical for trains on the UPRR and BNSF tracks.

According to the screening distance information provided in Table 3.4-20, wildlife and domestic animals might be within the screening distance for an at-grade HST (i.e., within 100 feet in both directions from the track centerline [for a total width of 200 feet]). Because fences control access to the right-of-way and the right-of-way would be 100 feet wide in rural locations, wildlife and domestic animals would have to be within approximately 50 feet of the edge of the right-of-way to experience noise effects above the recommended threshold. This issue would primarily occur where wildlife migration routes cross the HST right-of-way along at-grade locations. At locations adjacent to the UPRR, BNSF, or SR 99 where the existing noise is already high, there would be no effects under NEPA and no impacts under CEQA. However, in rural areas there could be impacts. These impacts are discussed in Section 3.7, Biological Resources and Wetlands, and Section 3.14, Agricultural Lands.

Table 3.4-20
Screening Distances for Effects on Wildlife and Domestic Animals

Track Location	Speed (mph)	SEL[a] (dBA)	Distance from Trackway Centerline Where Impacts Could Result (feet)
HST at-grade	220	100	100
HST 60-foot-high elevated structure	220	100	15[b]
Freight train, no horn noise	50	100	75
Freight train, sounding horn at-grade crossing	50	100	400

Source: Authority and FRA 2011.

Notes:
[a] The SEL represents a receiver's cumulative noise exposure from an event and represents the total A-weighted sound during the event normalized to a 1-second interval. This noise descriptor is used to assess effects on wildlife and domestic animals.

[b] These projections assume a safety barrier on the edge of the aerial structure as shown in typical cross sections (see Chapter 2, Alternatives). The safety barrier is assumed to be 3 feet above the top of rail height and 15 feet from the track centerline.

Acronyms:
dBA A-weighted decibel(s)
mph mile(s) per hour
SEL sound exposure level

Project Vibration

The FRA guidelines provide ground-borne vibration impact criteria as shown in Table 3.4-6 (FRA 2005). These levels represent the maximum RMS level of an event.

Table 3.4-21 provides the distances to the calculated vibration contours for the three land use categories for frequent events, assuming an HST speed of 220 mph. Vibration impacts associated with exposure of persons to excessive ground-borne vibration levels can be perceptible and intrusive to building occupants and can cause secondary rattling of windows, items on shelves, and pictures hanging on walls but would not cause damage to structures.

BNSF Alternative Alignment. There would be substantial vibration effects under NEPA and significant impacts under CEQA on 86 receivers along the BNSF Alternative Alignment. Category 1, 2, and 3 land use sensitive receivers within the approximated vibration contour distances of the BNSF Alternative centerline are presented in Table 3.4-22.

Corcoran Elevated Alternative Alignment. There would be 11 fewer sensitive receivers affected by this alternative, compared with those affected by the corresponding portion of the BNSF Alternative. There would be no vibration effects under NEPA and no impacts under CEQA.

Corcoran Bypass Alternative Alignment. There would be nine additional sensitive receivers affected by this alternative, compared with those affected by the corresponding portion of the BNSF Alternative. There would be substantial vibration effects under NEPA and significant impacts under CEQA.

Allensworth Bypass Alternative Alignment. There would be the same number of sensitive receivers affected by this alternative compared with those affected by the corresponding portion of the BNSF Alternative. There would be substantial vibration effects under NEPA and significant impacts under CEQA.

Table 3.4-21
Approximate Distances to Vibration Criterion Level Contours

Land Use Category	Vibration Criterion Level (VdB)	Approximated Vibration Contour Distance (feet)	
		At Grade	Elevated
Category 1	65	190	62
Category 2	72	86	28
Category 3	75	62	20

Source: Authority and FRA 2011.

Acronym:
VdB vibration velocity level

Table 3.4-22
Sensitive Vibration Receivers along the BNSF Alternative Alignment

BNSF Alternative Alignment Section	Number of Sensitive Receivers
Fresno	1 residences
Hanford	8 residences
Through Corcoran	11 residences
Pixley	None
Through Allensworth	1 residences
Through Wasco-Shafter	5 residences
Bakersfield	14 residences

Source: Authority and FRA 2011.

Wasco-Shafter Bypass Alternative Alignment. There would be three fewer sensitive receivers affected by this alternative, compared with those affected by the corresponding portion of the BNSF Alternative. There would be substantial vibration effects under NEPA and significant impacts under CEQA.

Bakersfield South Alternative Alignment. There would be the same number of sensitive receivers affected by this alternative, compared with those affected by the corresponding portion of the BNSF Alternative. There would be substantial vibration effects under NEPA and significant impacts under CEQA.

HMF Sites. Operation of the heavy maintenance facility would not require equipment that would create ground-borne vibrations. Because this type of this equipment would not be used at these sites, nearby sensitive receivers would not experience any vibrations as a result of the operation of the heavy maintenance facility. There would be no vibration effects under NEPA and no impacts under CEQA.

Traffic Noise

Implementation of the HST will cause increased traffic volumes in the areas around the station locations and changes in traffic patterns in areas where streets would be closed. The three major areas where traffic volumes would be increased would be around the city of Fresno, east of the city of Hanford, and in the city of Bakersfield. One additional area where roadways would be closed or realigned is in the city of Corcoran. Future traffic conditions with and without the HST project are compared in order to analyze the change in noise levels due to the increase in ADT volumes or changes in the peak hour traffic volumes in these four cities. Estimated traffic volumes for the year 2035 were obtained from the project traffic study and are used in this analysis.

Thirty seven major roadway segments in the city of Fresno were analyzed. An increase in traffic volume is expected for about half of the roadway segments. All of the increases in traffic volume would increase the future dBA L_{dn} values by 0.5 dBA or less. This slight increase would result in a negligible effect under NEPA and a less than significant impact under CEQA. The majority of roadways analyzed for increases in peak hour traffic show no increase. A few of the roadways show a 1 dB increase in noise, and the greatest increase would be at the intersection of Van Ness Avenue and California Avenue which shows a peak hour increase of 5 dB. These increases are not considered to be significant according to FHWA standards; therefore they would result in a negligible effect under NEPA and a less than significant impact under CEQA.

Thirteen major roadway segments in the area around the proposed Kings/Tulare Regional Station were analyzed. An increase in traffic volume is expected for many of the roadway segments. All of the increases in traffic volume would result in an increase in the future dBA L_{dn} values by 0.7 dBA or less. This slight increase would result in a negligible effect under NEPA and a less than significant impact under CEQA.

Four major roadway intersections in the city of Corcoran were analyzed. An increase in peak hour traffic is expected on most of these roadway segments. All of the increases in traffic volume would result in the peak hour traffic noise level by 1 to 7 dB. These increases are not considered to be significant according to FHWA standards, therefore would result in a negligible effect under NEPA and a less than significant impact under CEQA.

Forty seven major roadway segments in the city of Bakersfield were analyzed. An increase in traffic volume is expected for approximately half of the roadway segments. All of the increases in traffic volume would result in an increase in the future dBA L_{dn} values by less than 1 dBA. This slight increase would result in no impact under CEQA and a negligible impact under NEPA. The majority of roadways analyzed for increases in peak hour traffic show no increase, and a few of the roadways show a 1 dB increase in noise. These increases are not considered to be significant according to FHWA standards, therefore would result in a negligible effect under NEPA and a less than significant impact under CEQA.

3.4.6 Mitigation Measures

The Authority and FRA have considered avoidance and minimization measures consistent with the Statewide and Bay Area to Central Valley Program EIR/EIS commitments. FTA 2006 and FRA 2005 impact assessment guides have guidelines that will be followed during construction. In addition, the following mitigation measures are available to compensate for impacts that cannot be minimized or avoided. The Authority has developed proposed Noise and Vibration Mitigation Guidelines that identify criteria by which noise and vibration mitigation would be deemed effective. The proposed Noise and Vibration Mitigation Guidelines are included as Appendix 3.4-A.

A. CONSTRUCTION PERIOD

N&V-MM#1: Construction noise mitigation measures. Monitor construction noise to verify compliance with the noise limits. Provide the contractor the flexibility to meet the FRA construction noise limits in the most efficient and cost-effective manner. The contractor would have the flexibility of either prohibiting certain noise-generating activities during nighttime hours or providing additional noise control measures to meet the noise limits. To meet required noise limits, the following noise control mitigation measures will be implemented as necessary, for nighttime and daytime:

- Install a temporary construction site sound barrier near a noise source.
- Avoid nighttime construction in residential neighborhoods.
- Locate stationary construction equipment as far as possible from noise-sensitive sites.
- Re-route construction-related truck traffic along roadways that will cause the least disturbance to residents.
- During nighttime work, use smart back-up alarms, which automatically adjust the alarm level based on the background noise level, or switch off back-up alarms and replace with spotters.
- Use low-noise emission equipment.
- Implement noise-deadening measures for truck loading and operations.
- Monitor and maintain equipment to meet noise limits.
- Line or cover storage bins, conveyors, and chutes with sound-deadening material.
- Use acoustic enclosures, shields, or shrouds for equipment and facilities.
- Use high-grade engine exhaust silencers and engine-casing sound insulation.
- Prohibit aboveground jackhammering and impact pile driving during nighttime hours.
- Minimize the use of generators to power equipment.
- Limit use of public address systems.
- Grade surface irregularities on construction sites.
- Use moveable sound barriers at the source of the construction activity.
- Limit or avoid certain noisy activities during nighttime hours.

To mitigate noise related to pile driving, the use of an auger to install the piles instead of a pile driver would reduce noise levels substantially. If pile driving is necessary, limit the time of day that the activity can occur.

N&V-MM#2: **Construction vibration mitigation measures**. Building damage from construction vibration is only anticipated from impact pile driving at very close distances to buildings. If piling occurs more than 25 to 50 feet from buildings, or if alternative methods such as push piling or auger piling can be used, damage from construction vibration is not expected to occur. Other sources of construction vibration do not generate high enough vibration levels for damage to occur. Typically, once a construction scenario has been established, preconstruction surveys are conducted at locations within 50 feet of piling to document the existing condition of buildings in case damage is reported during or after construction. Damaged buildings would be repaired or compensation paid.

B. PROJECT

Noise

N&V-MM#3: Implement Proposed California High-Speed Train Project Noise Mitigation Guidelines. Figures 3.4-9 through 3.4-13 show the severe noise impact locations where the noise mitigation guidelines would be applied. Various options exist to address the potentially severe noise effects from HSTs. After receiving input from local jurisdictions and balancing technological factors, such as structural and seismic safety, cost, number of affected receptors, and effectiveness, mitigation measures would be selected and implemented. For example, where moderate increases in noise affect receptors, noise-reducing measures could be implemented, even though not required. Conversely, in rural areas devoid of receptors where severe noise effects are anticipated, it might be appropriate and acceptable not to apply any noise-reducing treatments. The noise guidelines include the following mitigation measures:

- Install sound barriers. Depending on the height and location relative to the tracks, sound barriers can achieve between 5 and 15 dB of noise reduction. The primary requirements for an effective sound barrier are that the barrier must (1) be high enough and long enough to break the line-of-sight between the sound source and the receiver, (2) be of an impervious material with a minimum surface density of 4 pounds per square foot, and (3) not have any gaps or holes between the panels or at the bottom. Because many materials meet these requirements, aesthetics, durability, cost, and maintenance considerations usually determine the selection of materials for sound barriers (examples are shown in Figure 3.4-14 below). Depending on the situation, sound barriers can become visually intrusive. Typically, the sound barriers style is selected with input from the local jurisdiction to reduce the visual effect of barriers on adjacent lands uses. For example, sound barriers could be solid or transparent, and made of various colors, materials, and surface treatments.

  The minimum number of affected sites should be at least 10, and the length of a sound barrier should be at least 800 feet. The maximum sound barrier height would be 14 feet for at-grade sections; however, all sound barriers would be designed to be as low as possible to achieve a substantial noise reduction. Berm and berm/wall combinations are the preferred types of sound barriers where space and other environmental constraints permit. On aerial structures, the maximum sound barrier height would also be 14 feet, but barrier material would be limited by engineering weight restrictions for barriers on the structure. Sound barriers on the aerial structure will still be designed to be as low as possible to achieve a substantial noise reduction. Sound barriers on both aerial structures and at-grade structures could consist of solid, semitransparent, or transparent materials.

- Work with the communities to determine how the use and height of sound barriers would be determined using jointly developed performance criteria. Other solutions may result in higher numbers of residual impacts than reported herein. Options may be to reduce the height of sound barriers and combine barriers with sound insulation or to accept higher noise thresholds than the FRA's current noise thresholds. Secondary impacts could potentially occur where sound barriers are installed. Changes to visual and aesthetic qualities and the existing environment might occur, which are addressed in Chapter 3.16, Aesthetics and Visual Resources.

- Install building sound insulation. Sound insulation of residences and institutional buildings to improve the outdoor-to-indoor noise reduction is a mitigation measure that can be provided when the use of sound barriers is not feasible in providing a reasonable level (5 to 7 dB) of noise reduction. Although this approach has no effect on noise in exterior areas, it may be the best choice for sites where sound barriers are not feasible or desirable and for buildings where indoor sensitivity is of most concern. Substantial improvements in building sound insulation (on the order of 5 to 10 dB) can often be achieved by adding an extra layer of glazing to windows, by sealing holes in exterior surfaces that act as sound leaks, and by providing forced ventilation and air conditioning so that windows do not need to be opened. Performance criteria would be established to balance existing noise events and ambient roadway noise conditions as factors for determining mitigation measures.

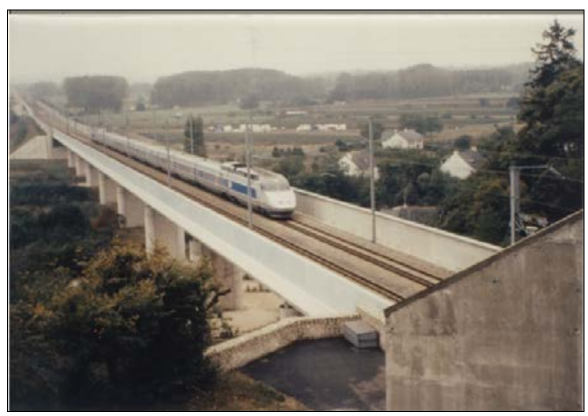
- Acquire easements on properties severely affected by noise. Another option for mitigating noise impacts is for the authority to acquire easements on residences likely to be impacted by HST operations in which the homeowners would accept the future noise conditions. This approach is usually taken only in isolated cases where other mitigation options are infeasible, impractical, or too costly.

Tables 3.4-23 through 3.4-26 show the number and length of sound barriers that would be cost effective for the Fresno to Bakersfield Section alternatives based on implementation of the noise mitigation guidelines. Figures 3.4-15 through 3.4-19 show the locations of potential sound barriers along the project alternatives.

(a) Denver, Colorado

(b) Slovenia, Italy

(c) Sha Tin, Hong Kong



(d) Loire Valley, France

Figure 3.4-14
Examples of sound barriers for rail corridors

(Photographs courtesy of Harris Miller Miller & Hanson Inc.)

Table 3.4-23
Potential Sound Barrier Mitigation for Operational Noise for BNSF Alternative

Receiver Location		Total Length (feet)	Barrier Height[a] (feet)	Impacted or Benefited Receivers	Number of Severe Residual Impacts
Fresno Area					
No sound barrier mitigation proposed for the Fresno Area					20
Hanford Area					
No sound barrier mitigation proposed for the Hanford Area					333
Corcoran Area					
North of Newark Ave to south of Oregon Ave	Southbound track	18,000	14	377	45
North of Newark Ave to south of Sherman Ave	Northbound track	10,500	14	118	0
Pixley Area					
No sound barrier mitigation proposed for the Pixley Area					2
Allensworth Area					
No sound barrier mitigation proposed for the Allensworth Area					31
Wasco-Shafter Area					
City of Wasco - McCombs Ave south to Jackson Ave	Southbound track	16,031	14	617	2
City of Shafter - north of Mayer Ln at the north of Shafter south ending before E. Los Angeles Ave	Southbound track	14,572	14	439	52
South of Renfro Rd to Hageman Rd	Southbound track	3,924	14	61	5
Paso Robles Hwy (SR 46) south to Poso Ave (Wasco)	Northbound track	5,188	14	209	1
South of Fresno Ave south to E Ash Ave (Shafter)	Northbound track	9,955	14	335	0
North of Reina Rd to Hageman Rd	Northbound track	7,359	14	126	0

Table 3.4-23
Potential Sound Barrier Mitigation for Operational Noise for BNSF Alternative

Receiver Location		Total Length (feet)	Barrier Height[a] (feet)	Impacted or Benefited Receivers	Number of Severe Residual Impacts
Bakersfield Area					
Hageman Rd to north of Palm Ave	Southbound track	12,135	14	548	0
North of Palm Ave to south Coffee Rd	Southbound track	9,654	14	404	0
West of Interstate 99 to Baker St	Southbound track	14,964	14	364	0
Hageman Rd to north of Palm Ave	Northbound track	6,466	14	602	0
North of Palm Ave to south of Calloway	Northbound track	6,114	14	202	0
West of Interstate 99 to Chester Ave	Northbound track	7,808	14	278	0
Q St to Baker St	Northbound track	4,842	14	72	0
Total					
		147,512	14	5,022	491

Source: Authority and FRA 2011.
Notes:
[a] Height above top-of-rail.

Table 3.4-24
Potential Mitigation for Operational Noise for Corcoran Elevated

Receiver Location		Total Length (feet)	Barrier Height[a] (feet)	Impacted or Benefited Receivers	Number of Severe Residual Impacts
North of Newark Ave to south of Oregon Ave	Southbound track	18,000	14	581	0
North of Newark Ave to south of Sherman Ave	Northbound track	14,000	14	160	0

Source: Authority and FRA 2011.
Note:
[a] Height above top-of-rail.

Table 3.4-25
Potential Mitigation for Operational Noise for Wasco-Shafter Bypass

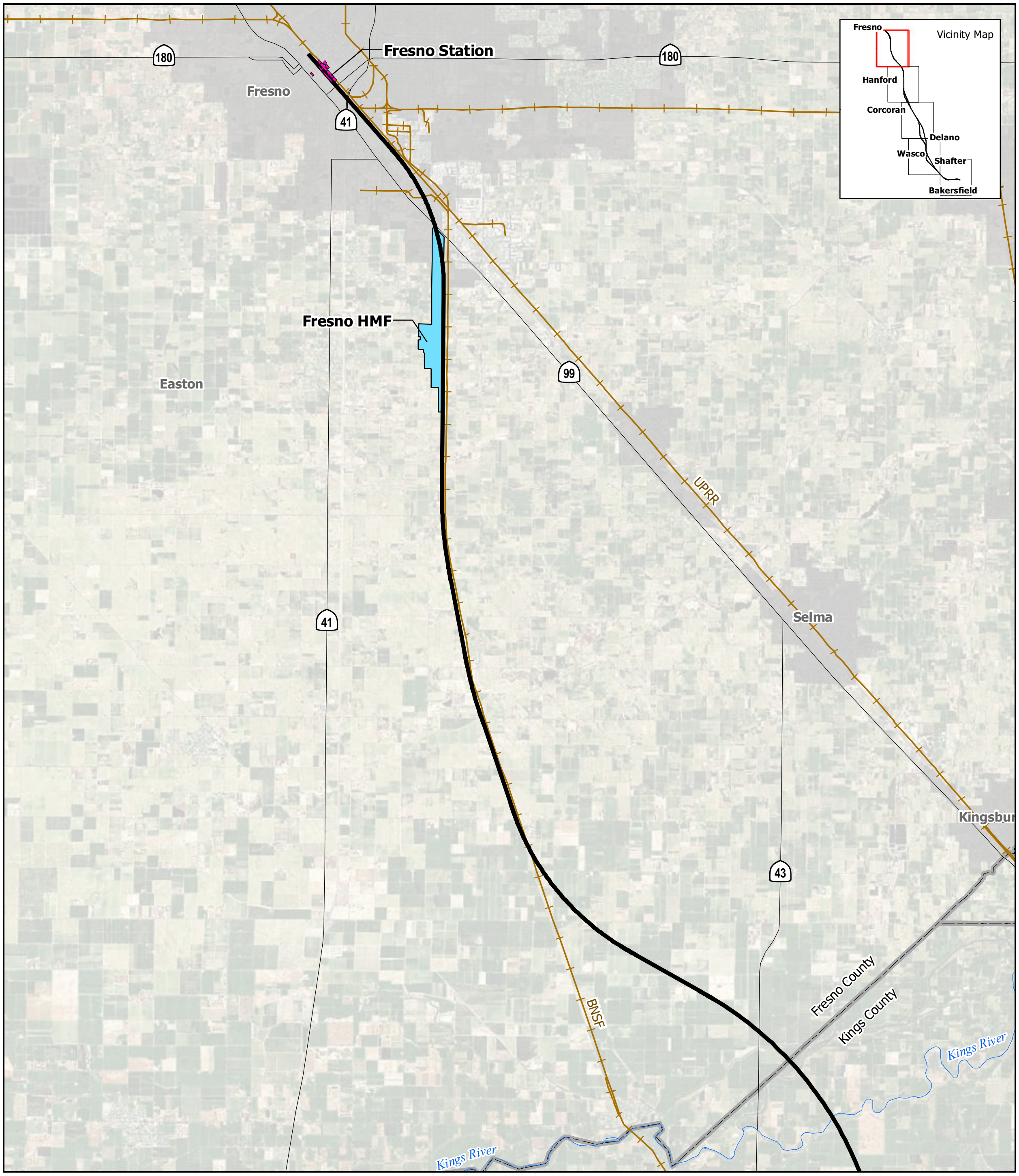
Receiver Location		Total Length (feet)	Barrier Height[a] (feet)	Impacted or Benefited Receivers	Number of Severe Residual Impacts
Belsera south of Reina Rd north of Noriega Rd	Northbound track	7,359	14	126	0
Belsera south of Reina Rd north of Noriega Rd	Southbound track	3,950	14	61	5

Source: Authority and FRA 2011.
Note:
[a] Height above top-of-rail.

Table 3.4-26
Potential Mitigation for Operational Noise for Bakersfield South

Receiver Location		Total Length (feet)	Barrier Height[a] (feet)	Impacted or Benefited Receivers	Number of Severe Residual Impacts
Hageman Rd. to south of Palm Ave.	Southbound track	12,189	14	326	0
South of Verdugo Ln. to south of Coffee Rd.	Southbound track	10,425	14	425	0
West of Interstate 99 to Baker St.	Southbound track	14,964	14	632	0
Hageman Rd. to north of Verdugo Lane.	Northbound track	12,189	14	670	0
North of Verdugo Lane to south of Coffee Road	Northbound track	6,466	14	157	0
West of Interstate 99 to Chester Ave.	Northbound track	7,808	14	276	0
Q St. to Baker St.	Northbound track	4,842	14	254	0

Source: Authority and FRA 2011.
Note:
[a] Height above top-of-rail.



PRELIMINARY DRAFT/SUBJECT TO CHANGE - HST ALIGNMENT IS NOT DETERMINED
Data source: URS, 2011
Base map source: USGS National Elevation Dataset, 90-m hillshade

May 10, 2011

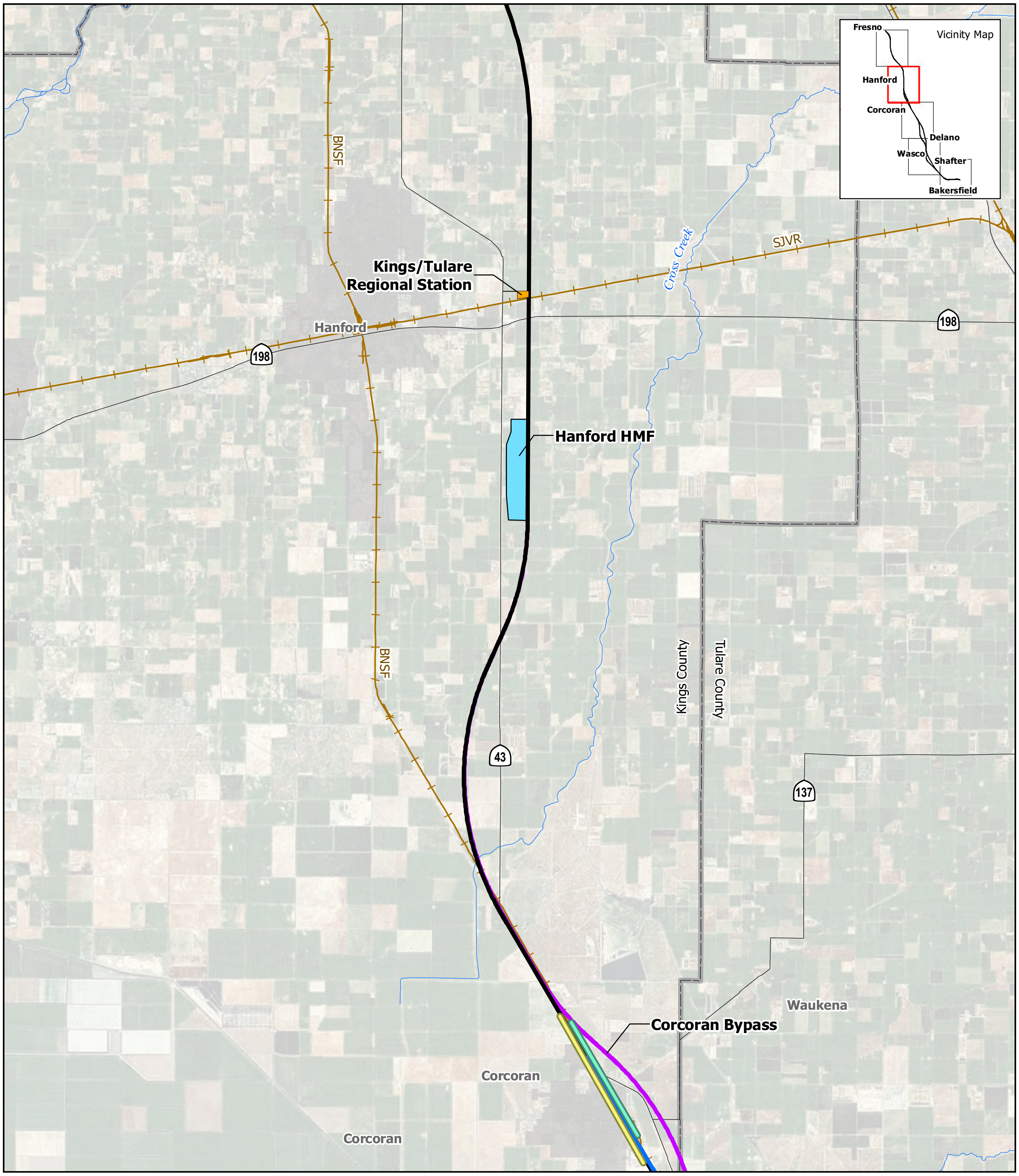
N

0 1 2 Miles

0 2 4 Kilometers

BNSF Alternative (Bypasses labeled)
Existing rail line
Steam/River
Highway
Community/Urban area
County boundary
Potential heavy maintenance facility
Proposed station
Potential Kings/Tulare Regional Station
Potential northbound sound barrier
Potential southbound sound barrier

Figure 3.4-15
Fresno area:
Potential sound barrier sites



PRELIMINARY DRAFT/SUBJECT TO CHANGE - HST ALIGNMENT IS NOT DETERMINED
Data source: URS, 2011
Base map source: USGS National Elevation Dataset, 90-m hillshade

May 10, 2011

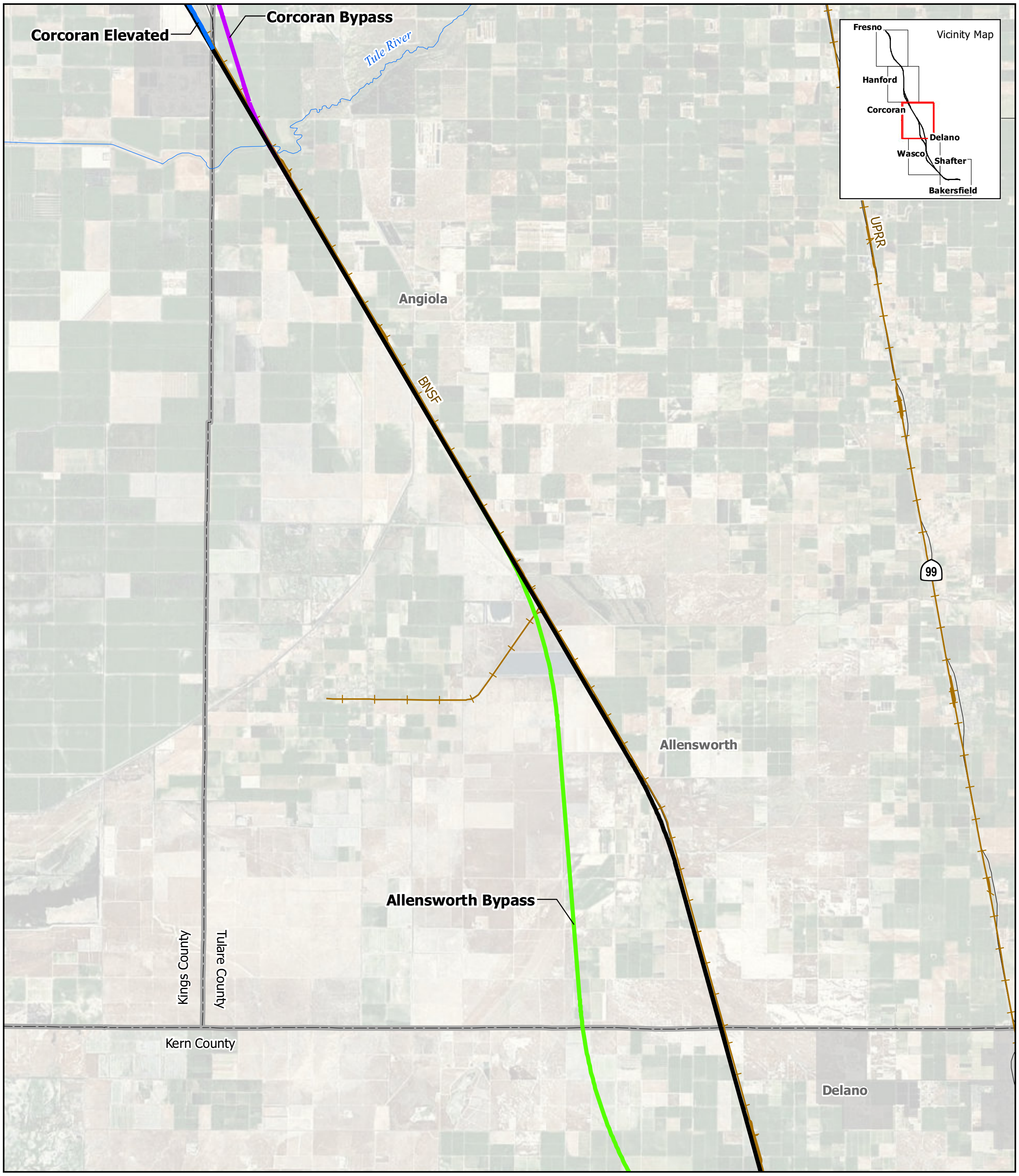
N

0 1 2 Miles

0 2 4 Kilometers

- BNSF Alternative (Bypasses labeled)
- Existing rail line
- Steam/River
- Highway
- Community/Urban area
- County boundary
- Potential heavy maintenance facility
- Proposed station
- Potential Kings/Tulare Regional Station
- Potential northbound sound barrier
- Potential southbound sound barrier

Figure 3.4-16
Hanford area:
Potential sound barrier sites



PRELIMINARY DRAFT/SUBJECT TO CHANGE - HST ALIGNMENT IS NOT DETERMINED
Data source: URS, 2011
Base map source: USGS National Elevation Dataset, 90-m hillshade

May 10, 2011

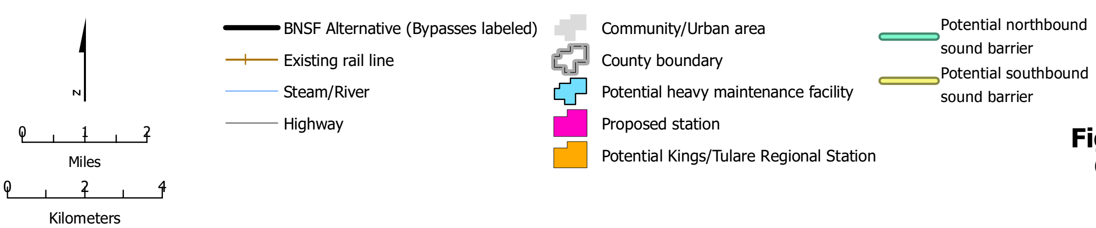
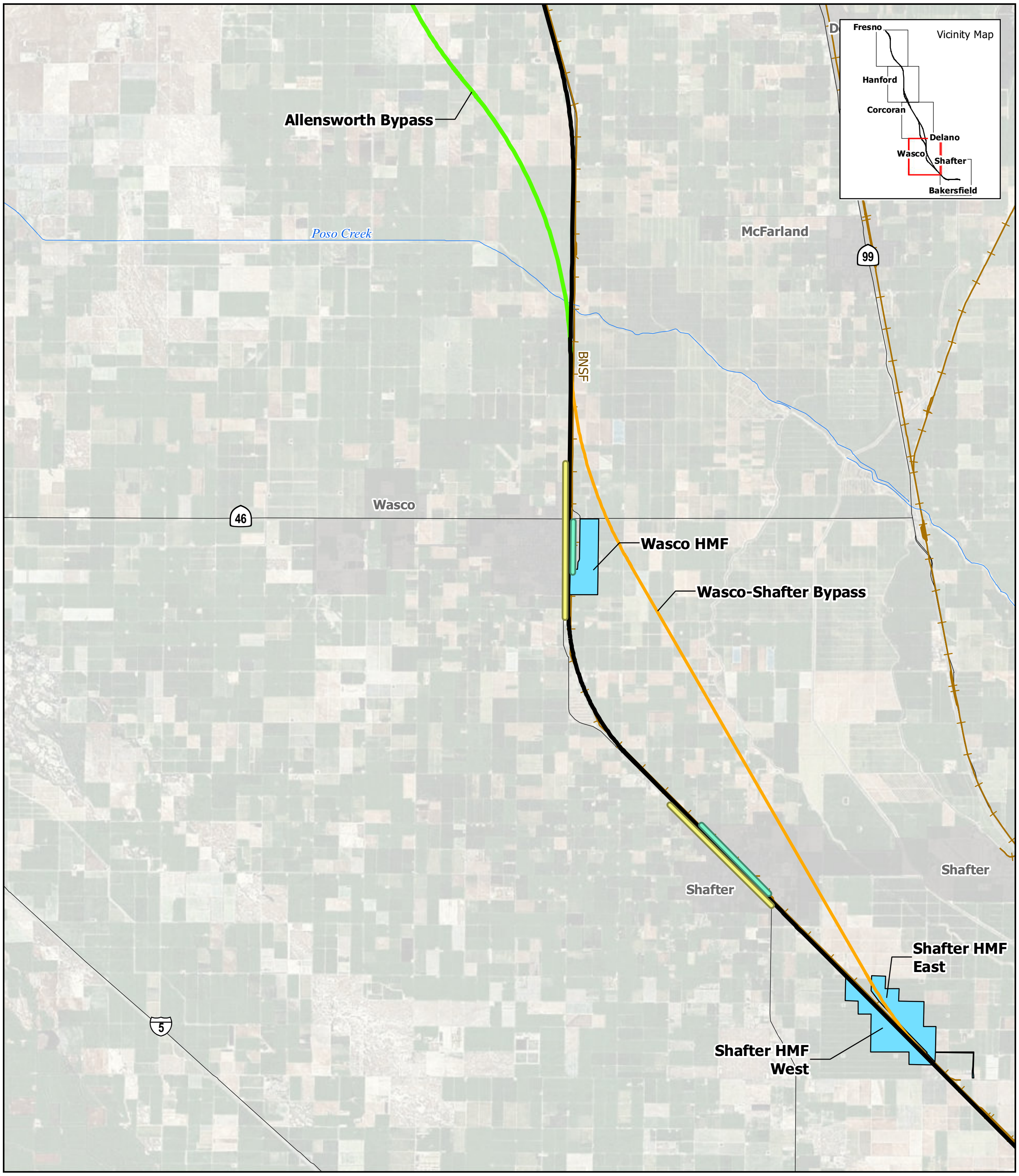


Figure 3.4-17
Corcoran area:
Potential sound barrier sites



PRELIMINARY DRAFT/SUBJECT TO CHANGE - HST ALIGNMENT IS NOT DETERMINED
Data source: URS, 2011
Base map source: USGS National Elevation Dataset, 90-m hillshade

May 10, 2011

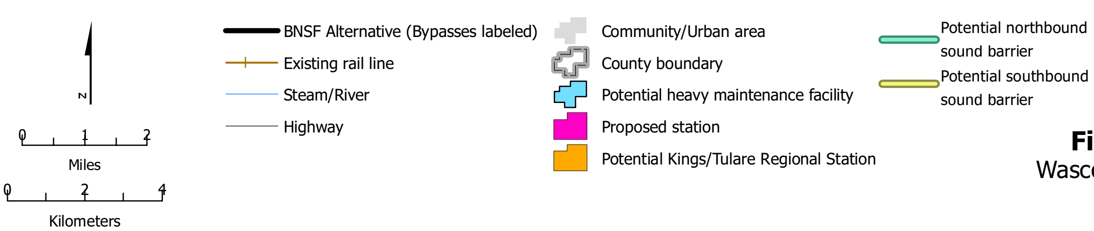
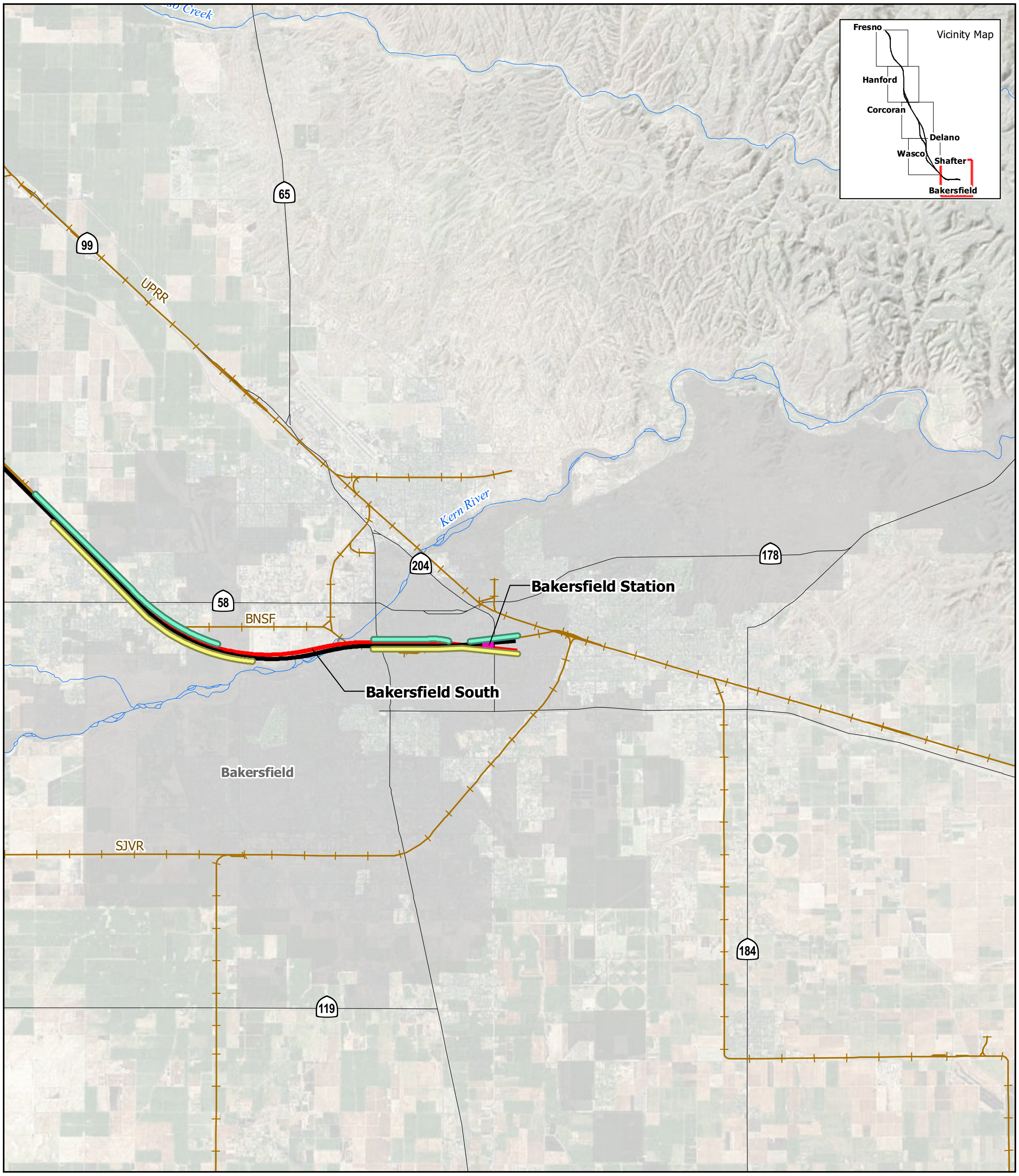


Figure 3.4-18
Wasco-Shafter area: Potential sound barrier sites



May 10, 2011

PRELIMINARY DRAFT/SUBJECT TO CHANGE - HST ALIGNMENT IS NOT DETERMINED
Data source: URS, 2011
Base map source: USGS National Elevation Dataset, 90-m hillshade

N

0 1 2
Miles

0 2 4
Kilometers

- BNSF Alternative (Bypasses labeled)
- Existing rail line
- Steam/River
- Highway
- Community/Urban area
- County boundary
- Potential heavy maintenance facility
- Proposed station
- Potential Kings/Tulare Regional Station
- Potential northbound sound barrier
- Potential southbound sound barrier

Figure 3.4-19
Bakersfield area: Potential sound barrier sites

BNSF Alternative Potential Mitigation Locations

Figures 3.4-15 through 3.4.19 show the locations where the criteria were met for the construction of sound barriers for all HST alternatives in the Fresno to Bakersfield Section. Table 3.4-23 summarizes potential sound barrier mitigation for operational noise for the BNSF Alternative during the design year (2035). The location of sound barriers as mitigation is shown on the table where a minimum of 5 dBA noise reduction at the impact receiver can be achieved. The table also summarizes the total length, maximum barrier height, the number of benefitted receivers, and the number of residual (post-mitigation) impacts within each portion of the alignment. The table references barrier heights from the top-of-rail elevation. A total of 13 sound barriers would be installed, with a combined length of approximately 134,039 feet and maximum height of 14 feet, for the BNSF Alternative Alignment. Only barrier mitigation measures providing 5 dBA, or more, noise reduction have been applied in the HST alternative tables that follow (Tables 3.4-23 through 3.4-26).

These sound barriers would mitigate 92% of the severe noise impacts in the Corcoran area, 97% of the severe noise impacts in the Wasco-Shafter area, and 100% of the severe noise impacts in the Bakersfield area. Noise receivers severely impacted in the Fresno, Hanford, Pixley, and Allensworth areas, as well as those noise receivers severely impacted in Corcoran, Wasco, Shafter, and Bakersfield that would not be mitigated by a sound barrier, would receive other forms of mitigation, such as building insulation or payment of property noise easements.

Corcoran Elevated Alternative Potential Mitigation Locations

This portion of the project alignment extends from just north of Idaho Avenue to just northwest of the intersection of Avenue 128 and Road 32. This alignment goes through Corcoran as an elevated alignment. This alternative will be elevated 33 feet above ground level from Niles Avenue south to 4th Avenue. The elevated alternative would be constructed on the east side of the BNSF track. Barrier 1 of this alternative would be on the southbound side of the alignment north of Newark Avenue to south of Oregon Avenue. The total length of the barrier would be approximately 18,000 feet long, and the height would be 14 feet. This barrier would benefit approximately 579 residential receivers. Barrier 1A would extend from the northbound side of the alignment north of Newark Avenue to south of Sherman Avenue. The total length of the barrier would be approximately 14,000 feet, at a height of 14 feet. This barrier would benefit approximately 158 residential receivers. The sound barrier results are presented in Table 3.4-24. Additional mitigation if necessary in the form of building insulation or payment of property noise easements would be implemented to reduce impacts at sensitive receivers not protected by sound barriers.

Corcoran Bypass Alternative Potential Mitigation Locations

This portion of the project alignment extends from just north of Idaho Avenue to just northwest of the intersection of Avenue 128 and Road 32. Around the east side of the city of Corcoran, this alignment would be at-grade at an elevation of about 10 feet above the existing grade. A total of 233 severe noise sites occur along the west and east sides of this alternative that would not benefit because no sound barriers would be built. Other mitigation in the form of building insulation or payment of property noise easements would be implemented to reduce impacts at these locations.

Allensworth Bypass Alternative Potential Mitigation Locations

This portion of the project alignment extends from just south of Avenue 84 to just south of Elmo Highway. The Allensworth Bypass Alternative would be at-grade and elevated to a height of approximately 8 feet above the existing grade. No noise receivers would be severely affected by this alternative.

Wasco-Shafter Bypass Alternative Potential Mitigation Locations

This portion of the project alignment extends from just northwest of Whisler Road to intersection of Hageman road and Rosedale Lane. This alignment is the only one under consideration for this portion of the project. The Wasco-Shafter Bypass, which runs around the east side of the city of Wasco and the city of Shafter, would be at-grade at an elevation of about 10 feet above the existing grade. The only exception would be the grade separation at 7th Standard Road. At this location, this alternative would be elevated to a height of 60 feet above-grade. A total of 31 severe noise sites occur along the southbound alignment of this alternative at 7th Standard Road that would not benefit because no barriers would be built along this alignment. A total of five severe noise sites occur along the northbound alignment of this alternative that would not benefit because no barriers would be built along this alignment.

The Wasco-Shafter Bypass Alternative Barrier 1 would be built on the northbound side of the alignment in Belsera, south of Reina Road and north of Noriega Road. The total length of the barrier would be approximately 7,359 feet long, at a height of 14 feet. This barrier would benefit approximately 126 residential receivers. The Wasco-Shafter Bypass Alternative Barrier 2 would be built on the southbound side of the alignment in Belsera, south of Reina Road and north of Noriega Road. The total length of the barrier would be approximately 3,950 feet long, at a height of 14 feet. This barrier would benefit approximately 61 residential receivers. The sound barrier results are presented in Table 3.4-25. Additional mitigation in the form of building insulation or payment of a property noise easement would be implemented to reduce impacts at sensitive receivers not protected by sound barriers.

Bakersfield South Alternative Potential Mitigation Locations

This portion of the project alignment extends from the intersection of Hageman Road and Rosedale Lane past the east end of the proposed station in downtown Bakersfield to Baker Street. The Bakersfield South Alternative would be at-grade for the western portion of the alignment (for approximately 11,330 feet), then be elevated to a height ranging from 50 to 80 feet throughout the rest of this segment of the project alignment for approximately 37,988 feet.

Barrier 1 for the Bakersfield South Alternative would be built on the southbound side of the alignment at Hageman Road to Verdugo Lane. The total length of the barrier would be approximately 12,189 feet long, and the height would be 14 feet. This barrier would benefit approximately 140 receivers.

Barrier 2 of the Bakersfield South Alternative would be built on the southbound side of the alignment from Verdugo Lane to south of Coffee Road. The total length of the barrier would be approximately 10,425 feet long, and the height would be 14 feet. This barrier would benefit approximately 404 residential receivers.

Barrier 3 of the Bakersfield South Alternative would be built on the southbound side of the alignment west of Interstate 99 to Baker Street. The total length of the barrier would be approximately 14,964 feet long, and the height would be 14 feet. This barrier would benefit approximately 478 residential receivers. Barrier 4 of the Bakersfield South Alternative would be built on the northbound side of the alignment from Hageman Road to south of Calloway Drive. The total length of the barrier would be approximately 6,466 feet long, and the height would be 14 feet. This barrier would benefit approximately 711 residential receivers.

Barrier 5 of the Bakersfield South Alternative would be built on the northbound side of the alignment west of SR 99 to Chester Avenue. The total length of the barrier would be approximately 7,808 feet long, and the height would be 14 feet. This barrier would benefit approximately 200 residential receivers.

Barrier 6 of the Bakersfield South Alternative would be built on the northbound side of the alignment from Q Street to Baker Street. The total length of the barrier would be approximately 4,842 feet long, and the height would be 14 feet. This barrier would benefit approximately 204 residential receivers.

The sound barrier results are presented in Table 3.4-26. Additional mitigation in the form of building insulation or payment of property noise easements would be implemented to reduce impacts at sensitive receivers not protected by sound barriers.

Heavy Maintenance Facility Alternatives

All the HMF site alternatives for the Fresno to Bakersfield Section are along the BNSF Alternative Alignment. The proposed sound barriers for these locations are shown on Figures 3.4-14 through 3.4-19.

N&V-MM#4: Vehicle noise specification. In the procurement of an HST vehicle technology, the project can set performance limits for noise levels in order to reduce community noise impacts throughout the corridor. Depending on the available technology, this could significantly reduce the number of impacts throughout the corridor.

N&V-MM#5: Special trackwork at crossovers and turnouts. Because the impacts of HST wheels over rail gaps at turnouts increases HST noise by approximately 6 dB over typical operations, turnouts can be a major source of noise impact. If the turnouts cannot be moved from sensitive areas, the project can use special types of trackwork that eliminate the gap.

N&V-MM# 6: Additional noise analysis following final design. If final design or final vehicle specifications result in changes to the assumptions underlying the noise analysis, reassess noise impacts and recommendations for mitigation and provide supplemental environmental documentation, as required by CEQA and NEPA.

N&V-MM#7: Heavy maintenance facilities. In order to reduce the noise from the heavy maintenance facilities, the follow noise mitigation measures are recommended:

- Enclose as many of the maintenance activities within the facility as possible.
- Eliminate windows in the maintenance building that would face toward noise sensitive land uses adjacent to the facility. If windows are required to be located on the side of the facility facing noise-sensitive land uses, they should be the fixed type of windows with a sound transmission class (STC) rating of at least 35. If the windows must of operable design, they should be closed during nighttime maintenance activities.
- Close maintenance facility doors where the rails enter the facility during nighttime maintenance activities.
- Maintenance tracks that cannot be located within the maintenance facility should be located on the far side of the facility from adjacent noise-sensitive receivers.
- For maintenance tracks that cannot be installed away from noise-sensitive receivers, install sound barrier along the maintenance tracks in order to protect the adjacent to noise-sensitive receivers.
- All mechanical equipment (compressors, pumps, generators, etc.) should be located within the maintenance facility structure.
- Any mechanical equipment located exterior to the maintenance facility (compressors, pumps, generators, etc.) should be located on the far side of the facility from adjacent noise-

sensitive receivers. If this is not possible, this equipment should be located within noise enclosures to mitigate the noise during operation.

- All ventilation ducting for the maintenance facility should be pointed away from the adjacent noise-sensitive receivers.

<u>**Vibration**</u>

N&V-MM#8: Implement Project Vibration Mitigation. For existing rail, adequate wheel and rail maintenance are very important in preventing vibration impacts. Rough wheels and rails can increase vibration levels by as much as 20 VdB, which can negate any vibration control measures. It is rare when practical vibration control measures provide up to 15 to 20 VdB in attenuation. When possible, it is best to grind rough or corrugated rail and implement wheel truing to restore the wheel surface and contour. This may reduce vibration more than completely replacing the existing track system with floating slabs.

If the train, railway and railway structures are in good condition, then other mitigation methods must be examined. Mitigation will fit into one of the categories found in Table 3.4-27. The table lists where the mitigation procedure will take place. Mitigation can take place at the source, sensitive receiver, or along the propagation path from the source to the sensitive receiver. A description of each type of mitigation procedure can also be found in Table 3.4-27.

Table 3.4-27
Potential Vibration Mitigation Procedures and Descriptions

Mitigation Procedure	Location of Mitigation	Description
Maintenance	Source	Rail condition monitoring systems with rail grinding on a regular basis. Wheel-truing to re-contour the wheel, provide a smooth running surface and remove wheel flats. Reconditioning vehicles. Installing wheel-condition monitoring systems.
Location and Design of Special Trackwork	Source	Careful review of crossover and turnout locations during the preliminary engineering stage. When feasible, relocate special trackwork to a less vibration-sensitive area. Installation of spring frogs eliminates gaps at crossovers and helps reduce vibration levels.
Vehicle Suspension	Source	Rail vehicle should have low unsprung weight, soft primary suspension, minimum metal-on-metal contact between moving parts of the truck, and smooth wheels that are perfectly round.
Special Track Support Systems	Source	Floating slabs, resiliently supported ties, high resilience fasteners and ballast mats all help reduce vibration levels from track support system.
Building Modifications	Receiver	For existing buildings, if vibration-sensitive equipment is affected by train vibration, the floor upon which the vibration-sensitive equipment is located could be stiffened and isolated from the remainder of the building. For new buildings, the building foundation should be supported by elastomer pads similar to bridge bearing pads.
Trenches	Along Vibration Propagation Path	A trench can be an effective vibration barrier if it changes the propagation characteristics of the soil. It can be open or solid. Open trenches can be filled with styrofoam. Solid barriers can be constructed with sheet piling, rows of drilled shafts filled with either concrete or a mixture of soil and lime, or concrete poured into a trench.

Table 3.4-27
Potential Vibration Mitigation Procedures and Descriptions

Mitigation Procedure	Location of Mitigation	Description
Operational Changes	Source	Reduce vehicle speed. Adjust nighttime schedules to minimize train movements during sensitive hours. Operating restrictions requires continuous monitoring and may not be practical.
Buffer Zones	Receiver	Negotiate a vibration easement from the affected property owners or expand rail right-of-way.

Secondary Impacts

Secondary impacts could potentially occur at the locations where the project would install sound barriers. The changes to visual and aesthetic qualities and the existing environment that might occur because of the installation of these barriers are covered in Chapter 3.16, Aesthetics and Visual Resources, but these changes are not assessed in site-specific locations because of uncertainty about the locations of these barriers, their heights, and their applications. The project design will incorporate communities' input on the appearance of the sound barriers to reduce secondary impacts. Sound barriers would not be additional obstacles to wildlife movement because they would be installed inside the fenced HST right-of-way.

3.4.7 NEPA Impacts Summary

Construction noise and vibration effects would be substantial for all alternatives and HMF sites. With proposed mitigation measures substantial effects would be reduced to a moderate or negligible level along the entire alignment. Substantial operational noise effects would occur for all alternatives and HMF sites. Effects to sensitive receivers can be reduced to a moderate or negligible level in most cases with the implementation of a sound barrier. In some cases a sound barrier is not advised to be constructed in which case several other mitigation measures are proposed (e.g., install building sound insulation or purchasing property noise easements). Even with proposed mitigation measures, effects to some receivers are expected to remain substantial. Similar to noise, operational vibration effects are projected to exceed the threshold outside the right-of-way along all alternatives and effects can be reduced with proposed mitigation measures (e.g., building modification, construction of a trench). However, even with proposed mitigation, effects are expected to remain substantial.

3.4.8 CEQA Significance Conclusions

Table 3.4-28 summarizes noise- and vibration-related impacts, their associated mitigation measures, and the level of significance after mitigation. Under CEQA, the potential for significant impacts remains after mitigation because some noise-sensitive receivers might still experience operational noise levels that are considered severe even after installation of sound barriers. Also, in collaboration with the communities, some severe noise effects may not be mitigated if barriers are found to be unwanted. Additional mitigation may be necessary, including N&V-MM#4, to further reduce impacts. The number of impacts for the alternatives under Impact N&V#3 are the difference (plus or minus) between that alternative (e.g., Bakersfield South Alternative) compared with the corresponding segment of the BNSF Alternative.

Table 3.4-28
Summary of Potential Impacts from Noise and Vibration

Impact	CEQA Level of Significance before Mitigation	Mitigation Measure	CEQA Level of Significance after Mitigation
N&V#1: Construction Noise	Significant	N&V-MM#1	Less than significant
N&V#2: Construction Vibration	Significant	N&V-MM#2	Less than significant
N&V#3: Operational Noise Impacts BNSF Alternative: 11,281 moderate and 5,513 severe impacts Corcoran Elevated Alternative: +131 moderate and +201 severe impacts Corcoran Bypass Alternative: -1,310 moderate and -307 severe impacts Allensworth Bypass: -33 moderate and -31 severe impacts Wasco-Shafter Bypass: -2,309 moderate and -1,655 severe impacts Bakersfield South: -382 moderate and 0 severe impacts	Significant	N&V-MM#3 through N&V-MM#7	Significant in some locations, maximum remaining severe impacts detailed below: Less than significant where fully mitigated BNSF: 419 severe impacts Corcoran Elevated Alternative: -45 impacts Corcoran Bypass Alternative: +188 impacts Allensworth Bypass: -31 impacts Wasco-Shafter Bypass: -55 impacts Bakersfield South: same impacts
N&V#4: Operational Vibration Impacts BNSF Alternative: 39 impacts Corcoran Elevated Alternative: 11 impacts Corcoran Bypass Alternative: +9 impacts Allensworth Bypass: -2 impacts Wasco-Shafter Bypass: -3 impacts Bakersfield South: same impacts	Significant	N&V-MM#8	Potentially significant
Source: Authority and FRA 2011.			