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[Project Title]

NSR

[Graphic]

Noise Study Report

[Project Name]

[General location information]

[District]-[County code]-[Route]-[PM]

[EA/Project No. or Federal-Aid Project Number]

April 2015



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Reviews and Approval:

The draft NSR must be reviewed, at a minimum, by the District noise specialist (for consultant-prepared documents) and the District Environmental Planner/Generalist responsible for the environmental document. The NSR is approved by the noise specialist's supervisor (District Branch Chief). For further guidance, see SER Volume 1, Chapter 12, "Noise" and Chapter 38, "NEPA Assignment."

Local Assistance Projects - Noise Study Reports prepared in support of local agency Federal-aid transportation projects "off" the SHS have the same review and approval requirements but are processed through the District Local Assistance Engineer (DLAE). The report shall be reviewed by the District noise specialist and the District Local Assistance Environmental Planner/Generalist, and approved by the noise specialist's supervisor (District Branch Chief).

Chapter 12 of the Standard Environmental Reference (SER)

(<http://www.dot.ca.gov/ser/vol1/sec3/physical/ch12noise/chap12noise.htm>) provides content guidance relevant to this document.

Bruce Rymer, Senior Transportation Engineer at Caltrans Division of Environmental Analysis, developed this template. Questions and comments regarding this template should be forwarded to Bruce Rymer, Caltrans Division of Environmental Analysis, (916) 653-6073.

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Noise Study Report

[Project Title]

[General location information]

[District]-[County code]-[Route]-[PM]

[EA/Project No. or Federal-Aid Project Number]

[Month Year]

Prepared By: _____ Date: _____

Author's Name, Title

Phone Number _____

Office Name _____

District/Region _____

Approved By: _____ Date: _____

Supervisor's Name, Title

Phone Number _____

Office Name _____

District/Region _____

[Blue Text = Instructions/guidance to be deleted]

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For Local Assistance NSRs, the “Prepared By” line should be signed by the person who prepared the NSR (noise specialist). The “Approved By” line should be signed by the District Branch Chief who reviewed and approved the report.

NSRs are prepared for Type I projects, as defined by Title 23 Part 772 of the Code of Federal Regulations (23 CFR 772). The Caltrans Noise Analysis Protocol (Protocol) (http://www.dot.ca.gov/hq/env/noise/pub/ca_tnap_may2011.pdf) (Caltrans 2011) provides Caltrans policy for applying 23 CFR 772. The Technical Noise Supplement (TeNS) (Caltrans 2013) to Caltrans Protocol provides further detailed technical guidance on the preparation of noise studies for highway construction and reconstruction projects, including the definition of technical terms used in the Protocol (http://www.dot.ca.gov/hq/env/noise/pub/TeNS_Sept_2013B.pdf).

A Type I project as defined in 23 CFR 772, is a federal or Federal-aid project for:

1. The construction of a highway on a new location; or
2. The physical alteration of an existing highway where there is either:
 - A. Substantial horizontal alteration. A project that halves the distance between the traffic noise source and the closest receptor between the existing condition to the future build condition; or
 - B. Substantial vertical alteration. A project that removes shielding thereby exposing the line-of-sight between the receptor and the traffic noise source. This is done by altering either the vertical alignment of the highway or the topography between the highway traffic noise source and the receptor; or
3. The addition of a through-traffic lane(s). This includes the addition of a through-traffic lane that functions as a high-occupancy vehicle (HOV) lane, high-occupancy toll (HOT) lane, bus lane, or truck climbing lane; or
4. The addition of an auxiliary lane, except for when the auxiliary lane is a turn lane; or
5. The addition or relocation of interchange lanes or ramps added to a quadrant to complete an existing partial interchange; or

6. Restriping existing pavement for the purpose of adding a through traffic lane or an auxiliary lane; or
7. The addition of a new or substantial alteration of a weigh station, rest stop, ride-share lot, or toll plaza.

The Department uses this same definition when evaluating State Highway System (SHS) projects without federal funding.

Under the 2011 Protocol there is no longer a screening procedure for determining if a detailed traffic noise analysis is required. Traffic noise must be predicted and reported for all lands adjacent to a Type I project. If there is no developed land adjacent to the project or if all developed land has no noise abatement criterion (e.g. airports, rail yards, bus yards) preparation of noise technical memorandum, rather than an NSR, may be warranted. A noise technical memorandum may also be warranted for projects that are not Type I but where adverse construction noise is anticipated.

Noise analysis under the California Environmental Quality Act (CEQA) may be required regardless of whether or not the project is a Type I project. The CEQA noise analysis is completely independent of the 23 CFR 772 analysis done for NEPA. Under CEQA, the baseline noise level is compared to the build noise level. The assessment entails looking at the setting of the noise impact and then how large or perceptible any noise increase would be in the given area. Key considerations include: the uniqueness of the setting, the sensitive nature of the noise receptors, the magnitude of the noise increase, the number of residences affected, and the absolute noise level.

The significance of noise impacts under CEQA are addressed in the environmental document rather than the NSR. Even though the NSR (or noise technical memorandum) does not specifically evaluate the significance of noise impacts under CEQA, it must contain the technical information that is needed to make that determination in the environmental document.

Summary

The Summary includes the results of the noise impact analysis and key conclusions related to noise abatement under the requirements of 23 CFR 772. The Summary should be limited to one to two pages and should not include any tables. Key topics that should be summarized in this section are:

- Purpose of NSR;
- Project location;
- Project purpose and need;
- Project alternatives;
- Land use and terrain in the project area (generally describe the various land uses in the project area such as residential, commercial, parks, and hotels.) Generally describe the terrain (such as the area is flat, slopes downhill from the roadway, or shielded by intervening hills);
- Existing noise levels (summarize the range of existing noise levels for each land use type);
- Predicted design-year noise levels (summarize the predicted design-year noise level for each land use type);
- Traffic noise impacts, if any (summarize traffic noise impacts associated with each land use type);
- Noise abatement considered (a summary should be provided that includes the range of heights, lengths, insertion losses, and number of benefited receptors for each area exposed to traffic noise impacts);

- Acoustical feasibility of noise abatement considered (summarize the feasibility of each noise abatement measure considered and identify those areas where abatement is not feasible);
- Reasonable allowances for feasible abatement (summarize the range of allowances for each feasible noise abatement measure considered); and
- Construction noise impacts.

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Table of Contents

Chapter 1.	Introduction	1
1.1.	Project Purpose and Need	2
Chapter 2.	Project Description	3
2.1.	No-Build	4
2.2.	Build Alternative—Addition of HOV Lanes	4
Chapter 3.	Fundamentals of Traffic Noise	5
3.1.	Sound, Noise, and Acoustics	5
3.1.	Frequency.....	5
3.2.	Sound Pressure Levels and Decibels	5
3.3.	Addition of Decibels	6
3.4.	A-Weighted Decibels.....	6
3.5.	Human Response to Changes in Noise Levels.....	7
3.6.	Noise Descriptors.....	8
3.7.	Sound Propagation	8
3.7.1.	Geometric Spreading	9
3.7.2.	Ground Absorption.....	9
3.7.3.	Atmospheric Effects	9
3.7.4.	Shielding by Natural or Human-Made Features.....	9
Chapter 4.	Federal Regulations and State Policies.....	11
4.1.	Federal Regulations	11
4.1.1.	23 CFR 772.....	11
4.1.2.	Traffic Noise Analysis Protocol for New Highway Construction and Reconstruction Projects	12
4.2.	State Regulations and Policies	13
4.2.1.	California Environmental Quality Act (CEQA).....	13
4.2.2.	Section 216 of the California Streets and Highways Code.....	14
Chapter 5.	Study Methods and Procedures	15
5.1.	Methods for Identifying Land Uses and Selecting Noise Measurement and Modeling Receiver Locations.....	18
5.2.	Field Measurement Procedures.....	18
5.2.1.	Short-Term Measurements	18
5.2.2.	Long -Term Measurements	19
5.3.	Traffic Noise Levels Prediction Methods	20
5.4.	Methods for Identifying Traffic Noise Impacts and Consideration of Abatement	21
Chapter 6.	Existing Noise Environment.....	23
6.1.	Existing Land Uses	24
6.2.	Noise Measurement Results.....	25
6.2.1.	Short-Term Monitoring	25
6.2.2.	Long-Term Monitoring	26
Chapter 7.	Future Noise Environment, Impacts, and Considered Abatement	28
7.1.	Future Noise Environment and Impacts.....	29
7.2.	Preliminary Noise Abatement Analysis.....	31
7.2.1.	Area A	32
7.2.2.	Area B.....	33
7.2.3.	Area C.....	33
7.2.4.	Area D	33
Chapter 8.	Construction Noise	35

Chapter 9. References	37
Appendix A Traffic Data	39
Appendix B Predicted Future Noise Levels and Noise Barrier Analysis	43
Appendix C Noise Barrier Analysis.....	45
Appendix D Supplemental Data.....	47

List of Figures

Figure 5-1. Analysis Areas, Noise Monitoring Positions, and Location of Evaluated Noise Barrier	21
Figure 6-1. Long-Term Monitoring at Location LT-1, January 19–25, 2006	27

List of Tables

	Page
Table 3-1. Typical A-Weighted Noise Levels	7
Table 6-1. Summary of Short-Term Measurements.....	25
Table 6-2. Summary of Long-Term Monitoring at Location LT-1.....	26
Table 6-3. Comparison of Measured to Predicted Sound Levels in the TNM Model	27
Table 7-1. Summary of Reasonableness Allowances —Barrier NB-1.....	33
Table 8-1. Construction Equipment Noise	36
Table A-1. Traffic Data for Existing Conditions	40
Table A-2. Traffic Data for Design Year No-Project Conditions	41
Table A-3. Traffic Data for Design Year with Project Conditions.....	42
Table B-1. Predicted Future Noise and Barrier Analysis.....	44
Table C-1. Analysis of Barrier NB-1.....	46

List of Abbreviated Terms

[Abbreviation] **[Spelled-out term]** *[You can add rows quickly by pressing tab at the end of the last row and using the ‘pencil’ function or by inserting rows. Type in acronyms as you use them, and then sort them alphabetically. To sort, pull down the “Table” menu, select “Sort,” be sure it specifies ascending order, and click on “OK.”]*

CEQA	California Environmental Quality Act
CFR	Code of Federal Regulations
CNEL	Community Noise Equivalent Level
dB	Decibels
FHWA	Federal Highway Administration
Hz	Hertz
kHz	Kilohertz
L _{dn}	Day-Night Level
L _{eq}	Equivalent Sound Level
L _{eq(h)}	Equivalent Sound Level over one hour
L _{max}	Maximum Sound Level
LOS	Level of Service
L _{xx}	Percentile-Exceeded Sound Level
mPa	micro-Pascals
mph	miles per hour
NAC	noise abatement criteria
NADR	Noise Abatement Decision Report
NEPA	National Environmental Policy Act
NSR	Noise Study Report
Protocol	Caltrans Traffic Noise Analysis Protocol for New Highway Construction, Reconstruction, and Retrofit Barrier Projects
SPL	sound pressure level
TeNS	Caltrans’ Technical Noise Supplement
TNM 2.5	FHWA Traffic Noise Model Version 2.5

Chapter 1. Introduction

The Introduction provides an overview on the purpose of the NSR. This chapter also provides background information on the project, as well as a concise statement of the project's purpose and need.

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1.1 Purpose of the Noise Study Report

The purpose of this NSR is to evaluate noise impacts and abatement under the requirements of Title 23, Part 772 of the Code of Federal Regulations (23 CFR 772) "Procedures for Abatement of Highway Traffic Noise." 23 CFR 772 provides procedures for preparing operational and construction noise studies and evaluating noise abatement considered for federal and Federal-aid highway projects. According to 23 CFR 772.3, all highway projects that are developed in conformance with this regulation are deemed to be in conformance with Federal Highway Administration (FHWA) noise standards. Compliance with 23 CFR 772 provides compliance with the noise impact assessment requirements of the National Environmental Policy Act (NEPA).

The Caltrans Traffic Noise Analysis Protocol for New Highway Construction, Reconstruction, and Retrofit Barrier Projects (Protocol) (Caltrans 2011) provides Caltrans policy for implementing 23 CFR 772 in California. The Protocol outlines the requirements for preparing noise study reports (NSR). Noise impacts associated with this project under the California Environmental Quality Act (CEQA) are evaluated separately in the **project's environmental document** [insert name of environmental document and provide reference].

Project Purpose and Need

A brief statement describing the name of the project and project location, including a statement describing the existing facility, together with a clear discussion of the purpose and need for the project, is provided here. This information should be obtained from the Environmental Planner/Generalist to ensure that information presented here is consistent with information to be provided in the environmental document.

Caltrans annotated outlines for environmental documents provide detailed guidance on how to prepare the purpose and need statement (<http://www.dot.ca.gov/ser/forms.htm>).

1.1. Project Purpose and Need

[Begin typing here].

Chapter 2. Project Description

The project description includes:

- A detailed description of the components of each alternative under consideration with enough information for the reader to understand how the project alternatives fit into the transportation system of the area;
- A description of the capacity-increasing components of the project (additional lanes, new alignments, new ramps, etc.);
- A vicinity map clearly showing how the alternatives relate to the general transportation system;
- A location map showing the alternative alignments being studied and their spatial relationship with receptors in the project area; and
- A discussion of when the action is expected to be constructed.

This information should be obtained from the Caltrans Environmental Planner/Generalist to ensure that information presented here is consistent with information to be provided in the environmental document.

Caltrans annotated outlines for environmental documents provide detailed guidance on how to prepare the project description (<http://www.dot.ca.gov/ser/forms.htm>). The project description for the NSR does not necessarily need to contain all of the project description components described in the annotated outlines. For example, discussions of alternatives considered but eliminated from further discussion and of permits and approvals needed may not be needed for the NSR. The guidance contained in the annotated outlines will be helpful in developing the information described in the bullets above.

The following is sample text for this chapter. Since the sample below is for illustrative purposes only, only one build alternative is described. This alternative is carried forward in the discussions in Chapters 5, 6, and 7.

[Begin typing here]

Under the Build Alternative, improvements would be made to the SR 26 main line to meet current design standards for a six-lane freeway by adding two 12-foot lanes in the

median; constructing a concrete median barrier throughout the length of the project; widening the outside shoulders to 10 feet; and correcting the cross slope to 2% by overlaying concrete asphalt to improve drainage.

The interchange structures at Main Street and Maple Avenue would be removed and reconstructed to accommodate future widening of SR 26 to eight lanes. Ramp meters would be included at all proposed on-ramps.

2.1. No-Build

Under the No-Build Alternative, no changes would be made to SR 26 in the project area.

2.2. Build Alternative—Addition of HOV Lanes

Under the Build Alternative, two HOV lanes (one in each direction) would be constructed in the center median. No outside widening of the existing roadway would be required. Embankment slopes for the proposed interchange improvements would be at a 4:1 slope. The proposed ramps would be constructed to current design standards and would be configured to accommodate a future eight-lane facility on SR 26. Ramp metering would be installed at the east and westbound on ramps at Main Street and Maple Avenue.

Chapter 3. Fundamentals of Traffic Noise

This section provides key information on the fundamentals of traffic noise. Include the following boilerplate language.

The following is a brief discussion of fundamental traffic noise concepts. For a detailed discussion, please refer to Caltrans' Technical Noise Supplement (TeNS) (Caltrans 2013), a technical supplement to the Protocol that is available on Caltrans Web site (http://www.dot.ca.gov/hq/env/noise/pub/TeNS_Sept_2013B.pdf).

3.1. Sound, Noise, and Acoustics

Sound can be described as the mechanical energy of a vibrating object transmitted by pressure waves through a liquid or gaseous medium (e.g., air) to a hearing organ, such as a human ear. Noise is defined as loud, unexpected, or annoying sound.

In the science of acoustics, the fundamental model consists of a sound (or noise) source, a receptor, and the propagation path between the two. The loudness of the noise source and obstructions or atmospheric factors affecting the propagation path to the receptor determine the sound level and characteristics of the noise perceived by the receptor. The field of acoustics deals primarily with the propagation and control of sound.

3.1. Frequency

Continuous sound can be described by frequency (pitch) and amplitude (loudness). A low-frequency sound is perceived as low in pitch. Frequency is expressed in terms of cycles per second, or Hertz (Hz) (e.g., a frequency of 250 cycles per second is referred to as 250 Hz). High frequencies are sometimes more conveniently expressed in kilohertz (kHz), or thousands of Hertz. The audible frequency range for humans is generally between 20 Hz and 20,000 Hz.

3.2. Sound Pressure Levels and Decibels

The amplitude of pressure waves generated by a sound source determines the loudness of that source. Sound pressure amplitude is measured in micro-Pascals (mPa). One mPa is approximately one hundred billionth (0.0000000001) of normal atmospheric pressure. Sound pressure amplitudes for different kinds of noise environments can range from less than 100 to 100,000,000 mPa. Because of this huge range of values, sound is rarely expressed in terms of mPa. Instead, a logarithmic scale is used to describe sound

pressure level (SPL) in terms of decibels (dB). The threshold of hearing for young people is about 0 dB, which corresponds to 20 mPa.

3.3. Addition of Decibels

Because decibels are logarithmic units, SPL cannot be added or subtracted through ordinary arithmetic. Under the decibel scale, a doubling of sound energy corresponds to a 3-dB increase. In other words, when two identical sources are each producing sound of the same loudness, the resulting sound level at a given distance would be 3 dB higher than one source under the same conditions. For example, if one automobile produces an SPL of 70 dB when it passes an observer, two cars passing simultaneously would not produce 140 dB—rather, they would combine to produce 73 dB. Under the decibel scale, three sources of equal loudness together produce a sound level 5 dB louder than one source.

3.4. A-Weighted Decibels

The decibel scale alone does not adequately characterize how humans perceive noise. The dominant frequencies of a sound have a substantial effect on the human response to that sound. Although the intensity (energy per unit area) of the sound is a purely physical quantity, the loudness or human response is determined by the characteristics of the human ear.

Human hearing is limited in the range of audible frequencies as well as in the way it perceives the SPL in that range. In general, people are most sensitive to the frequency range of 1,000–8,000 Hz, and perceive sounds within that range better than sounds of the same amplitude in higher or lower frequencies. To approximate the response of the human ear, sound levels of individual frequency bands are weighted, depending on the human sensitivity to those frequencies. Then, an “A-weighted” sound level (expressed in units of dBA) can be computed based on this information.

The A-weighting network approximates the frequency response of the average young ear when listening to most ordinary sounds. When people make judgments of the relative loudness or annoyance of a sound, their judgments correlate well with the A-scale sound levels of those sounds. Other weighting networks have been devised to address high noise levels or other special problems (e.g., B-, C-, and D-scales), but these scales are rarely used in conjunction with highway-traffic noise. Noise levels for traffic noise reports are typically reported in terms of A-weighted decibels or dBA. Table 3-1 describes typical A-weighted noise levels for various noise sources.

Table 3-1. Typical A-Weighted Noise Levels

Common Outdoor Activities	Noise Level (dBA)	Common Indoor Activities
	— 110 —	Rock band
Jet fly-over at 1000 feet	— 100 —	
Gas lawn mower at 3 feet	— 90 —	
Diesel truck at 50 feet at 50 mph	— 80 —	Food blender at 3 feet Garbage disposal at 3 feet
Noisy urban area, daytime	— 70 —	Vacuum cleaner at 10 feet
Gas lawn mower, 100 feet	— 60 —	Normal speech at 3 feet
Commercial area	— 50 —	Large business office
Heavy traffic at 300 feet	— 40 —	Dishwasher next room
Quiet urban daytime	— 30 —	Theater, large conference room (background)
Quiet urban nighttime	— 20 —	Library
Quiet suburban nighttime	— 10 —	Bedroom at night, concert hall (background)
Quiet rural nighttime	— 0 —	Broadcast/recording studio
Lowest threshold of human hearing	— 0 —	Lowest threshold of human hearing

Source: Caltrans 2013.

3.5. Human Response to Changes in Noise Levels

As discussed above, doubling sound energy results in a 3-dB increase in sound. However, given a sound level change measured with precise instrumentation, the subjective human perception of a doubling of loudness will usually be different than what is measured.

Under controlled conditions in an acoustical laboratory, the trained, healthy human ear is able to discern 1-dB changes in sound levels, when exposed to steady, single-frequency (“pure-tone”) signals in the midfrequency (1,000 Hz–8,000 Hz) range. In typical noisy environments, changes in noise of 1 to 2 dB are generally not perceptible. However, it is widely accepted that people are able to begin to detect sound level increases of 3 dB in typical noisy environments. Further, a 5-dB increase is generally perceived as a distinctly noticeable increase, and a 10-dB increase is generally perceived as a doubling of loudness. Therefore, a doubling of sound energy (e.g., doubling the volume of traffic on a highway) that would result in a 3-dB increase in sound, would generally be perceived as barely detectable.

3.6. Noise Descriptors

Noise in our daily environment fluctuates over time. Some fluctuations are minor, but some are substantial. Some noise levels occur in regular patterns, but others are random. Some noise levels fluctuate rapidly, but others slowly. Some noise levels vary widely, but others are relatively constant. Various noise descriptors have been developed to describe time-varying noise levels. The following are the noise descriptors most commonly used in traffic noise analysis.

- **Equivalent Sound Level (L_{eq}):** L_{eq} represents an average of the sound energy occurring over a specified period. In effect, L_{eq} is the steady-state sound level containing the same acoustical energy as the time-varying sound that actually occurs during the same period. The 1-hour A-weighted equivalent sound level ($L_{eq}[h]$) is the energy average of A-weighted sound levels occurring during a one-hour period, and is the basis for noise abatement criteria (NAC) used by Caltrans and FHWA.
- **Percentile-Exceeded Sound Level (L_{xx}):** L_{xx} represents the sound level exceeded for a given percentage of a specified period (e.g., L_{10} is the sound level exceeded 10% of the time, and L_{90} is the sound level exceeded 90% of the time).
- **Maximum Sound Level (L_{max}):** L_{max} is the highest instantaneous sound level measured during a specified period.
- **Day-Night Level (L_{dn}):** L_{dn} is the energy average of A-weighted sound levels occurring over a 24-hour period, with a 10-dB penalty applied to A-weighted sound levels occurring during nighttime hours between 10 p.m. and 7 a.m.
- **Community Noise Equivalent Level (CNEL):** Similar to L_{dn} , CNEL is the energy average of the A-weighted sound levels occurring over a 24-hour period, with a 10-dB penalty applied to A-weighted sound levels occurring during the nighttime hours between 10 p.m. and 7 a.m., and a 5-dB penalty applied to the A-weighted sound levels occurring during evening hours between 7 p.m. and 10 p.m.

3.7. Sound Propagation

When sound propagates over a distance, it changes in level and frequency content. The manner in which noise reduces with distance depends on the following factors.

3.7.1. Geometric Spreading

Sound from a localized source (i.e., a point source) propagates uniformly outward in a spherical pattern. The sound level attenuates (or decreases) at a rate of 6 decibels for each doubling of distance from a point source. Highways consist of several localized noise sources on a defined path, and hence can be treated as a line source, which approximates the effect of several point sources. Noise from a line source propagates outward in a cylindrical pattern, often referred to as cylindrical spreading. Sound levels attenuate at a rate of 3 decibels for each doubling of distance from a line source.

3.7.2. Ground Absorption

The propagation path of noise from a highway to a receptor is usually very close to the ground. Noise attenuation from ground absorption and reflective-wave canceling adds to the attenuation associated with geometric spreading. Traditionally, the excess attenuation has also been expressed in terms of attenuation per doubling of distance. This approximation is usually sufficiently accurate for distances of less than 200 feet. For acoustically hard sites (i.e., sites with a reflective surface between the source and the receptor, such as a parking lot or body of water,), no excess ground attenuation is assumed. For acoustically absorptive or soft sites (i.e., those sites with an absorptive ground surface between the source and the receptor, such as soft dirt, grass, or scattered bushes and trees), an excess ground-attenuation value of 1.5 decibels per doubling of distance is normally assumed. When added to the cylindrical spreading, the excess ground attenuation results in an overall drop-off rate of 4.5 decibels per doubling of distance.

3.7.3. Atmospheric Effects

Receptors located downwind from a source can be exposed to increased noise levels relative to calm conditions, whereas locations upwind can have lowered noise levels. Sound levels can be increased at large distances (e.g., more than 500 feet) from the highway due to atmospheric temperature inversion (i.e., increasing temperature with elevation). Other factors such as air temperature, humidity, and turbulence can also have significant effects.

3.7.4. Shielding by Natural or Human-Made Features

A large object or barrier in the path between a noise source and a receptor can substantially attenuate noise levels at the receptor. The amount of attenuation provided by shielding depends on the size of the object and the frequency content of the noise source. Natural terrain features (e.g., hills and dense woods) and human-made features (e.g., buildings and walls) can substantially reduce noise levels. Walls are often

constructed between a source and a receptor specifically to reduce noise. A barrier that breaks the line of sight between a source and a receptor will typically result in at least 5 dB of noise reduction. Taller barriers provide increased noise reduction. Vegetation between the highway and receptor is rarely effective in reducing noise because it does not create a solid barrier.

Chapter 4. Federal Regulations and State Policies

This section discusses key federal regulations and state policies. Include the following boilerplate language.

This report focuses on the requirements of 23 CFR 772, as discussed below.

4.1. Federal Regulations

4.1.1. 23 CFR 772

23 CFR 772 provides procedures for preparing operational and construction noise studies and evaluating noise abatement considered for federal and Federal-aid highway projects. Under 23 CFR 772.7, projects are categorized as Type I, Type II, or Type III projects.

- FHWA defines a Type I project as a proposed federal or federal-aid highway project for the construction of a highway on a new location or the physical alteration of an existing highway which significantly changes either the horizontal or vertical alignment of the highway. The following projects are also considered to be Type I projects:
- The addition of a through-traffic lane(s). This includes the addition of a through-traffic lane that functions as a high-occupancy vehicle (HOV) lane, high-occupancy toll (HOT) lane, bus lane, or truck climbing lane,
- The addition of an auxiliary lane, except for when the auxiliary lane is a turn lane,
- The addition or relocation of interchange lanes or ramps added to a quadrant to complete an existing partial interchange,
- Restriping existing pavement for the purpose of adding a through traffic lane or an auxiliary lane,
- The addition of a new or substantial alteration of a weigh station, rest stop, ride-share lot, or toll plaza.

If a project is determined to be a Type I project under this definition, the entire project area as defined in the environmental document is a Type I project.

A Type II project is a noise barrier retrofit project that involves no changes to highway capacity or alignment. A Type III project is a project that does not meet the classifications of a Type I or Type II project. Type III projects do not require a noise analysis.

Under 23 CFR 772.11, noise abatement must be considered for Type I projects if the project is predicted to result in a traffic noise impact. In such cases, 23 CFR 772 requires that the project sponsor “consider” noise abatement before adoption of the final NEPA document. This process involves identification of noise abatement measures that are reasonable, feasible, and likely to be incorporated into the project, and of noise impacts for which no apparent solution is available.

Traffic noise impacts, as defined in 23 CFR 772.5, occur when the predicted noise level in the design-year approaches or exceeds the NAC specified in 23 CFR 772, or a predicted noise level substantially exceeds the existing noise level (a “substantial” noise increase). 23 CFR 772 does not specifically define the terms “substantial increase” or “approach”; these criteria are defined in the Protocol, as described below.

Table 4-1 summarizes NAC corresponding to various land use activity categories. Activity categories and related traffic noise impacts are determined based on the actual or permitted land use in a given area.

4.1.2. Traffic Noise Analysis Protocol for New Highway Construction and Reconstruction Projects

The Protocol specifies the policies, procedures, and practices to be used by agencies that sponsor new construction or reconstruction of federal or Federal-aid highway projects. The Protocol defines a noise increase as substantial when the predicted noise levels with project implementation exceed existing noise levels by 12 dBA or more. The Protocol also states that a sound level is considered to approach an NAC level when the sound level is within 1 dB of the NAC identified in 23 CFR 772 (e.g., 66 dBA is considered to approach the NAC of 67 dBA, but 65 dBA is not).

The Technical Noise Supplement to the Protocol provides detailed technical guidance for the evaluation of highway traffic noise. This includes field measurement methods, noise modeling methods, and report preparation guidance.

Table 4-1. Activity Categories and Noise Abatement Criteria (23 CFR 772)

Activity Category	Activity $L_{eq}[h]^1$	Evaluation Location	Description of Activities
A	57	Exterior	Lands on which 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.
B ²	67	Exterior	Residential.
C ²	67	Exterior	Active sport areas, amphitheaters, auditoriums, campgrounds, cemeteries, day care centers, hospitals, libraries, medical facilities, parks, picnic areas, places of worship, playgrounds, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, recreation areas, Section 4(f) sites, schools, television studios, trails, and trail crossings.
D	52	Interior	Auditoriums, day care centers, hospitals, libraries, medical facilities, places of worship, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, schools, and television studios.
E	72	Exterior	Hotels, motels, offices, restaurants/bars, and other developed lands, properties, or activities not included in A–D or F.
F			Agriculture, airports, bus yards, emergency services, industrial, logging, maintenance facilities, manufacturing, mining, rail yards, retail facilities, shipyards, utilities (water resources, water treatment, electrical), and warehousing.
G			Undeveloped lands that are not permitted.

¹ The $L_{eq}(h)$ activity criteria values are for impact determination only and are not design standards for noise abatement measures. All values are A-weighted decibels (dBA).

² Includes undeveloped lands permitted for this activity category.

4.2. State Regulations and Policies

4.2.1. California Environmental Quality Act (CEQA)

Noise analysis under the California Environmental Quality Act (CEQA) may be required regardless of whether or not the project is a Type I project. The CEQA noise analysis is completely independent of the 23 CFR 772 analysis done for NEPA. Under CEQA, the baseline noise level is compared to the build noise level. The assessment entails looking at the setting of the noise impact and then how large or perceptible any noise increase would be in the given area. Key considerations include: the uniqueness of the setting, the sensitive nature of the noise receptors, the magnitude of the noise increase, the number of residences affected, and the absolute noise level

The significance of noise impacts under CEQA are addressed in the environmental document rather than the NSR. Even though the NSR (or noise technical memorandum) does not specifically evaluate the significance of noise impacts under CEQA, it must contain the technical information that is needed to make that determination in the environmental document.

4.2.2. Section 216 of the California Streets and Highways Code

Section 216 of the California Streets and Highways Code relates to the noise effects of a proposed freeway project on public and private elementary and secondary schools.

Under this code, a noise impact occurs if, as a result of a proposed freeway project, noise levels exceed 52 dBA- $L_{eq}(h)$ in the interior of public or private elementary or secondary classrooms, libraries, multipurpose rooms, or spaces. This requirement does not replace the “approach or exceed” NAC criterion for FHWA Activity Category E for classroom interiors, but it is a requirement that must be addressed in addition to the requirements of 23 CFR 772.

If a project results in a noise impact under this code, noise abatement must be provided to reduce classroom noise to a level that is at or below 52 dBA- $L_{eq}(h)$. If the noise levels generated from freeway and roadway sources exceed 52 dBA- $L_{eq}(h)$ prior to the construction of the proposed freeway project, then noise abatement must be provided to reduce the noise to the level that existed prior to construction of the project.

Chapter 5. Study Methods and Procedures

Study methods used in the preparation of the NSR are discussed in this chapter. The following methods should be described:

- Methods for identifying land uses and selecting noise measurement and modeled receptor locations.
- Field measurement procedures.
- Noise prediction methods.
- Process for evaluating noise abatement.

Each of these steps is described in more detail below.

Describe the Methods for Identifying Land Uses and Selecting Noise Measurement and Modeled Receptor Locations

This section describes the process used to select modeled receptor and noise measurement locations, including the following:

- Types of land uses in the project area relative to the FHWA activity categories;
- Extent of frequent human use at the land uses in the project area;
- Geometry of the project relative to nearby existing and permitted land uses;
- Locations where traffic noise impacts are expected to be the worst;
- Reasons why a receptor represents a larger area; and
- Acoustical equivalence (areas are usually acoustically equivalent if their shielding and geometric relationship to the highway are the same).

Land uses in the project area are categorized in terms of FHWA activity categories (see Table 4-1). Receptor locations to be measured and modeled for the analysis are selected to represent various land uses in the project area. Since it is often not practical to place a modeled receptor at each individual residence or building (such as church and/or school), a limited number of locations may need to be selected that represents groups of buildings with similar land uses. It is also often not practical to conduct noise measurements at every modeled receptor location. Therefore, a limited number of noise measurement

locations may need to be selected that represent the various land uses in the project area. Refer to TeNS for guidance on receptor selection.

Measurement locations outside the direct project area are useful for documenting existing community background noise levels. After the project is built, this information can be helpful in defending against unsubstantiated public claims that noise barriers constructed as part of a project increased noise levels at distant receptors. Measurement locations outside the direct project area are discussed, as appropriate.

It is often convenient to group land uses along the project corridor by major sub-areas. These sub-areas can be defined by common land uses, acoustical equivalence, major cross streets, topography, and/or other physical features in the area. Existing land uses, noise barriers, or topography that provides acoustical shielding are identified and discussed.

Describe Field Measurement Procedures

This section describes field measurement procedures that can serve several purposes for the noise analysis. Refer to TeNS for detailed guidance on measurement procedures.

Most commonly, short-term sound level measurements are taken adjacent to an existing roadway along with simultaneous collection of traffic counts and speeds. The count and speed data is then input to the noise model so that the measurements and modeled results can be compared. The differences between the measured and modeled noise levels can then be used to adjust the model or develop calibration factors.

Short-term measurements can also be used to characterize ambient noise conditions at locations away from the project area or, in the case of a new project alignment, at locations adjacent to the proposed alignment. In these situations, since there are no simultaneous traffic counts to be collected, no adjustment or calibration of the model is conducted with these measurements.

Long-term measurements (typically 24 hours a day for several days) are used to characterize the diurnal traffic noise pattern at selected locations in the project area. This data can be used to identify the worst noise hour and to develop relationships between non-worst-hour and worst-hour noise levels. This information can be used to estimate worst-hour noise levels from levels measured during non-worst hour times.

The discussion on field measurement procedures includes the following:

- Description of instrumentation (with serial numbers) and measurement setups,

- Short- and long-term noise measurement and other data collection procedures,
- Traffic count and speed collection methods,
- Meteorological observation methods, and
- Data reduction methods.
- Additional detailed information such as copies of field notes, photographs, measurement sketches, time and date of measurements, and other data from the field investigation should be provided in an appendix.

Describe Noise Prediction Methods

Traffic and construction noise modeling methods used to predict noise levels are described in this section. The discussion on noise modeling methods should include the following:

- Description of the traffic noise and construction noise models used, primarily the FHWA Traffic Noise Model (TNM) for traffic noise and the Roadway Construction Noise Model (RCNM) for construction noise;
- Description of any other supplementary models used;
- Description of mapping used to develop the model (aerial photos, layout maps, profiles, etc);
- Description of tools used to develop TNM input data (digitizing tables, CAD tools); and
- Summary of operational assumptions used in the analysis (such as forecasted traffic volumes, speeds, and construction equipment operational assumptions).

Short and concise summaries of data are provided in the body of the text. Detailed data summaries, such as design-year traffic assumptions are provided in the NSR appendices.

Describe the Process for Evaluating Noise Abatement

This section discusses methods used to evaluate noise impacts and abatement. The discussion includes:

- Narrative discussion of the criteria used for identifying traffic noise impacts under 23 CFR 772 (“approach or exceed NAC,” “substantial increase”, or both);

- A description of how the feasibility of abatement is determined; and
- A description of how reasonable cost allowances are determined.

The following is sample text for this chapter.

[Begin typing here].

5.1. Methods for Identifying Land Uses and Selecting Noise Measurement and Modeling Receiver Locations

A field investigation was conducted to identify land uses that could be subject to traffic and construction noise impacts from the proposed project. Existing land uses in the project area were categorized by land use type and Activity Category as defined in Table 4-1, and the extent of frequent human use. As stated in the Protocol, noise abatement is only considered where frequent human use occurs and where a lowered noise level would be of benefit. Although all land uses are evaluated in this analysis, the focus is on locations of frequent human use that would benefit from a lowered noise level.

Accordingly, this impact analysis focuses on locations with defined outdoor activity areas, such as residential backyards and common use areas at multi-family residences.

The geometry of the project relative to nearby existing and planned land uses was also identified.

Short-term measurement locations were selected to represent each major developed area within the project area. A single long term measurement site was selected to capture the diurnal traffic noise level pattern in the project area. Short-term measurement locations were selected to serve as representative modeling locations. Several other non-measurement locations were selected as modeling locations.

5.2. Field Measurement Procedures

A field noise study was conducted in accordance with recommended procedures in TeNS. The following is a summary of the procedures used to collect short-term and long term sound level data.

5.2.1. Short-Term Measurements

Short-term monitoring was conducted at four locations on Thursday, January 19, 2013 and Wednesday, January 25, 2013, using an Acme Systems Model 812 Precision Type 1 sound level meters (serial numbers 0430 and 0239). The calibration of the meter was

checked before and after the measurement using an Acme Systems Model CA250 calibrator (serial number 0125). Measurements were taken over a 15-minute period at each site. Short-term monitoring was conducted at Activity Category B land uses. The short-term measurement locations are identified in Figure 5-1.

During the short-term measurements, field staff attended each meter. Minute-to-minute L_{eq} values collected during the measurement period (typically 15 minutes in duration) were logged manually, and dominant noise sources observed during each individual 1-minute period were also identified and logged. Using this approach, those minutes when traffic noise was observed to be a dominant contributor to noise levels at a given measurement location could be distinguished from one-minute noise levels where other non-traffic noise sources (such as aircraft and lawn equipment) contributed significantly to existing noise levels.

Temperature, wind speed, and humidity were recorded manually during the short-term monitoring session using an Acme Systems Model 3000 portable weather station. During the short-term measurements, wind speeds typically ranged from 1 to 4 miles per hour (mph). Temperatures ranged from 10–14°C (50–57°F), with relative humidity typically 70–90%.

Traffic on SR 26 was classified and counted during short-term noise measurements. Vehicles were classified as automobiles, medium-duty trucks, or heavy-duty trucks. An automobile was defined as a vehicle with two axles and four tires that are designed primarily to carry passengers. Small vans and light trucks were included in this category. Medium-duty trucks included all cargo vehicles with two axles and six tires. Heavy-duty trucks included all vehicles with three or more axles. The posted speed on SR 26 was 65 mph.

5.2.2. Long -Term Measurements

Long-term monitoring was conducted at one location (LT-1) using an Acme Systems Model 720 Type 2 sound level meter (serial numbers 0506). The purpose of these measurements was to identify variations in sound levels throughout the day. The long-term sound level data was collected over five consecutive 24-hour periods, beginning Thursday, January 19, 2013, and ending Wednesday, January 25, 2013.

Long-term monitoring location LT-1 was located at the residence at 485 Chestnut Drive on the north side of SR 26, approximately 200 feet from the SR 26 edge-of-pavement (refer to Figure 5-1). This is the same location where ST-2 measurements were taken.

5.3. Traffic Noise Levels Prediction Methods

Traffic noise levels were predicted using the FHWA Traffic Noise Model Version 2.5 (TNM 2.5). (Use the current applicable model version.) TNM 2.5 is a computer model based on two FHWA reports: FHWA-PD-96-009 and FHWA-PD-96-010 (FHWA 1998a, 1998b). Key inputs to the traffic noise model were the locations of roadways, traffic mix and speed, shielding features (e.g., topography and buildings), noise barriers, ground type, and receptors. Three-dimensional representations of these inputs were developed using CAD drawings, aerials, and topographic contours provided by the County Transportation Authority.

Traffic noise was evaluated under existing conditions, design-year no-project conditions, and design-year conditions with the project alternative. Loudest-hour traffic volumes, vehicle classification percentages, and traffic speeds under existing and design-year (2030) conditions were provided by Acme Traffic Engineers for input into the traffic noise model. The highest average traffic volumes on SR 26 are predicted to occur during the PM peak hour; therefore PM peak hour traffic volumes were used in the model. Tables A-1 to A-3 in Appendix A summarize the traffic volumes and assumptions used for modeling existing and design-year conditions with and without the project alternative.

The loudest hour is generally characterized by free-flowing traffic at the highway design speed (i.e., Level of Service [LOS] C or better). Although the addition of median lanes on SR 26 will improve LOS, most segments on SR 26 are forecast to be at LOS D or worse during peak hours. For this analysis, it is assumed that each lane has a maximum capacity of 2,000 vehicles per hour at the design speed of the highway. Therefore, for the design-year six-lane case, total modeled volumes in each direction were capped at 12,000 vehicles per hour.

To validate the accuracy of the model calculations, TNM 2.5 was used to compare measured traffic noise levels to modeled noise levels at field measurement locations. For each receptor, traffic volumes counted during the short-term measurement periods were normalized to 1-hour volumes. These normalized volumes were assigned to the corresponding project area roadways to simulate the noise source strength at the roadways during the actual measurement period. Modeled and measured sound levels were then compared to determine the accuracy of the model and if additional adjustment of the model was necessary.

Figure 5-1. Analysis Areas, Noise Monitoring Positions, and Location of Evaluated Noise Barrier¹

5.4. Methods for Identifying Traffic Noise Impacts and Consideration of Abatement

Traffic noise impacts are considered to occur at receptor locations where predicted design-year noise levels are 12 dB or more greater than existing noise levels, or where predicted design-year noise levels approach or exceed the NAC for the applicable activity category. Where traffic noise impacts are identified, noise abatement must be considered for reasonableness and feasibility as required by 23 CFR 772 and the Protocol.

According to the Protocol, abatement measures are considered acoustically feasible if a minimum noise reduction of 5 dB at impacted receptor locations is predicted with implementation of the abatement measures. In addition, barriers should be designed to intercept the line-of-sight from the exhaust stack of a truck to the first tier of receptors, as required by the Highway Design Manual, Chapter 1100. Other factors that affect feasibility include topography, access requirements for driveways and ramps, presence of local cross streets, utility conflicts, other noise sources in the area, and safety considerations.

The overall reasonableness of noise abatement is determined by the following three factors:

- The noise reduction design goal.
- The cost of noise abatement.
- The viewpoints of benefited receptors (including property owners and residents of the benefited receptors).

The Caltrans' acoustical design goal is that a barrier must be predicted to provide at least 7 dB of noise reduction at one benefited receptor. This design goal applies to any receptor and is not limited to impacted receptors.

The Protocol defines the procedure for assessing reasonableness of noise barriers from a cost perspective. Based on 2014 construction costs an allowance of \$71,000 is provided for each benefited receptor (i.e., receptors that receive at least 5 dB of noise reduction from a noise barrier). The total allowance for each barrier is calculated by multiplying

¹ Figure 5-1 can be found on the [SER Forms and Templates](#) page.

the number of benefited receptors by \$71,000. The allowance should be adjusted annually based on the published Caltrans Construction Price Index (CPI) and a base 2011 allowance of \$55,000. If the estimated construction cost of a barrier is less than the total calculated allowance for the barrier, the barrier is considered reasonable from a cost perspective. The viewpoints of benefits receptors are determined by a survey that is typically conducted after completion of the noise study report. The process for conducting the survey is described in detail in the Protocol.

The noise study report identifies traffic noise impacts and evaluates noise abatement for acoustical feasibility. It also reports information that will be used in the reasonableness analysis including if the 7 dB design goal reduction in noise can be achieved and the abatement allowances. The noise study report does not make any conclusions regarding reasonableness. The feasibility and reasonableness of noise abatement is reported in the Noise Abatement Decision Report.

Chapter 6. Existing Noise Environment

Information relating to the existing noise environment is summarized here. The following information should be included:

- Existing and permitted land uses and activity categories for adjacent land uses,
- Noise measurement results, and
- Traffic model development based on measurement results.

Existing and Permitted Land Uses

Existing and permitted land uses in the project area are identified and categorized by land use type and activity category.

Noise Measurement Results

In general, noise measurement results presented in the body of the report are short and concise. More detailed information or lengthy data summaries are provided in the NSR appendices. The more detailed information may include:

- Sound level measurement results;
- Equipment calibration information/certificates;
- Traffic counts and speeds;
- Meteorological data;
- Site mapping and topography; and
- Detailed information on measurement locations (site photos, aerial photographs, etc).

Brief summary tables of short-term and long-term measured results may be presented in the body of the NSR.

Traffic Model Development Based on Measurement Results

A table that compares measured traffic noise levels with traffic noise levels modeled from collected traffic data is provided. Reasons as to why model calibration has or has not been implemented are discussed. If model calibration has been conducted, details on the process are described.

The following is sample text for this chapter.

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6.1. Existing Land Uses

A field investigation was conducted to identify land uses that could be subject to traffic and construction noise impacts from the proposed project. The following land uses were identified in the project area:

- Single-family residences and multi-family residences: Activity Category B
- Places of worship: Activity Category C (exterior), Activity Category D (interior)
- Hotel: Activity Category E
- Commercial retail uses: Activity Category F

Although all developed land uses are evaluated in this analysis, noise abatement is only considered for areas of frequent human use that would benefit from a lowered noise level. Accordingly, this impact analysis focuses on locations with defined outdoor activity areas, such as residential backyards and common use areas at multi-family residences.

Land uses in the project area have been grouped into a series of lettered analysis areas that are identified in Figure 5-1. Each of these analysis areas is considered to be acoustically equivalent.

- **Area A:** Area A is located on the north side of SR 26 east of Main Street. A residential subdivision (Activity Category B) is located in this area. This area is generally flat. Backyards face the highway. A sound barrier with a nominal height of 12 feet is located between SR 26 and the residential area. (Refer to Figure 5-1.)
- **Area B:** Area B is located on the north side of SR 26 west of Maple Avenue. A residential subdivision (Activity Category B) is located in this area. This area is generally flat. Backyards face the highway. No sound barriers or topographical shielding occur between the highway and the residential uses. (Refer to Figure 5-1.)
- **Area C:** Area C is located on the south side of SR 26 east of Main Street. A commercial retail center (Activity Category F) is located in this area. The ground generally slopes away from the highway in this area. Developed areas are lower than the highway. No sound barrier or topographical shielding occurs between the

highway and the commercial area. Outdoor areas immediately adjacent to the commercial land uses are parking lots. Therefore, no outdoor areas associated with the commercial uses are considered to be areas of frequent human use. (Refer to Figure 5-1.)

- **Area D:** Area D is located on the south side of SR 26 west of Maple Avenue. A church (exterior Activity Category C, interior Activity Category D) and a hotel (Activity Category E) are located in this area. No sound barrier or topographical shielding occurs between the highway and this area. All of the outdoor uses areas are parking lots. Therefore, no exterior areas of frequent human use occur in this area. (Refer to Figure 5-1.)

6.2. Noise Measurement Results

The existing noise environment in the project area is characterized below based on short- and long-term noise monitoring that was conducted.

6.2.1. Short-Term Monitoring

Table 6-1 summarizes the results of the short-term noise monitoring conducted in the project area.

Table 6-1. Summary of Short-Term Measurements

Position	Address	Area	Land Uses	Start Time	Duration (minutes)	Measured L_{eq}	Autos	Medium Trucks	Heavy Trucks	Observed Speed (mph)
ST-1	123 Chestnut Drive	A	Residential	9:22 a.m.	15	61.2	428	14	5	66
ST-2	485 Chestnut Drive	B	Residential	10:15 a.m.	15	68.2	465	12	6	64
ST-3	685 Chestnut Drive	B	Residential	2:30 p.m.	15	68.9	422	13	4	64
ST-4	159 Pecan Drive, 161 Pecan Drive	D	Hotel, Church	3:24 p.m.	15	69.2	480	10	3	67

Note: Refer to Figure 5-1 for measurement locations and boundaries of each area.

(Note that no noise monitoring was conducted in Area C where the commercial retail center is located. Since there is no noise abatement criterion for this land use, monitoring in this area is less important than other areas. As discussed below a noise modeling receptor has been included in Area C for the purposes of documenting noise levels in the area.)

6.2.2. Long-Term Monitoring

The long-term sound level data was collected over five consecutive 24-hour periods, beginning Thursday, January 19, 2013, and ending Wednesday, January 25, 2013.

Long-term monitoring location LT-1 was located at the residence at 485 Chestnut Drive on the north side of SR 26, approximately 200 feet from the SR 26 edge-of-pavement (refer to Figure 5-1). This is the same location where ST-2 measurements were taken. The average loudest-hour sound level measured was 68.9 dBA $L_{eq}(h)$ during the 2:00 p.m. hour. Table 6-2 and Figure 6-1 summarize the results of the long-term monitoring.

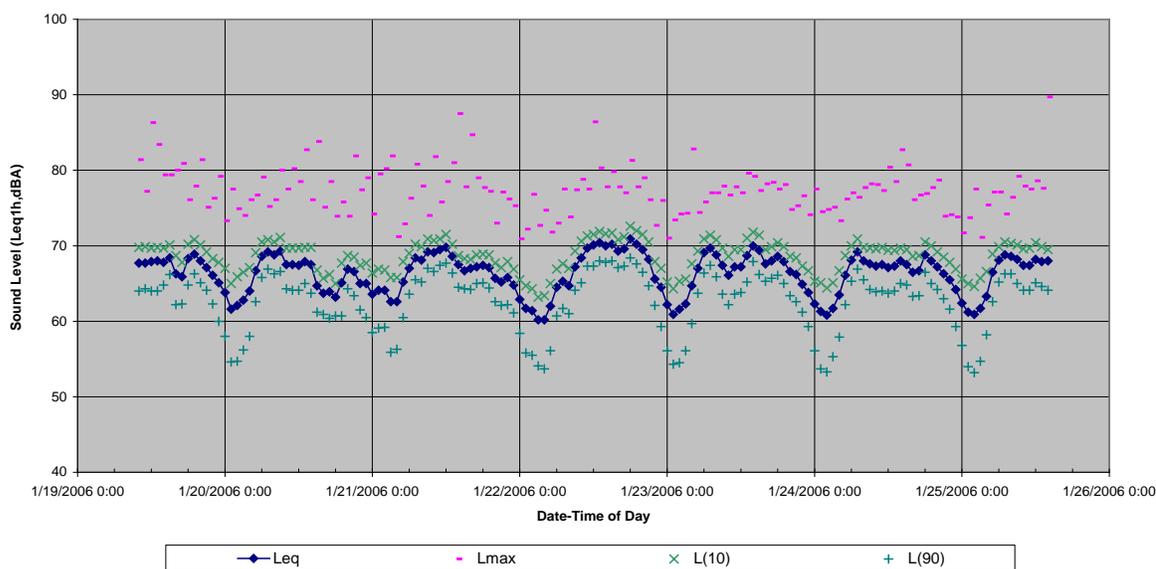
(This example includes long-term data over a 5-day period. The number of days over which long-term data is collected is determined at the discretion of the noise analyst based on actual field conditions, equipment limitations, and other factors.)

Table 6-2. Summary of Long-Term Monitoring at Location LT-1

Hour Beginning	Five-Day Average (dBA $L_{eq}(h)$)	Difference from Loudest Hour (dB)
12:00 a.m.	62.9	-6.0
1:00 a.m.	61.8	-7.1
2:00 a.m.	61.8	-7.1
3:00 a.m.	61.9	-7.0
4:00 a.m.	63.1	-5.8
5:00 a.m.	65.6	-3.3
6:00 a.m.	67.6	-1.3
7:00 a.m.	68.4	-0.5
8:00 a.m.	67.8	-1.1
9:00 a.m.	68.2	-1.6
10:00 a.m.	67.6	-1.3
11:00 a.m.	68.1	-0.8
12:00 p.m.	68.2	-0.7
1:00 p.m.	68.1	-0.8
2:00 p.m.	68.9	0.0
3:00 p.m.	67.8	-1.1
4:00 p.m.	66.7	-2.2
5:00 p.m.	66.9	-2.0
6:00 p.m.	67.9	-1.0
7:00 p.m.	67.9	-1.0
8:00 p.m.	67.3	-1.6
9:00 p.m.	66.6	-2.2
10:00 p.m.	65.5	-3.4
11:00 p.m.	64.6	-4.3

Note: Worst noise hour noise level is bolded.

Figure 6-1. Long-Term Monitoring at Location LT-1, January 19–25, 2006



TNM 2.5 was used to compare measured traffic noise levels to modeled noise levels at field measurement locations. Table 6-3 compares measured and modeled noise levels at each measurement location (see Figure 5-1). The predicted sound levels are within 2 dB of the measured sound levels and are, therefore, considered to be in reasonable agreement with the measured sound levels. Therefore, no further adjustment of the model was necessary.

Table 6-3. Comparison of Measured to Predicted Sound Levels in the TNM Model

Measurement Position	Measured Sound Level (dBA)	Predicted Sound Level (dBA)	Measured minus Predicted (dB)
ST-1	61.2	62.0	- 0.8
ST-2	68.2	67.0	+ 1.2
ST-3	68.9	70.5	- 1.6
ST-4	69.2	70.2	- 1.0

Table B-1 in Appendix B presents existing noise levels at each receptor.

Chapter 7. Future Noise Environment, Impacts, and Considered Abatement

This section discusses the predicted traffic noise level under existing and design-year conditions (with and without the project), identifies traffic noise impacts, and considers noise abatement. The results of this analysis are provided in a table contained in an appendix to the NSR. This table (or tables) includes the following for each modeled receptor:

- Location identifiers that corresponds to those used in the aerial figure of modeled receptor and measurement locations;
- Description of location (physical address if possible);
- Type of land use;
- Number of dwelling units represented by each receptor;
- Noise abatement category and criterion;
- Worst-hour noise levels for existing, design-year no-project, and design-year with project conditions;
- Change in noise levels including:
 - Design year with project versus existing conditions, and
 - Design year with project versus design-year no- project; and traffic noise impact conclusions (“approach or exceed NAC,” “substantial increase”, or both).

For each sub-area, predicted traffic noise levels and traffic noise impacts, if any, are discussed based on modeling results. Interior noise levels must also be evaluated if there are any land uses in Activity Category D (i.e. schools, places of worship, hospitals.) The FHWA Highway Traffic Noise Analysis and Abatement Guidance document states that interior noise levels may be estimated using predicted exterior noise levels and building noise reduction factors reported in Table 6 of the FHWA guidance document. If exterior or interior traffic noise impacts are identified, noise abatement must be considered. A

discussion of noise abatement options identified in 23 CFR 772 is provided. Typically, abatement in the form of noise barriers is evaluated and discussed in detail.

The noise reduction (i.e. barrier insertion loss) provided by a range of barrier walls heights is evaluated for each barrier considered. Barrier heights in the range of 6 to 16 feet in 2-foot increments are typically evaluated. Higher barriers may be evaluated if a 16 foot high barrier does not achieve the 7 dB design goal. A table summarizing the noise reduction for each barrier height and the number of benefited receptors for each height evaluated is provided. This table also identifies the minimum wall height necessary for each barrier evaluated to break the line-of-sight between an 11.5-foot truck stack and a 5-foot-high receptor in the first row of residences. Chapter 1100 of the Caltrans Highway Design Manual states that noise barriers should intercept the line of sight from the exhaust stack of a truck to the receptor. The truck stack height is assumed to be 11.5 feet above the pavement. The receptor is assumed to be 5 feet above the ground and located 5 feet from the living unit nearest the roadway. This table can be combined with the table that summarizes existing and modeled noise levels.

Reasonableness cost allowances for each height increment of each barrier are calculated by multiplying the number of benefited receptors by the current allowance (\$71,000 per benefited receptor in 2015). Allowances for each barrier are summarized in a table in the body of the report.

The NSR provides information on the acoustical feasibility of barriers and reasonable cost allowances for a range of barrier heights for each barrier evaluated. It does not provide information on the construction cost of barriers considered. Construction cost information is provided in the Noise Abatement Decision Report (NADR). The NADR compares the allowances to construction cost estimates and identifies those barrier heights that are reasonable from a cost perspective.

The following is sample text for this chapter.

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7.1. Future Noise Environment and Impacts

Table B-1 in Appendix B summarizes the traffic noise modeling results for existing conditions and design-year conditions with and without the project. Predicted design-year traffic noise levels with the project are compared to existing conditions and to design-year no-project conditions. The comparison to existing conditions is included in

the analysis to identify traffic noise impacts as defined under 23 CFR 772. The comparison to no-project conditions indicates the direct effect of the project.

As stated in the TeNS, modeling results are rounded to the nearest decibel before comparisons are made. In some cases, this can result in relative changes that may not appear intuitive. An example would be a comparison between calculated sound levels of 64.4 and 64.5 dBA. The difference between these two values is 0.1 dB. However, after rounding, the difference is reported as 1 dB.

Modeling results in Table B-1 indicate the following:

Area A

The traffic noise modeling results in Table B-1 indicate that traffic noise levels at residences in Area A are predicted to be in the range of 64 to 65 dBA $L_{eq}(h)$ in the design-year. The results also indicate that the increase in noise between existing conditions and the design-year is predicted to be 3 dB. Because the predicted noise levels in the design-year are not predicted to approach or exceed the noise abatement criterion (67 dBA $L_{eq}(h)$) or result in a substantial increase in noise, no traffic noise impacts are predicted in Area A.

Area B

The traffic noise modeling results in Table B-1 indicate traffic noise levels at residences in Area B are predicted to be in the range of 64 to 70 dBA $L_{eq}(h)$ in the design-year, and that the increase in noise will be 3 dB in the design-year. Because the predicted noise level in the design-year exceeds 67 dBA $L_{eq}(h)$, traffic noise impacts are predicted at residences in this area, and noise abatement must be considered in this area.

Area C

The traffic noise modeling results in Table B-1 indicate traffic noise levels at commercial uses in Area C will be 70 dBA $L_{eq}(h)$ in the design-year. The results also indicate that the increase in noise between existing conditions and the design-year is 3 dB. Because there is no noise abatement criterion for Category F uses in this area and because the project would not result in a substantial increase in noise, no traffic noise impacts are predicted to occur in this area and noise abatement does not need to be considered in this area.

Area D

The traffic noise modeling results in Table B-1 indicate exterior traffic noise levels at the hotel and church will be 70 dBA $L_{eq}(h)$ in the design-year and that the increase in noise will be 3 dB. Because the predicted design-year noise level does not approach or exceed the 72 dBA $L_{eq}(h)$ NAC for the hotel, no traffic noise impacts are predicted at the hotel. The predicted exterior noise level does however exceed the 67 dBA $L_{eq}(h)$ exterior NAC for the church. An exterior traffic noise impact is therefore predicted to occur at the church. Exterior noise abatement therefore needs to be considered at the church.

Because the church has an interior noise abatement criterion in addition to the exterior criterion, interior noise must be considered at the church as well. From Table 6 in the FHWA Highway Traffic Noise Analysis and Abatement Guidance document, the building noise reduction factor for standard construction with ordinary windows closed is 20 dB. The interior noise level in the church in the design-year is therefore predicted to be 50 dBA $L_{eq}(h)$. Because this predicted design-year noise level does not exceed the interior NAC of 52 dBA $L_{eq}(h)$, no interior traffic noise impacts are predicted at the church.

7.2. Preliminary Noise Abatement Analysis

Noise abatement is considered where noise impacts are predicted in areas of frequent human use that would benefit from a lowered noise level. According to 23 CFR 772(13)(c) and 772(15)(c), federal funding may be used for the following abatement measures:

- Construction of noise barriers, including acquisition of property rights, either within or outside the highway right-of-way.
- Traffic management measures including, but not limited to, traffic control devices and signing for prohibition of certain vehicle types, time-use restrictions for certain vehicle types, modified speed limits, and exclusive lane designations.
- Alteration of horizontal and vertical alignments.
- Acquisition of real property or interests therein (predominantly unimproved property) to serve as a buffer zone to preempt development which would be adversely impacted by traffic noise.
- Noise insulation of Activity Category D land use facilities listed in Table 1. Post-installation maintenance and operational costs for noise insulation are not eligible for Federal-aid funding.

Noise barriers are the only form of noise abatement considered for this project. Each noise barrier evaluated has been evaluated for feasibility based on achievable noise reduction. For each noise barrier found to be acoustically feasible, reasonable cost allowances were calculated by multiplying the number of benefited receptors by \$71,000. Table B-1 in Appendix B summarizes results at receptor locations for the single noise barrier (Barrier NB-1) that has been evaluated in detail for this project.

For any noise barrier to be considered reasonable from a cost perspective the estimated cost of the noise barrier should be equal to or less than the total cost allowance calculated for the barrier. The cost calculations of the noise barrier must include all items appropriate and necessary for construction of the barrier, such as traffic control, drainage modification, retaining walls, landscaping for graffiti abatement, and right-of-way costs. Construction cost estimates are not provided in this NSR, but are presented in the NADR. The NADR is a design responsibility and is prepared to compile information from the NSR, other relevant environmental studies, and design considerations into a single, comprehensive document before public review of the project. The NADR is prepared by the project engineer after completion of the NSR and prior to publication of the draft environmental document. The NADR includes noise abatement construction cost estimates that have been prepared and signed by the project engineer based on site-specific conditions. Construction cost estimates are compared to reasonableness allowances in the NADR to identify which wall configurations are reasonable from a cost perspective.

The design of noise barriers presented in this report is preliminary and has been conducted at a level appropriate for environmental review and not for final design of the project. Preliminary information on the physical location, length, and height of noise barriers is provided in this report. If pertinent parameters change substantially during the final project design, preliminary noise barrier designs may be modified or eliminated from the final project. A final decision on the construction of the noise abatement will be made upon completion of the project design.

The following is a discussion of noise abatement considered for each evaluation area where traffic noise impacts are predicted.

7.2.1. Area A

No traffic noise impacts are predicted for Area A. Accordingly, noise abatement does not need to be considered in this area.

7.2.2. Area B

Traffic noise impacts are predicted at residences in this area, and noise abatement must be considered. Receptors ST-2, ST-3, R-3, and R-4 represent a total of 63 residences in Area B. Detailed modeling analysis was conducted for a barrier located at the edge of the shoulder. The barrier evaluated is identified as Barrier NB-1 in Figure 5-1. Barrier heights in the range of 6 to 16 feet were evaluated in 2-foot increments. Table D-1 in Appendix D summarizes the results of the barrier analysis for each receptor location in Area B. Table 7-1 summarizes the calculated noise reductions and reasonable allowances for each barrier height.

Table 7-1. Summary of Reasonableness Allowances —Barrier NB-1

Barrier I.D.: NB-1 in Area B						
Critical Receptor: ST-2						
Design Year Noise Level, dBA $L_{eq}(h)$: 69						
Design Year Noise Level Minus Existing Noise Level: 3						
Design Year with Barrier	6-Foot Barrier	8-Foot Barrier	10-Foot Barrier ¹	12-Foot Barrier ²	14-Foot Barrier	16-Foot Barrier
Barrier Noise Reduction, dB	4	5	6	7	8	9
Number of Benefited Receptors	0	14	30	63	63	63
Reasonable Allowance Per Benefited Receptor	0	\$71,000	\$71,000	\$71,000	\$71,000	\$71,000
Total Reasonable Allowance	0	\$994,000	\$2.130M	\$4.473M	\$4.4732M	\$4.473M

¹Minimum height needed to break the line of sight between 11.5 foot truck stack and first row receptor.
²Minimum height need to achieve 7 dB noise reduction design goal.

7.2.3. Area C

The traffic noise modeling results in Table B-1 indicate traffic noise levels at commercial uses in Area C will be 70 dBA $L_{eq}(h)$ in the design-year. The results also indicate that the increase in noise between existing conditions and the design-year is 3 dB. Because there is no noise abatement criterion for this area and because the project would not result in a substantial increase in noise, noise abatement does not need to be considered in this area.

7.2.4. Area D

The traffic noise modeling results in Table B-1 indicate exterior traffic noise levels at the hotel and church will be 70 dBA $L_{eq}(h)$ in the design-year and that the increase in noise will be 3 dB. Because the church has an interior noise abatement criterion in addition to the exterior criterion, interior noise must be considered at the church as well. Because the predicted exterior noise level in the design-year is predicted to approach or exceed the noise abatement criterion (67 dBA $L_{eq}[h]$), noise abatement must be considered in this

area. The interior noise abatement criterion (52 dBA $L_{eq}[h]$) is not predicted to be approached or exceeded so abatement does not need to be considered relative to the interior noise abatement criterion.

All of the outdoor use areas at the church and hotel that are directly exposed to noise from traffic on SR 26 are parking areas. Parking areas are not considered to be areas of frequent human use that would benefit from a lowered noise level. Therefore, noise abatement is not considered further in this area.

Chapter 8. Construction Noise

23 CFR 772 requires that construction noise impacts be identified, but does not specify specific methods or abatement criteria for evaluating construction noise. However, the FHWA Roadway Construction Noise Model (Federal Highway Administration 2006) can be used to determine if construction would result in adverse construction noise impacts on land uses or activities in the project area. The discussion of construction noise impacts includes:

- A description of the type of equipment anticipated to be used and when and where it will be used;
- Predicted construction noise levels in the project area;
- Conclusions regarding the severity of construction noise impacts; and
- Identification of construction noise abatement, if any.

If adverse construction noise impacts are anticipated (e.g. nighttime pile driving near residences), project plans and specifications should identify abatement measures that would minimize or eliminate adverse construction noise impacts to the community. In determining the feasibility of construction noise abatement, Caltrans will consider the benefits achieved and the overall adverse social, economic, and environmental effects and the costs of the construction noise abatement measures.

The following is sample text for this chapter.

[Begin typing here.]

During construction of the project, noise from construction activities may intermittently dominate the noise environment in the immediate area of construction. Noise associated with construction is controlled by Caltrans Standard Specification Section 14-8.02, “Noise Control,” which states the following:

Do not exceed 86 dBA L_{max} at 50 feet from the job site activities from 9 p.m. to 6 a.m.

Equip an internal combustion engine with the manufacturer-recommended muffler. Do not operate an internal combustion engine on the job site without the appropriate muffler.

Table 8-1 summarizes noise levels produced by construction equipment that is commonly used on roadway construction projects. Construction equipment is expected to generate noise levels ranging from 70 to 90 dB at a distance of 50 feet, and noise produced by construction equipment would be reduced over distance at a rate of about 6 dB per doubling of distance.

Table 8-1. Construction Equipment Noise

Equipment	Maximum Noise Level (dBA at 50 feet)
Scrapers	89
Bulldozers	85
Heavy Trucks	88
Backhoe	80
Pneumatic Tools	85
Concrete Pump	82

Source: Federal Transit Administration, 2006. See also:
http://www.fhwa.dot.gov/environment/noise/construction_noise/handbook/handbook09.cfm

No adverse noise impacts from construction are anticipated because construction would be conducted in accordance with Caltrans Standard Specifications Section 14.8-02. Construction noise would be short-term, intermittent, and overshadowed by local traffic noise.

Chapter 9. References

This chapter contains references cited in the NSR. The format for cited references is provided below. References cited in the boiler plate and example text are also provided below.

Books, Journal Articles, Reports: [Author(s). YEAR Title. Publisher/Source. Volume: Page begin-Page end].

Correspondence: [Author(s). Date. Subject. Agency/Company. Pp. (pages)].

Phone: [Contact Name. Date. Subject. Agency/Company. Phone Number. Result/Action].

E-mail: [Contact Name. Date. Subject. Agency/Company. E-mail address. Result/Action].

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Appendix A Traffic Data

This appendix contains tables presenting the traffic data for existing conditions, design-year conditions without the project, and design-year conditions with the project for each alternative.

Tables A-1 through A-3 are sample tables containing traffic data.

[Begin typing here].

Table A-1. Traffic Data for Existing Conditions

	Segment	Number of Lanes	Total Volume PM Peak Hour Volume	Auto		Medium Trucks		Heavy Trucks		Speed (A/MT/HT)
				%	Volume	%	Volume	%	Volume	
Mainline										
SR 26 eastbound	West of Main Street	2	3,760	90.0%	3,389	3.0%	113	7.0%	264	65/65/55
SR 26 eastbound ^a	Main Street to Maple Avenue	2	4,000	90.0%	3,600	3.0%	120	7.0%	280	65/65/55
SR 26 eastbound	East of Maple Avenue	2	3,860	90.0%	3,476	3.0%	116	7.0%	270	65/65/55
SR 26 westbound	West of Main Street	2	3,620	89.0%	3,224	4.0%	145	7.0%	254	65/65/55
SR 26 westbound ^a	Main Street to Maple Avenue	2	4,000	89.0%	3,560	4.0%	160	7.0%	280	65/65/55
SR 26 westbound	East of Maple Avenue	2	3,740	89.0%	3,333	4.0%	150	7.0%	262	65/65/55
Surface Streets										
Main Street	North of SR 26	2	640	97.0%	626	2.0%	13	1.0%	6	35
Main Street	South of SR 26	2	720	97.0%	700	2.0%	14	1.0%	7	35
Maple Avenue	North of SR 26	2	710	97.0%	684	2.0%	14	1.0%	7	35
Maple Avenue	South of SR 26	2	640	97.0%	625	2.0%	13	1.0%	6	35

^a Forecast peak hour volume exceeds 2,000 vehicles per lane per hour (vplph). Volume has been limited to 2,000 vplph to model the maximum noise condition.

Table A-2. Traffic Data for Design Year No-Project Conditions

	Segment	Number of Lanes	Total Volume PM Peak Hour Volume	Auto		Medium Trucks		Heavy Trucks		Speed
				%	Volume	%	Volume	%	Volume	
Mainline										
SR 26 eastbound ^a	West of Main Street	2	4,000	90.0%	3,600	3.0%	120	7.0%	280	65/65/55
SR 26 eastbound ^a	Main Street to Maple Avenue	2	4,000	90.0%	3,600	3.0%	120	7.0%	280	65/65/55
SR 26 eastbound ^a	East of Maple Avenue	2	4,000	90.0%	3,600	3.0%	120	7.0%	280	65/65/55
SR 26 westbound ^a	West of Main Street	2	4,000	89.0%	3,560	4.0%	160	7.0%	280	65/65/55
SR 26 westbound ^a	Main Street to Maple Avenue	2	4,000	89.0%	3,560	4.0%	160	7.0%	280	65/65/55
SR 26 westbound ^a	East of Maple Avenue	2	4,000	89.0%	3,560	4.0%	160	7.0%	280	65/65/55
Surface Streets										
Main Street	North of SR 26	2	760	97.0%	722	2.0%	15	1.0%	7	35
Main Street	South of SR 26	2	840	97.0%	810	2.0%	17	1.0%	8	35
Maple Avenue	North of SR 26	2	820	97.0%	797	2.0%	16	1.0%	8	35
Maple Avenue	South of SR 26	2	700	97.0%	685	2.0%	14	1.0%	7	35

^a Forecast peak hour volume exceeds 2,000 vehicles per lane per hour (vplph). Volume has been limited to 2,000 vplph to model the maximum noise condition.

Table A-3. Traffic Data for Design Year with Project Conditions

	Segment	Number of Lanes	Total Volume PM Peak Hour Volume	Auto		Medium Trucks		Heavy Trucks		Speed
				%	Volume	%	Volume	%	Volume	
Mainline										
SR 26 eastbound	West of Main Street	3	5,120	90.0%	4,608	3.0%	154	7.0%	358	65/65/55
SR 26 eastbound	Main Street to Maple Avenue	3	4,960	90.0%	4,464	3.0%	149	7.0%	347	65/65/55
SR 26 eastbound	East of Maple Avenue	3	5,440	90.0%	4,896	3.0%	163	7.0%	381	65/65/55
SR 26 westbound	West of Main Street	3	5,890	89.0%	5,242	4.0%	236	7.0%	412	65/65/55
SR 26 westbound	Main Street to Maple Avenue	3	4,840	89.0%	4,308	4.0%	194	7.0%	339	65/65/55
SR 26 westbound	East of Maple Avenue	3	4,760	89.0%	4,236	4.0%	190	7.0%	333	65/65/55
Surface Streets										
Main Street	North of SR 26	2	840	97.0%	817	2.0%	17	1.0%	8	35
Main Street	South of SR 26	2	890	97.0%	863	2.0%	18	1.0%	9	35
Maple Avenue	North of SR 26	2	906	97.0%	879	2.0%	18	1.0%	9	35
Maple Avenue	South of SR 26	2	840	97.0%	819	2.0%	17	1.0%	8	35

Appendix B Predicted Future Noise Levels and Noise Barrier Analysis

This appendix contains a table (or tables) that summarizes the traffic noise modeling results for existing and design-year conditions with and without the project. This table also compares the predicted noise reductions by barrier height for each noise barrier analyzed.

Table B-1 is a sample table.

[Begin typing here]

Appendix C Noise Barrier Analysis

This appendix contains a table that compares the predicted noise reductions by barrier height for each noise barrier analyzed.

Table D-1 is a sample table for a noise barrier analysis.

[Begin typing here]

Table C-1. Analysis of Barrier NB-1

	Position				Total Number of Benefited Receptors
	ST-2	St-3	R-3	R-4	
Number of Units Represented	14	16	15	18	
Existing Traffic Noise Level (dBA L _{eq} [h])	66	67	61	62	
Design Year with Project Traffic Noise Level (dBA L _{eq} [h])	69	70	64	65	
Design Year with Project minus Existing Traffic Noise Level (dBA L _{eq} [h])	+3	+3	+3	+3	
6-Foot Barrier					
Design Year with Project Traffic Noise Level (dBA L _{eq} [h])	65	67	62	64	
Predicted Noise Reduction (dB)	-4	-3	2	1	
Number of Benefited Receptors	0	0	0	0	0
8-Foot Barrier					
Design Year with Project Traffic Noise Level (dBA L _{eq} [h])	64	66	61	63	
Predicted Noise Reduction (dB)	-5	-4	-3	-2	
Number of Benefited Receptors	14	0	0	0	14
10-Foot Barrier					
Design Year with Project Traffic Noise Level (dBA L _{eq} [h])	63	65 ^a	60	61	
Predicted Noise Reduction (dB)	-6	-5	4	4	
Number of Benefited Receptors	14	16	0	0	30
12-Foot Barrier^b					
Design Year with Project Traffic Noise Level (dBA L _{eq} [h])	62	64	59	60	
Predicted Noise Reduction (dB)	-7	-6	-5	-5	
Number of Benefited Receptors	14	16	15	18	63
14-Foot Barrier					
Design Year with Project Traffic Noise Level (dBA L _{eq} [h])	61	63	58	60	
Predicted Noise Reduction (dB)	-8	-7	-6	-5	
Number of Benefited Receptors	14	16	15	18	63
16-Foot Barrier					
Design Year with Project Traffic Noise Level (dBA L _{eq} [h])	60	61	58	59	
Predicted Noise Reduction (dB)	-9	-9	-6	-6	
Number of Benefited Receptors	14	16	15	18	63

^a Traffic noise levels that approach or exceed 67 dBA L_{eq}(h) are shown in bold.

^b 12-foot-high barrier breaks the line of sight to an 11.5-foot truck stack.

Appendix D Supplemental Data

Supplemental data such as field notes, photographs, and other data from the field investigation should be provided here.