

Traffic Noise Analysis



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August, 2006

California Department of Transportation
Division of Environmental Analysis



Traffic Noise Analysis Protocol

**For New Highway Construction,
Reconstruction, and Retrofit Barrier
Projects**

**California Department of Transportation
Division of Environmental Analysis**

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*Traffic Noise Analysis Protocol for New Highway Construction,
Reconstruction Projects, and Retrofit Barrier Projects. August.*

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Acronyms and Abbreviations

Caltrans	California Department of Transportation
CEQA	California Environmental Quality Act
CFR	Code of Federal Regulations
CNEL	community noise equivalent level
CPI	Construction Price Index
dB	decibel
dBA	A-weighted decibel
FHWA	Federal Highway Administration
FTA	Federal Transit Administration
L _{dn}	day-night level
L _{eq} [h]	1-hour equivalent sound level
NAC	noise abatement criteria
NADR	Noise Abatement Decision Report
NEPA	National Environmental Policy Act
NSR	Noise Study Report
Protocol	Traffic Noise Analysis Protocol
RTP	Regional Transportation Plan
RTPA	Regional Transportation Planning Agency
SER	Caltrans Standard Environmental Reference
TeNS	Technical Noise Supplement
TNM	Traffic Noise Model

Section 1

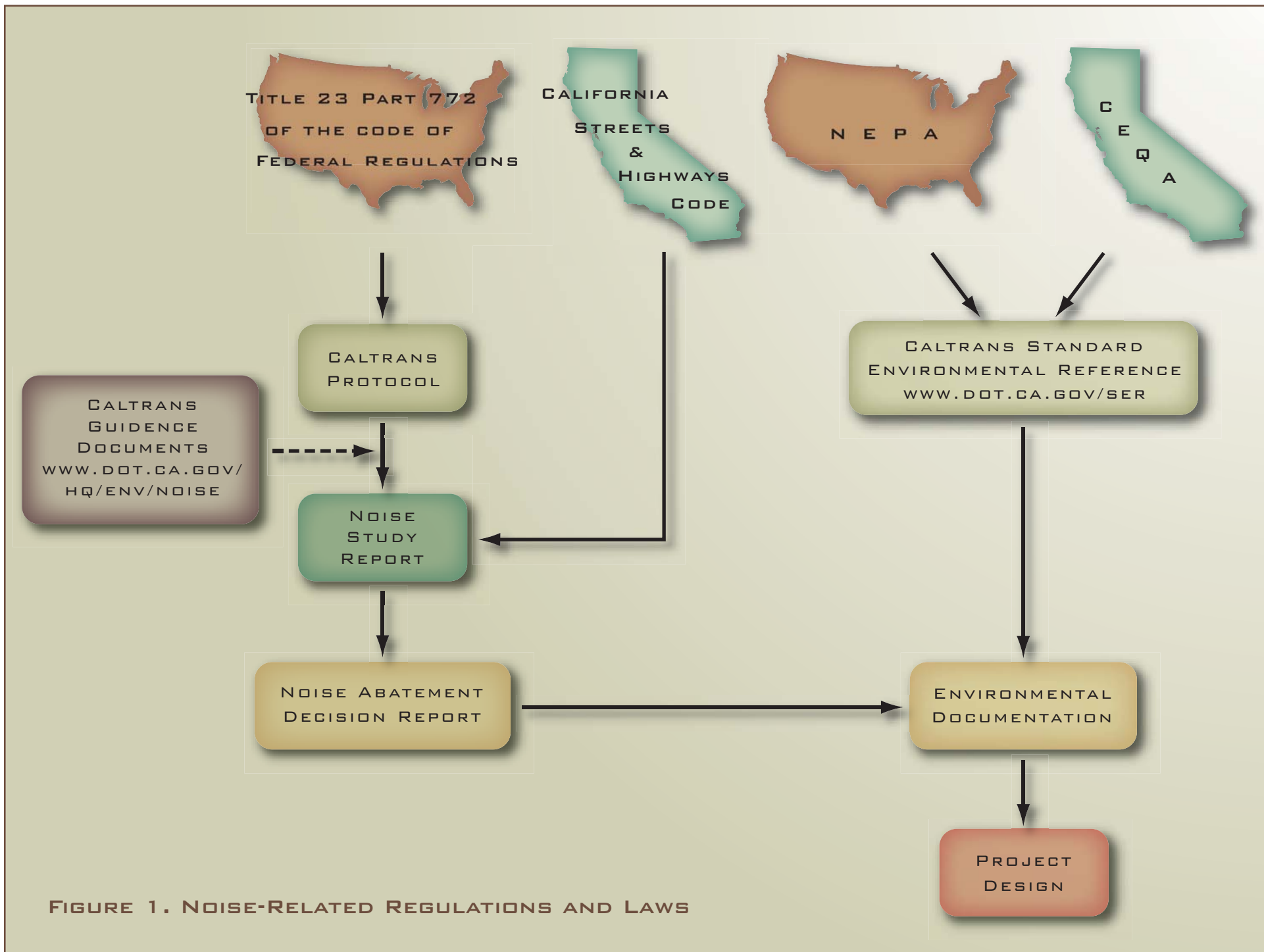
Introduction

Title 23, Part 772 of the Code of Federal Regulations (CFR), titled “Procedures for Abatement of Highway Traffic Noise and Construction Noise,” outlines procedures for noise studies that are required for approval of Federal-aid highway projects. The Federal Highway Administration (FHWA) requires that State highway agencies prepare state-specific policies and procedures for applying 23 CFR 772.

The purpose of this *Traffic Noise Analysis Protocol for New Highway Construction, Reconstruction, and Retrofit Barrier Projects* (Protocol) is to present California Department of Transportation (Caltrans) policies and procedures for applying 23 CFR 772 in California. This Protocol applies to Caltrans and local agency projects that receive Federal funding or require FHWA approval action.

A noise study conducted according to this Protocol should contain the analysis required for completion of environmental documentation under the National Environmental Policy Act (NEPA) or California Environmental Quality Act (CEQA). Refer to the Caltrans Standard Environmental Reference (SER) for guidance on procedures for implementing NEPA and CEQA (California Department of Transportation 2006). In addition, Caltrans has prepared a document titled *Technical Noise Supplement* (TeNS) (California Department of Transportation 1998a) to assist noise analysts with the technical aspects of noise impact analysis. The TeNS supplements this Protocol and contains Caltrans noise analysis procedures, practices, and other useful technical background information related to the analysis of highway noise impacts and abatement. Refer to the TeNS for definitions of technical terms used in the Protocol (<http://www.dot.ca.gov/hq/env/noise>).

If necessary, the noise study should also contain analysis required under Section 216 of the California Streets and Highway Code. This code relates to how traffic noise from a proposed freeway project affects noise levels in school classrooms. Figure 1 outlines the relationship between the State and Federal regulations and laws, the Protocol, Caltrans guidance,



noise study documentation, environmental documentation, and project design.

This Protocol addresses the following main topics:

- Type I: New Construction or Reconstruction Projects.
- Type II: Retrofit Noise Abatement Projects.
- Noise Documentation.
- Liaison with Local Agencies.

This Protocol was developed by a team from several areas of Caltrans and FHWA. This Protocol is a complete revision of and supercedes the previous *Traffic Noise Analysis Protocol* (California Department of Transportation 1998b). Noise studies initiated before the publication date of this version of the Protocol may be completed using the requirements of the previous Protocol. In cases where it is anticipated that the date of the Record of Decision for the environmental document will occur beyond 2 years from the Protocol publication date it is recommended that the new Protocol be utilized.

Definitions of key terms used in the Protocol are provided in the glossary provided in Appendix A. Terms defined in the glossary are shown as bold italicized text on first use in the Protocol.

The Protocol does not apply to projects sponsored by the Federal Transit Administration (FTA). Noise studies for projects sponsored by FTA should be prepared in accordance with guidance in the FTA document entitled *Transit Noise and Vibration Impact Assessment*. (FTA 2006).

Section 2

23 CFR 772

The purpose of 23 CFR 772 is to provide procedures to help protect public health and welfare, supply noise abatement criteria (NAC), and establish requirements for information to be given to local officials for use in the planning and design of highways approved pursuant to 23 CFR 772.1. As such, 23 CFR 772 provides procedures for preparing operational and construction noise studies and evaluating **noise abatement** considered for 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 the FHWA noise standards. This Protocol provides California policies and procedures for compliance with 23 CFR 772. The text of 23 CFR 772 is contained in Appendix B.

Under 23 CFR 772.7, projects are categorized as ***Type I*** or ***Type II 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, or increases the number of through-traffic lanes. A Type II project is a noise barrier retrofit project that involves no changes to highway capacity or alignment.

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 environmental documentation. This process involves identification of noise abatement measures that are reasonable, feasible, and likely to be incorporated into the project, and noise impacts for which no apparent solution is available. Figure 2 summarizes the highway noise analysis process.

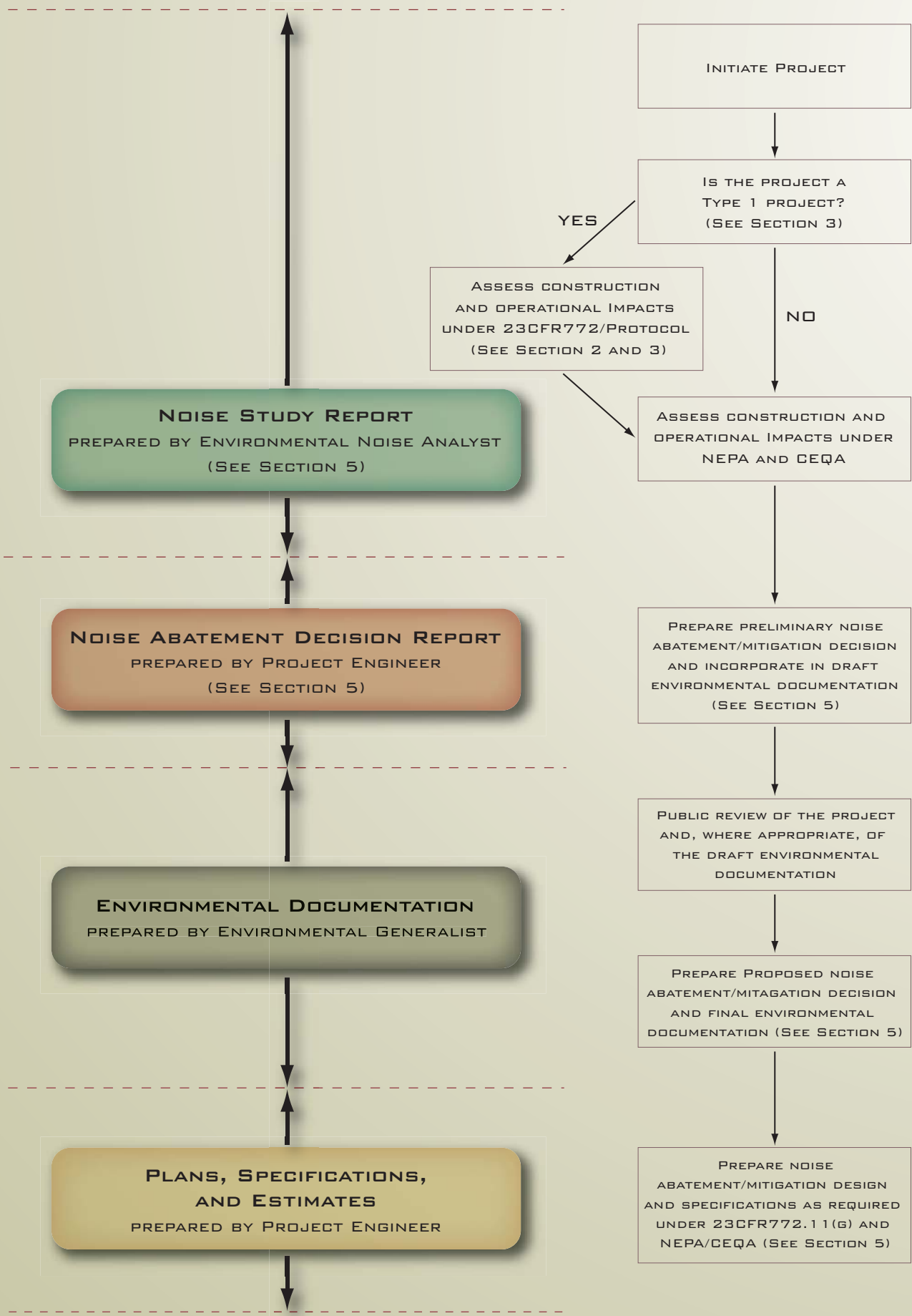


FIGURE 2. HIGHWAY NOISE ASSESSMENT FLOW CHART

Section 3

Type I: New Construction or Reconstruction Projects

Type I projects include projects that create a completely new noise source and projects that increase the volume or speed of traffic or move the traffic closer to a **receiver**. Projects unrelated to increased noise levels, such as striping, lighting, signing, and landscaping projects, are not considered Type I projects. The FHWA has stated that, in rare cases, a project that is not a Type I project may cause a traffic noise impact. These projects must be analyzed on a case-by-case basis.

Type I projects could include the addition of an interchange, ramp, auxiliary lane, or truck-climbing lane to an existing highway, or the widening an existing ramp by a full lane width for its entire length (Federal Highway Administration 1995). The addition of high-occupancy vehicle lanes or truck-climbing lanes to highways is considered a Type I project regardless of whether the lanes are added in the median or on the outside of the existing highway. Traffic noise analysis is required for both sides of the highway, even when the lanes are added on only one side of the highway. The addition of an auxiliary lane should also be classified as a Type I project if the lane is long enough to function as a through-traffic lane or increases capacity. An auxiliary lane added between interchanges to improve operational efficiency should be classified as a Type I project if the lane is at least 1.5 miles long or is made continuous through successive interchanges.

Traffic Noise Impacts

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).

Table 1 summarizes noise abatement criteria corresponding to various land use activity categories. Activity categories and related traffic noise

impacts are determined based on the actual land use in a given area. A noise level is considered to approach the NAC for a given activity category if it is within 1 ***dB*A** (A-weighted decibel) of the NAC.

A substantial noise increase occurs when the project's predicted worst-hour design-year noise level exceeds the existing worst-hour noise level by 12 dBA- $L_{eq}(h)$ (1-hour equivalent sound level) or more.

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

Activity Category	NAC (dBA- $L_{eq}(h)$)	Description of Activities
A	57: Exterior	Lands on which serenity and quiet are extraordinarily significant 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	67: Exterior	Picnic areas, recreation areas, playgrounds, active sport areas, parks, residences, motels, hotels, schools, churches, libraries, and hospitals.
C	72: Exterior	Developed lands, properties, or activities not included in categories A and B above.
D	—	Undeveloped lands.
E	52: Interior	Residences, motels, hotels, public meeting rooms, schools, churches, libraries, hospitals, and auditoriums.

In identifying noise impacts, primary consideration is given to exterior areas. In situations where there are no exterior activities, or where the exterior activities are far from the roadway or physically shielded in a manner that prevents an impact on exterior activities, the Activity Category E interior criterion is used as the basis for determining noise impacts.

If undeveloped lands are ***planned, designed, and programmed*** before the ***date of public knowledge***, noise abatement must be considered as part of the transportation project. The date of public knowledge is the date of approval of the final NEPA environmental documentation for that transportation project. The date of approval is the date that the Categorical Exclusion, Finding of No Significant Impact, or Record of Decision under NEPA; or the Notice of Determination or Notice of Completion under CEQA is signed.

Land development is considered to be planned, designed, and programmed when the development has received all final discretionary approvals from the local agency with jurisdiction. This is generally the date that the building permit or vesting tentative map is issued.

Undeveloped land adjacent to highway right-of-way that is planned, designed, and programmed after the date of public knowledge of the transportation project is an Activity Category D land use. Noise abatement is not considered for Activity Category D land uses.

Screening Procedure

All Type I projects must be analyzed for noise impacts using a preliminary screening procedure to determine whether additional detailed noise impact analysis is warranted. If a project passes the screening procedure, additional noise analysis under 23 CFR 772 is normally not necessary. If a project is considered controversial or the net effects of changes in topography and shielding are not obvious, a detailed analysis (see “Detailed Impact Analysis”) is warranted regardless of whether the screening procedure indicates otherwise. The screening procedure is summarized below. The complete screening procedure can be found in the TeNS.

- Determine whether there are receivers that could potentially be exposed to traffic noise impacts from the project. If there are no receivers that could potentially be exposed to traffic noise impacts, the project passes the screening and no further analysis is required. Traffic noise impacts can occur at any of the activity category land uses listed in Table 1 and are not limited to residential areas.
- If one or more of the project alternatives would be along a new alignment, the project fails the screening and a detailed analysis is required.
- If shielding of the receivers would not be the same or improved after the project, the project fails the screening and a detailed analysis is required.
- If the existing worst hourly noise levels at the ***critical design receivers*** are within 5 dBA of the applicable NAC, the project fails the screening and a detailed analysis is required.
- If the increase in noise levels after the project would be 3 dBA or more above existing noise levels, a detailed analysis is required. The increase is calculated from a simple formula involving existing and future traffic and existing and future distances between the roadway and receivers. Refer to the TeNS for a description of this calculation.

If the screening procedure is passed and no need for a detailed impact analysis is indicated, the results of the screening procedure are summarized in a brief technical memorandum. The memorandum must also address construction noise as required under 23 CFR 772.19.

Information in this memorandum is then used as the basis for the noise analysis presented in the draft environmental documentation.

Detailed Impact Analysis

If a project does not pass the screening procedure or if warranted by other conditions, a detailed noise impact analysis must be performed. The first step is to determine whether traffic noise impacts under 23 CFR 772 are predicted. A detailed traffic noise impact analysis must be done for each project alternative, including the no-build or no-action alternative. The steps of the analysis are summarized below:

1. Identify existing developed land uses and planned, designed, and programmed land uses adjacent to the project that may be affected by the project.
2. Determine worst-hour existing noise levels at adjacent land uses.
3. Predict traffic noise levels using traffic characteristics that will yield the worst hourly traffic noise impact on a regular basis for the **design year** using traffic noise prediction methodology that is consistent with officially approved Caltrans noise prediction models. The current approved methodology at the publishing date of this Protocol is the FHWA Traffic Noise Model[®] (TNM[®]) Version 2.5.

Current highway traffic noise prediction models have been shown to be inaccurate at distances of more than 500 feet from the highway. No current or future prediction model should be used beyond that distance unless it has been validated for distances beyond 500 feet from a highway. Judgment should be used to evaluate borderline receivers. The more complex the intervening terrain, the more rigidly the 500-foot limit should be applied; in some extremely complex topography, the limit may prudently be reduced.

4. Determine whether traffic noise impacts are predicted at adjacent land by comparing predicted worst-hour noise levels in the design year to existing noise levels and the NAC.

The results of this analysis should be provided to local agencies pursuant to 23 CFR 772.15, which requires Caltrans to inform local officials about estimated future noise levels and to provide information that will allow local communities to avoid noise-incompatible future land development.

Construction Noise Impacts

23 CFR 772 requires that construction noise be evaluated for all Type I and Type II projects. To perform an assessment of construction noise, land uses or activities that may be affected by noise from construction of the project should be identified. 23 CFR 772 does not specify specific methods or abatement criteria for evaluating construction noise. However, a reasonable analysis method such as FHWA Roadway Construction Noise Model (Federal Highway Administration 2006) should be used to determine whether construction would result in adverse construction noise impacts on land uses or activities in the project area.

Section 7-1.101I of the Caltrans Standard Specifications states the following.

- The Contractor shall comply with all local sound control and noise level rules, regulations, and ordinances which apply to any work performed pursuant to the contract.
- Each internal combustion engine, used for any purpose on the job or related to the job, shall be equipped with a muffler of a type recommended by the manufacturer. No internal combustion engine shall be operated on the project without the muffler.

If adverse construction noise impacts are anticipated, project plans and specifications should identify abatement measures which would minimize or eliminate adverse construction noise impacts to the community. When construction noise abatement is identified, Caltrans will consider the benefits achieved and the overall adverse social, economic, and environmental effects and the costs of the construction noise abatement measures.

If noise barriers are planned as part of the project, Caltrans will consider constructing the barriers before beginning project construction, so that the barriers can reduce construction noise transmission to adjacent land uses. Construction of barriers before project construction can be accomplished through a separate contract or as a first phase of work under the project construction contract.

Noise Abatement

Abatement Alternatives In 23 CFR 772

If traffic noise impacts are predicted, noise abatement measures must be considered. Noise abatement is only considered where ***frequent human use*** occurs and where a reduced noise level would be of benefit. Noise abatement must be designed for a substantial reduction in noise, which is defined as a 5-decibel (dB) minimum reduction. This reduction represents a “readily perceptible change” in the noise level as described in the TeNS. Noise abatement measures that are determined reasonable and feasible and are likely to be incorporated into the project must be identified before adoption of the final environmental documentation.

According to 23 CFR 772(13)(c), Federal funding may be used for the following abatement measures:

1. Traffic management measures (e.g., 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).
2. Alteration of horizontal and vertical alignments.
3. Acquisition of property rights (either in fee or lesser interest) for construction of noise barriers.
4. Construction of noise barriers (including landscaping for aesthetic purposes) whether within or outside the highway right-of-way. Interstate construction funds may not participate in landscaping.
5. Acquisition of real property or interests therein (predominantly unimproved property) to serve as a buffer zone to preempt development that would be adversely impacted by traffic noise. This measure may be included in Type I projects only.
6. Noise insulation of public use or nonprofit institutional structures.

Interior noise abatement measures may routinely be considered for public use or non-profit institutional structures such as churches, schools, hospitals, and libraries if there are no exterior areas of frequent human use. Interior noise abatement measures for private dwellings may only be considered under certain conditions (see “Special Considerations” below).

Design objectives and criteria for noise abatement measures are discussed in detail in Chapter 1100, “Noise Abatement,” of the *Highway Design Manual*. Section 1101 contains general requirements, and Section 1102 discusses design criteria. The Caltrans Project Manager is responsible for

ensuring that the guidance and requirements in the most current version of *Highway Design Manual* are implemented in the final design.

Noise abatement measures that provide noise reduction of more than 5 dB are encouraged as long as they meet the reasonableness guidelines discussed under “Reasonableness” below. When a noise barrier is designed, its end locations should be influenced by the impacted receivers only, not by any potentially benefited receivers that flank the barrier. The NAC in Table 1 are not design goals for noise abatement, but rather thresholds at which noise abatement must be considered.

State-Funded Abatement

Quieter pavement is currently not listed in 23 CFR 772 as a noise abatement measure for which Federal funding may be used. Caltrans is actively researching the benefits of pavement types in reducing tire noise source levels to demonstrate the long-term noise abatement characteristics of quieter pavement. Information about the ongoing pavement research can be found on the Caltrans web site (California Department of Transportation 2003). In some special circumstances, Caltrans may consider using state only funds to pay for quieter pavement to reduce traffic noise.

Feasibility

The feasibility of a noise abatement measure is an engineering consideration. Noise abatement must reduce noise at least 5 dB to be considered feasible from an acoustical perspective. As stated above, noise abatement measures that provide noise reduction of more than 5 dB are encouraged as long as they meet the reasonableness guidelines covered under “Reasonableness” below. Feasibility may also be restricted by various factors, including topography, access requirements for driveways, presence of local cross streets, underground utilities, other noise sources in the area, and safety considerations.

Reasonableness

The determination of the reasonableness of noise abatement is more subjective than the determination of its feasibility. The overall reasonableness of noise abatement is determined by many factors. Primary factors that affect reasonableness include the cost of noise abatement, absolute noise levels, existing versus design-year noise levels,

achievable noise reduction, date of development along the highway, life cycle of noise abatement measures, and environmental impacts of abatement construction. Additional factors to consider include opinions of affected residents; input from the public and public agencies; and social, economic, legal, and technological factors.

With regard to the life cycle of the project, it is normally not reasonable to construct a noise abatement measure where planned future use as identified in a Regional Transportation Plan (RTP) would limit its useful life to less than 20 years.

The noise abatement recommendations presented in the draft environmental documentation are based on the primary factors listed above. The additional factors, such as input from the public and public agencies, are considered through the remainder of the environmental review process. The Project Development Team will make the proposed noise abatement decisions that will be incorporated into the final environmental documentation. Any proposed changes to the noise abatement decision subsequent to adoption of the final environmental document should be reviewed with the District noise specialists to insure adequate acoustic performance.

Cost considerations for determining noise abatement reasonableness are evaluated by comparing reasonableness allowances and projected abatement costs. The following discussion provides detailed guidance for calculating reasonableness allowances.

Residential Cost Considerations

Cost considerations in the reasonableness determination of noise abatement for exteriors of residential areas begin with a 2006 base allowance per *benefited residence* of \$32,000. A benefited residence is a dwelling unit that is predicted to receive a noise reduction of at least 5 dBA from the proposed noise abatement measure. A residence can be a benefited residence even if it is not subject to a traffic noise impact.

For each noise abatement location, the base allowance per benefited residence is adjusted by the five reasonableness factors described below, resulting in a 2006 reasonableness allowance per benefited residence for the noise abatement measure. The reasonableness allowance should always be rounded up to the nearest \$1,000.

The 2006 base allowance of \$32,000 is based on the published Caltrans annual 2005 Construction Price Index (CPI) of 268.3. In the future, the

base allowance must be adjusted based on the most recent annual CPI found at the Caltrans web site.

The five reasonableness cost factors for computing the total reasonableness allowance are described below:

1. **Absolute Noise Level:** This factor relates to the predicted design-year noise level (with the project, without noise abatement) at the *critical design receiver*. Cost adjustment factors for absolute noise levels are listed below:

Design-Year Noise Level (dBA- $L_{eq}[h]$)	Cost Added
69 or less	\$2,000
70–74	\$4,000
75–78	\$6,000
78+	\$8,000

2. **Increase in Noise Level:** This factor relates to the increase in the noise level from existing to predicted design-year with-project conditions at the critical design receiver. Cost adjustment factors for increased noise levels are listed below:

Noise Increase (dBA)	Cost Added
0–2	\$0
3–7	\$2,000
8–11	\$4,000
12+	\$6,000

3. **Achievable Noise Reduction:** This factor relates to the noise reduction (e.g., noise barrier insertion loss) provided by the noise abatement at the critical design receiver. Cost adjustment factors for the achievable noise reduction are listed below:

Noise Reduction (dBA)	Cost Added
5	\$0
6–8	\$2,000
9–11	\$4,000
12	\$6,000

4. **Date of Highway Construction vs. Date of Residential Construction:** This adjustment increases the abatement allowance by \$10,000 if the project is new highway construction or if most of the benefited residences (more than 50%) existed before January 1, 1978, for a highway reconstruction project.

5. **Total Reasonableness Allowance vs. Project Cost:** This adjustment relates to the cost of abatement relative to the cost of the project without abatement. The fundamental premise is that it is not reasonable to spend more than 50% of the project cost (without abatement) on abatement. If the final total reasonableness allowance for all evaluated noise abatement exceeds 50% of the engineer's construction cost estimate for the project without noise abatement, the reasonableness allowance for each noise abatement measure is modified as follows:
- divide the allowance for the individual noise abatement measure by the total unmodified reasonableness allowances for all noise abatement measures, and
 - multiply the result by 50% of the engineer's construction cost estimate for the project without abatement (round up to the nearest \$1,000).

A simple example of how this factor works is provided below. First, the unmodified costs for the noise abatement measures and for the project without abatement are as follows:

- **Noise Abatement Measure 1:** \$200,000
- **Noise Abatement Measure 2:** \$300,000
- **Noise Abatement Measure 3:** \$400,000
- **Project without abatement:** \$1,500,000

The sum of the unmodified abatement is \$900,000, which exceeds 50% of the project cost (\$750,000). The modified allowances are as follows:

- **Noise Abatement Measure 1 Modified Cost:**
 $(200,000/900,000) \times (1,500,000 \times 0.5) = \$166,666 \sim \textbf{\$167,000}$
- **Noise Abatement Measure 2 Modified Cost:**
 $(300,000/900,000) \times (1,500,000 \times 0.5) = \textbf{\$250,000}$
- **Noise Abatement Measure 3 Modified Cost:**
 $(400,000/900,000) \times (1,500,000 \times 0.5) = \$333,333 \sim \textbf{\$334,000}$

If the engineer's cost estimate for a given proposed noise abatement measure is less than the total reasonableness allowance for all benefited residences, the noise abatement measure is considered to be reasonable from a cost perspective. The total reasonableness allowance for a given barrier is the calculated reasonableness allowance multiplied by the number of benefited residences for that barrier.

The cost calculations of the noise abatement measure should include all items appropriate and necessary for the construction of the noise abatement measure. Examples of cost items that should be included in estimating the construction cost of a noise abatement measure include traffic control, drainage modification, retaining walls, landscaping for graffiti abatement, right-of-way costs, and standard aesthetic treatments. Only those costs directly related to the construction of the noise abatement should be included in the noise abatement construction estimate.

If visual mitigation requirements include the use of a transparent noise barrier, the additional cost shall not be included in the abatement construction cost estimate for the purpose of determining reasonableness. If a retaining wall is a project feature for reasons other than constructing a noise barrier, the cost of the retaining wall is not included in the abatement construction cost estimate. If site conditions require a retaining wall or modification of a planned retaining wall for the proposed noise barrier foundation, the cost of the retaining wall or related modifications is included in the construction cost estimate.

To determine whether a cost is attributable to a noise abatement measure, it should be determined whether the cost would be necessary if no noise abatement measures were constructed. For example, only the portion of the traffic control, landscape, or retaining wall cost that is added because a noise abatement measure is being constructed should be attributed to the cost of the abatement.

The reasonableness allowance discussed in this section is calculated independently from the estimated construction cost of the noise abatement measure. The reasonableness allowance is the maximum amount that should reasonably be spent on noise abatement and should be used for comparative purposes only. It should not be construed as a spending goal. If the estimated cost of the noise abatement measure turns out to be less than the reasonableness allowance and the noise abatement goals will be met, it is not necessary to increase spending for noise abatement to the maximum of the reasonableness allowance. However, an effort should be made to achieve the greatest noise reduction possible within the calculated abatement allowance.

Examples of the modified reasonableness allowance calculation on the basis of the above reasonableness factors 1 to 5 and suggested worksheets are provided in Appendix B.

Normally, when abatement in the form of barriers is considered, barriers ranging in height from 6 to 16 feet are evaluated in 2-foot increments. A range of abatement allowances and construction costs can then be calculated and compared. Barriers with heights greater than 16 feet may

be considered if necessary to achieve acoustical feasibility (i.e., at least 5 dB of noise reduction) or cost reasonableness (i.e., calculated allowance exceeds estimated cost). Coordination with Design is needed to support the final height.

Non-Residential Cost Considerations

Reasonableness allowances may also be calculated for exterior non-residential land uses listed in Table 1 (e.g., churches, schools, hospitals). The same base allowance, adjustments, and modifications explained under “Reasonableness” above are used in determining the reasonableness allowance, except that the number of 100-foot frontage units is used instead of the number of residential units. A frontage unit is the length of the frontage of the land use along the highway divided by 100 feet. The frontage length is not necessarily the entire frontage length of the parcel under consideration, but rather the length along the highway where there is frequent human use that would benefit from a reduced noise level. Frontage units are always rounded up to the next whole unit. This approach is intended to provide non-residential land uses with the same degree of abatement consideration that is provided for residential uses. At interior locations where Activity Category E applies, frontage units should be calculated based on the length of the building facing the highway.

Special Considerations

Special circumstances related to abatement location and type will sometimes arise. These circumstances are related to the following topics: ultimate abatement location, noise abatement outside the right-of-way, unusual and extraordinary abatement, and reflected noise.

Ultimate Location

Noise abatement measures should be constructed to accommodate planned widening of the facility. A noise abatement measure is normally not constructed where planned future use (i.e., a use identified in an RTP) would limit its useful life to less than 20 years. If the route concept plan indicates the freeway will be widened and the noise abatement measures are to be constructed adjacent to the shoulder, the design should provide for salvage in the future.

Outside the Right-of-Way

Noise abatement measures are normally constructed within the State right-of-way. However, under certain topographical and geometric configurations, it may be more effective to construct noise abatement measures outside the right-of-way on private property. If it is determined that noise abatement should be considered for properties adjacent to the freeway and abatement in the State right-of-way is not feasible, construction outside the State right-of-way may be implemented under the conditions described below.

For a proposed abatement location outside the State right-of-way, a permanent easement must be secured for all of the affected properties to construct and maintain the noise abatement measure. On a Federally funded project, FHWA will hold Caltrans responsible for structural maintenance of the noise abatement measures. In most cases, right-of-way agreements require the property owner to perform routine maintenance on walls. The acquisition of this permanent easement is part of the abatement cost for the purposes of assessing reasonableness. If the noise abatement is determined not to be reasonable, the property owner may donate the permanent easement by signing a waiver of just compensation. Because noise abatement is a consideration, not a requirement, requesting donation of a permanent easement from the property owner when noise abatement is determined not to be reasonable is not a violation of the Uniform Relocation Assistance Act.

Additionally, all of the *affected property owners* must support the proposed noise abatement measure, location, and materials to be used for construction. Each affected property owner must enter into a contract with Caltrans that specifies that they agree:

- to allow Caltrans personnel, representatives, and contractors to enter their property for purposes of constructing the noise abatement measure and all other related work;
- to allow Caltrans personnel and representatives to enter their property with appropriate prior notification for the purpose of periodic inspection or structural repair of the noise abatement measure;
- to accept aesthetic maintenance responsibility of their respective portion of the noise abatement measure upon its completion and to perpetuate the noise abatement measure's initial aesthetic qualities;
- not to remove the noise abatement measure without full consent of all other affected property owners and Caltrans; and
- that the contract provisions will be a permanent burden on the property involved. Caltrans District Right-of-Way will determine specific

wording that, at a minimum, should include the following provision:
“The term of this contract shall be a burden that runs with the land, and shall inure and be binding upon the successors, assigns, or transferees of the property owner.”

Unusual and Extraordinary Abatement

There may be situations where “severe” traffic noise impacts exist or are expected but the abatement measures listed in 23 CFR 772.13(c) are not feasible or reasonable. A severe noise impact is considered to occur when predicted exterior noise levels equal or exceed 75 dBA- $L_{eq}(h)$ or are 30 dB or more above existing noise levels. In these instances, noise abatement measures other than those listed in 23 CFR 772.13(c) must be considered. Such measures are considered “unusual and extraordinary” abatement measures and may include measures such as constructing noise barriers that have an estimated construction cost that exceeds the reasonableness allowance or providing interior abatement in residential units. Unusual and extraordinary abatement proposed on a Federal-aid project is subject to approval by FHWA on a case-by-case basis. When noise abatement is provided on public or private properties consistent with this policy, an agreement must be entered into with the owner of the subject property that specifies that Caltrans is not responsible for any future costs of operating or maintaining the noise abatement measures. Unusual and extraordinary abatement must reduce noise by at least 5 dB to be considered feasible from an acoustical perspective.

Reflected Noise

In certain configurations, noise reflecting off reflective noise barriers (i.e., noise barriers constructed of noise-reflective materials) or structures can degrade the noise barriers’ performance or cause noise increases in areas not protected by the barriers. When designing noise barriers, the potential effects of the following occurrences should be evaluated:

- noise reflections between proposed parallel barriers (i.e., barriers on both sides of a highway), or between a proposed single barrier and an existing noise barrier on the opposite side of the highway, that reduce barrier performance or increase noise at unprotected receivers;
- noise reflections from a proposed single barrier that increase noise at unprotected receivers on the opposite side of the highway; and
- noise reflections from the interaction of one or more proposed noise barriers with existing or proposed structures that reduce barrier performance or increase noise at unprotected receivers.

The TeNS may be used as a guide to help identify and evaluate reflective noise effects. The evaluations should be based on available Caltrans-approved methods and engineering judgment. The effects of potential noise reflections should be included in the noise impact analysis, if necessary, and considered in the noise abatement reasonableness determination.

Measures to avoid or minimize noise reflections should be considered in the design of new noise barriers if the conditions discussed below are predicted. Measures to be considered are also outlined below. Features to avoid noise reflections should be considered as part of the ***noise abatement design*** if:

- the ratio of the spacing between parallel barriers or retaining walls and the average height of the barriers or walls is 15:1 or less, or
- receivers on one side of the highway have a direct line of sight to a barrier or retaining wall on the opposite side of the highway.

All methods and products considered to avoid or minimize reflections must be approved by Caltrans. The measures may include the following:

- avoiding noise reflections through appropriate design of noise barrier and structure configurations;
- constructing absorptive noise barriers or noise barriers lined with absorptive material;
- using earth berms where possible; and
- using available noise abatement measures other than noise barriers.

For comparison with the reasonable allowance, any cost associated with the proposed measure to avoid or minimize noise reflections should be included in the cost of the abatement. An exception to this occurs when a new barrier on one side of a highway results in a noise impact to a receiver on the opposite side of the highway. In this case, the cost of the reflection avoidance measure is excluded from the abatement construction cost estimate.

Noise Analysis Process Summary

Figure 1 contains a flow chart of the highway noise analysis process. The following discussion describes the process.

If the project is exempt from analysis under 23 CFR 772 (i.e., it is not a Type I project), or if no traffic noise impacts are predicted under

23 CFR 772, NEPA, or CEQA, then no evaluation of abatement is necessary. The project sponsor should report in the applicable draft environmental documentation that the project is exempt from 23 CFR 772, or that no traffic noise impacts under 23 CFR 772, NEPA, or CEQA are predicted and no noise abatement is required.

If traffic noise impacts are predicted, however, noise abatement must be considered. Noise abatement allowances for a range of noise barrier heights and information on the feasibility of noise abatement are reported in the noise study report. A specific recommended noise barrier height and information on construction costs are not presented in the noise study report.

The noise abatement recommendation is made after the abatement noise reductions, reasonableness allowances, and construction costs have been calculated. There are two possible outcomes, as described below.

- **Outcome 1:** If the proposed abatement is predicted to provide at least 5 dB of noise reduction, has an estimated cost of construction less than the calculated reasonableness allowance, and meets other reasonableness factors, then the noise abatement is determined to be feasible and reasonable and is therefore recommended. The recommendation is reported in the Noise Abatement Decision Report (NADR) and applicable draft environmental documentation. The following statement shall be included in both the NADR and the draft and final environmental documentation:

Based on the studies so far accomplished, Caltrans intends to incorporate noise abatement measures in the form of (a) barrier(s) at [location], with respective lengths and average heights of [total length and average height measurement]. Calculations based on preliminary design data indicate that the barrier(s) will reduce noise levels by 5 to [number] dBA for [number] residences at a cost of [dollars]. If during final design the project has substantially changed, noise barriers might not be provided. The final decision on the noise barriers will be made after completion of the public involvement process during the final project design process.

Similar language should be provided for other non-barrier abatement.

- **Outcome 2:** If traffic noise impacts are predicted and the proposed noise abatement is not feasible or reasonable, noise abatement is not recommended. This conclusion is reported in the NADR and applicable draft environmental documentation. The project sponsor states in the NADR and applicable draft environmental documentation that traffic noise impacts exist for which no apparent solutions are available. The reasons for this conclusion are also provided.

The noise abatement recommendation is subject to revision after public and environmental review of the project. The final reasonableness determination is based on the noise abatement recommendation and any relevant information received during the public review process. It is included in the final environmental documentation.

Circumstances may warrant outreach to affected residents in the form of a mail survey or public meetings on noise impact or abatement issues before completion of the draft environmental documentation. If there is reason to believe that most benefited residents would not be in favor of a noise barrier for reasons such as impacts to views, early contact should be initiated. Project managers should be made aware of the benefit of early outreach on projects that have the potential for issues because of conflicting impacts, such as noise and visual intrusion. Each district should develop plans for implementing outreach that are consistent with local policies and agreements.

Section 4

Type II: Retrofit Noise Abatement Projects

This section addresses retrofit noise abatement on existing transportation facilities for projects proposed within the State right-of-way or projects proposed by any agency using Type II Federal-aid funds under 23 CFR 772. Under current state law, Regional Transportation Planning Agencies (RTPAs), rather than Caltrans, are responsible for sponsoring retrofit noise abatement projects. However, abatement proposed for construction within the State right-of-way must be approved by Caltrans and therefore must meet certain minimum requirements as described in this section.

Retrofit noise abatement discussed in this section is limited to residential areas. In identifying areas for retrofit noise abatement, primary consideration must be given to exterior areas. Noise abatement is considered only where frequent human use occurs and a reduced noise level would be beneficial.

Eligibility and Funding

The development and implementation of retrofit noise abatement is an optional program under 23 CFR 772. Information in this section applies only to retrofit abatement projects proposed within the State right-of-way or projects proposed by any agency using Type II Federal-aid funds. Retrofit noise abatement projects can be eligible for Federal participation if projects are classified as Type II as defined in 23 CFR 772.7. All Type II projects require approval from FHWA. A categorical exclusion (non-programmatic) is the lowest level of NEPA document allowed for Type II projects.

When Type II projects are proposed for Federal-aid highway participation, the applicable provisions in 23 CFR 772.13 apply. RTPAs using Federal funds for retrofit noise abatement must follow the provisions of this chapter or those of a Federally approved noise abatement policy. Approval of a Type II policy which is different from the policy described herein is granted by FHWA on a case-by-case basis, with recommendation by and through Caltrans.

As stated in 23 CFR 772.13, Type II projects are projects that were approved before November 28, 1995, or are proposed along lands where land development or substantial construction predated the existence of any highway. The granting of a building permit, filing of a plat plan, or a similar action must have occurred before right-of-way acquisition or construction approval for the original highway. Noise abatement measures will not be approved at locations where such measures were previously determined not to be reasonable and feasible for a Type I project.

Qualification Criteria

The following criteria apply to retrofit noise abatement proposed within the State right-of-way:

- residential areas must have been developed before construction of the highway or before any expansion or alteration of the highway that would result in increased traffic noise at the residential areas;
- existing worst-hour noise level at the exterior of dwelling unit areas must exceed 67 dBA- $L_{eq}(h)$; and
- any other FHWA-approved criteria established and implemented by sponsoring RTPAs responsible for retrofit noise abatement program must be met.

Impact Analysis

All noise measurements and analysis must be performed in accordance with guidance in the TeNS. All analysis and modeling must be conducted with Caltrans-approved models.

Noise Abatement

Feasibility

For the proposed noise abatement measure to be considered feasible, the noise abatement must be designed to provide a minimum of 5 dBA of noise reduction at ***impacted receivers***. The feasibility criterion is not necessarily a noise abatement design goal; larger noise reductions are encouraged if they can be achieved within the noise abatement allowance.

Reasonableness

In addition to meeting the feasibility criteria, the proposed noise abatement should be reasonable from a cost perspective. A reasonable cost allowance calculation procedure should be established and updated by the sponsoring RTPAs for each responsible region. The reasonable cost allowance calculation procedure must be consistent with the allowance calculation procedure used by Caltrans and must be approved by Caltrans.

Design Criteria

The design of noise abatement must be consistent with the guidance and requirements in the Caltrans *Highway Design Manual*. Guidance can also be found in the Project Development Procedures Manual (Chapter 30).

Abatement Considerations

In certain configurations, noise reflecting off reflective noise barriers (i.e., noise barriers constructed of noise-reflective materials) can degrade the barriers' performance or cause noise increases in areas not protected by the barriers. When designing proposed noise barriers, the potential effects of the following situations should be evaluated as outlined in "Special Considerations": parallel barrier (i.e., barriers on both sides of a highway) performance degradation, and a single barrier causing noise increases at unprotected receivers on the opposite side of the highway.

Noise Study Report

The noise study report format and contents, presentation of methods and results of the traffic noise analysis, and presentation of data supporting the conclusions must be in accordance with noise study report guidance in the TeNS.

Noise Abatement Decision

The decision on retrofit noise abatement measures is made by the project proponent, considering the results of the reasonableness determination and information collected during the public input process. The opinions of the affected property owners are considered in reaching a final decision on the noise abatement measures to be provided. Noise abatement within the

State right-of-way will not be provided if more than 50% of the affected property owners do not want it. Noise abatement will not be provided on private property unless 100% of the owners of the property on which the abatement will be located want it.

Section 5

Noise Documentation

This section discusses the various reports that are prepared to document the noise analysis process. These reports include:

- Noise Study Report
- Noise Abatement Decision Report
- Draft Environmental Documentation
- Final Environmental Documentation

Noise Study Report

Before adoption of the final NEPA environmental document, 23 CFR 772 requires the identification of noise abatement that is reasonable and feasible and likely to be incorporated into the project. The noise study report is a technical document that identifies traffic noise impacts, acoustically feasible abatement, and reasonable cost allowances for noise abatement. The noise study report should include a discussion of each of the following items:

- existing land uses in the vicinity of project alternatives;
- existing undeveloped land uses for which development is planned, designed, and programmed in the vicinity of project alternatives;
- existing and predicted design year traffic noise levels at all existing and planned, designed, and programmed land uses in the project area under each project alternative, including the no-project alternative;
- traffic noise impacts predicted to occur for each project alternative;
- noise abatement evaluated, including proposed abatement locations and a discussion of acoustical feasibility and reasonableness allowances, and
- construction noise and measures to minimize or eliminate adverse construction noise impacts.

The non-acoustical feasibility of the noise abatement considered is addressed by the project engineer in the NADR (see “Noise Abatement Decision Report” below). Non-acoustical feasibility is determined based on issues such as geometric standards, property access, safety, maintenance, and security. The TeNS provides detailed guidance on noise study report preparation.

Noise Abatement Decision Report

The NADR is a design responsibility and is prepared to compile information from the noise study report, 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 noise study report and prior to publication of the draft environmental document. The NADR shall include noise abatement construction cost estimates that have been prepared and signed by the project engineer based on site-specific conditions.

The following data is to be included in the NADR:

- noise abatement reasonableness allowances presented in the noise study report;
- acoustical feasibility of noise abatement presented in the noise study report;
- locations and dimensions of noise barriers evaluated;
- approved cost estimates of acoustically feasible noise abatement;
- non-acoustical feasibility issues of proposed noise abatement based on the best available design information available; and
- effects of abatement, including effects on cultural resources, scenic views, hazardous materials, biological resources, and other known social, economic, legal, and technical factors.

The NADR should include a table which summarizes key information related to the proposed noise abatement. Examples of summary tables are provided in TeNS and in the “Noise Tidbits” guidance document prepared by FHWA California Division(Federal Highway Administration 2003).

The discussion of secondary effects in the NADR will likely be preliminary because a more detailed analysis of these effects will be contained in the draft environmental document as appropriate. The purpose of presenting the information in the NADR is to highlight the fact that these secondary effects may occur.

The NADR presents the noise abatement recommendation based on acoustical and non-acoustical feasibility factors, noise abatement allowances, and the project engineer's noise abatement construction cost estimate. The NADR does not present the final decision regarding noise abatement. Rather, it presents key information on abatement to be considered in the environmental review process that is based on the best information available at the time the project is subject to public review.

The noise abatement recommendation identified in the NADR will become the proposed noise abatement decision unless compelling information received during the public review or the final design process indicates that it should be changed. The proposed noise abatement decision is included in the final environmental document for approval by Caltrans and FHWA.

Draft Environmental Documentation

Public review and comment on draft environmental documentation through the NEPA or CEQA process is the primary means of conveying information on noise impacts and abatement to the public. The information in the draft environmental documentation is used to obtain formal input from the adjacent landowners, local community, and general public on the proposed abatement measures.

The noise study report and the NADR shall be completed before the draft environmental document is made available for public review. For the purpose of completing the draft environmental document, the noise study report must include predicted noise levels in the design year for all alternatives, including the No-Project Alternative. If impacts on other resources would result from the proposed noise abatement, these impacts must be summarized in the draft environmental documentation. The noise study report and NADR should be made available for public inspection during the public comment period.

Final Environmental Documentation

Before adoption of the final environmental documentation, 23 CFR 772 requires the identification of noise abatement measures that are reasonable, feasible, and likely to be incorporated into the project. Input received from affected landowners and the public through the environmental review process is considered in the noise abatement decision. The noise abatement decision must be reported in the final environmental documentation, along with a statement that the noise

abatement might change or might not be provided if the project changes substantially during final design.

Categorical Exclusions

There is no formal public review process for Categorical Exclusions. In cases in which Caltrans proposes noise abatement, Caltrans endeavors to engage the public in the noise abatement decision process. The information in the noise study report and the NADR is used to obtain input from the adjacent landowners, local community, and general public on the proposed abatement measures.

Final Design Considerations

A noise impact analysis is typically based on a preliminary design. The project design may change between the start of the environmental review process and the final design. Changes in the design that could affect noise impacts from a preliminary design or the effectiveness of noise abatement from that design must be evaluated. Because the noise analyst might not be contacted regarding these design changes, it is good practice for the noise analyst to periodically contact the project engineer during plan, specification, and estimate development to keep informed of significant design changes. If the project is changed in a way that would affect the acoustical performance of a barrier, the barrier design should be modified if practical to achieve the noise reduction goals of the original design.

If noise impacts or noise abatement measures change after approval of the final environmental documentation, FHWA must be consulted to determine whether a written re-evaluation or other document is required.

The final step in the noise abatement process is to prepare the final noise abatement/mitigation design and specifications in accordance with the requirements of 23 CFR 772.19(c), NEPA, and CEQA. Data on the length, height, and cost of planned noise barrier abatement should be forwarded to FHWA once the final design is complete. Barrier data shall be included in the 100% Plans, Specifications, and Estimates as part of the Districts Ready-to-List data.

Section 6

Liaison with Local Agencies

Caltrans has a responsibility under 23 CFR 772 to inform local officials about estimated future noise levels and to provide information that will allow local communities to avoid noise-incompatible future land development.

Caltrans shall inform local officials of their eligibility for Federal-aid participation for Type II projects. Type II noise abatement projects will only be approved for development projects that were approved before November 28, 1995, or are proposed along lands where land development or substantial construction predated the existence of any highway. The development project must have been planned, designed, and programmed before right-of-way acquisition or construction approval for the original highway. Land development is considered to be planned, designed, and programmed when the development has received all final discretionary approvals from the local agency with jurisdiction. This is generally the date that the building permit or vesting tentative map is issued. Noise abatement measures will not be approved at locations where such measures were previously determined not to be reasonable and feasible for a Type I project.

Typically, local agencies place conditions on new subdivisions that require the developer to provide **noise** mitigation where noise exceeds or is predicted to exceed noise compatibility standards adopted by the agency. Noise studies prepared for local agency projects are often evaluated in terms of 24-hour metrics such as the day-night level (L_{dn}) or the community noise equivalent level (CNEL). For the purposes of complying with 23 CFR 772 and this Protocol, noise levels must be expressed in terms of worst-hour equivalent sound level ($L_{eq}[h]$).

Appendix A

Glossary

Terms provided in this glossary are indicated with bold italicized text on their first use in the *Traffic Noise Analysis Protocol for New Highway Construction and Reconstruction Projects*.

Affected property owners. Property owners are considered affected by a proposed noise abatement measure if their properties (adjacent to the abatement) are predicted to be impacted or benefited receivers, or if the physical environment of their properties will be altered directly by the noise abatement measure. Alteration of the physical environment includes (but is not necessarily limited to) blocking access, interrupting scenic views, causing loss of visibility from the highway, creating shadows, and interrupting natural airflow. For noise barriers, the combined effects of acoustical and physical alterations of the environment are generally limited to 150 meters (500 feet) or less from the edge of traveled way of a highway.

Benefited residence. A dwelling unit predicted to receive a noise reduction of at least 5 dBA from a proposed noise abatement measure. The definition is primarily used in the determination of noise abatement reasonableness.

Critical design receiver. Depending on the context in which it is used, the critical design receiver is the design receiver that is subject to a traffic noise impact and for which the absolute noise levels, existing versus design year with project noise levels, or achievable noise reduction will be at a maximum where noise abatement is considered. Excluded is the single receiver that, by virtue of a unique location or situation, will receive considerably higher allowances for these factors than surrounding receivers and is therefore not acoustically representative. The definition is primarily used in the determination of noise abatement reasonableness. Further guidance is provided in *Technical Noise Supplement*.

Date of public knowledge. The date that the final environmental documentation for a transportation project is completed and the project approved. Typically, this is the date that the National Environmental

Policy Act Categorical Exclusion, Finding of No Significant Impact, or Record of Decision is signed. In cases where there is no Federal involvement, it is the date that the California Environmental Quality Act Negative Declaration or Environmental Impact Report is certified.

dBA. Unit of sound pressure level in decibels on the “A-weighted” scale.

Design receiver. Any receiver used in the noise impact analysis or noise abatement design. Normally, a design receiver represents several locations judged to receive approximately the same predicted noise levels, same existing versus build noise levels, or same achievable noise reduction where noise abatement is considered.

Design year. The future year as defined in the Caltrans Highway Design Manual that is used to estimate the probable traffic volume for which a highway is designed. This year is 20 years after the completion of project construction.

Existing noise level. The noise resulting from the natural and mechanical sources and human activity that is considered normally present in a particular area.

Frequent human use. Any activity that results in human exposure to traffic noise on a regular basis over the course of a year at a given location.

Impacted receivers. Receivers that are predicted to be exposed to a traffic noise impact under 23 Code of Federal Regulations 772.

$L_{eq}(h)$. The equivalent steady-state sound level that, in a specific hour, contains the same acoustic energy as a time-varying sound level during the same hour.

Noise abatement. Noise attenuation measures for traffic or construction noise impacts under 23 CFR 772.

Noise abatement design. The acoustic design of a noise abatement measure based on all California Department of Transportation–approved noise prediction models or methods and proposed physical features that affect the acoustical performance based on the best available input information at the time of the design.

Noise mitigation. Noise attenuation measures provided for adverse environmental effects due to noise under the National Environmental Policy Act or significant adverse environmental effects under the California Environmental Quality Act.

Planned, designed, and programmed. Land development is considered planned, designed, and programmed on the date that it has received all final discretionary approvals from the local agency with jurisdiction. This date is generally considered the date that the building permit or vesting tentative map is issued.

Predicted noise level. A future noise level, based on modeling, resulting from natural and mechanical sources and human activity that is considered usually present in a particular area. A predicted noise level may be for build or no-build conditions.

Receiver. A location selected for determining traffic noise impacts. These locations should represent land use activities where frequent human use occurs or is likely to occur in the foreseeable future (e.g., vacant property for which development plans are planned, designed, and programmed).

Traffic noise impact. An impact that occurs at a receiver when the predicted noise level substantially exceeds the existing noise level or the predicted noise level with the project approaches or exceeds the noise abatement criteria.

Type I project. 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 that significantly changes the horizontal or vertical alignment or increases the number of through-traffic lanes.

Type II project. A proposed Federal or Federal-aid highway project for noise abatement on an existing highway.

Appendix B

Suggested Worksheets and Examples of Calculating Reasonable Allowances per Residence

Worksheet A
Reasonable Allowance Calculation for Noise Abatement based on Critical Design Receiver

Base Allowance			
Base Year 2006			\$32,000
1. Absolute Noise Levels		check one	
69 dBA or less	Add \$2,000		
70-74 dBA	Add \$4,000		
75-78 dBA	Add \$6,000		
More than 78 dBA	Add \$8,000		
2. Design Year Increase over Existing Noise Levels		check one	
Less than 3 dBA	Add \$0		
3-7 dBA	Add \$2,000		
8-11 dBA	Add \$4,000		
12 dBA or more	Add \$6,000		
3. Achievable Noise Reduction		check one	
5 dBA	Add \$0		
6-8 dBA	Add \$2,000		
9-11 dBA	Add \$4,000		
12 dBA or more	Add \$6,000		
4. New Hwy Construction or Pre 1978 residences?		check one	
YES on either one	Add \$10,000		
NO on both	Add \$0		
Reasonable Allowance for Benefited Residence			
Unmodified Barrier Allowance			
Adjusted Reasonable Allowance for Benefited Residence			
Adjusted Unmodified Barrier Allowance			

Adjusted reasonable allowance for Residence and Barrier must be rounded up to nearest \$1,000.

County:
Route:
Kilo Post:
Project Exp Auth:
Program Code:

Barrier Name or ID	
Barrier Height (meters)	
Critical Design Receiver	
Number of benefited Residences	
New Hwy Construction	
Pre 1978 residences	
Existing Noise Level	
Future Noise Level	
Change in Noise Level	
Noise Level with Abatement	
Barrier Insertion Loss	

Continue to Worksheet B

Worksheet B
Noise Barrier Reasonable Allowance Calculation

County: Route: Kilo Post: Program Code:
 Project Exp Auth:

Construction cost without abatement:

From Worksheet A				Adjusted Barrier Allowance vs Construction Cost	Percentage of Total Barrier Allowance	Modified Barrier Allowance	Modified Allowance per Benefite Residence
Barrier ID	Adusted Allowance for Critical Design Receiver	Number of Benefited Residences	Adjusted Unmodified Barrier Allowance		(col 4: A/ΣA)	(A/ΣA x .5 x Const Cost)	(col 7/col 3)
				If the total in column 4 is equal to or less than 50% of construction cost without abatement, no adjustment is necessary, otherwise continue to columns 6 through 8.			
	Totals		\$ -			\$ -	
1	2	3	4	5	6	7	8

Worksheet A
Example A (1 of 3)
Reasonable Allowance Calculation for Noise Abatement based on Critical Design Receiver

Base Allowance			
Base Year 2006			\$32,000
1. Absolute Noise Levels		check one	
69 dBA or less	Add \$2,000	☐	
70-74 dBA	Add \$4,000	☐	
75-78 dBA	Add \$6,000	☒	\$6,000
More than 78 dBA	Add \$8,000	☐	
2. Design Year Increase over Existing Noise Levels		check one	
Less than 3 dBA	Add \$0	☒	
3-7 dBA	Add \$2,000	☐	
8-11 dBA	Add \$4,000	☐	
12 dBA or more	Add \$6,000	☐	
3. Achievable Noise Reduction		check one	
5 dBA	Add \$0	☐	
6-8 dBA	Add \$2,000	☒	\$2,000
9-11 dBA	Add \$4,000	☐	
12 dBA or more	Add \$6,000	☐	
4. New Hwy Construction or Pre 1978 residences?		check one	
YES on either one	Add \$10,000	☒	\$10,000
NO on both	Add \$0	☐	
Reasonable Allowance for Benefited Residence			\$50,000
Unmodified Barrier Allowance			\$1,150,000
Adjusted Reasonable Allowance for Benefited Residence			
Adjusted Unmodified Barrier Allowance			

Adjusted reasonable allowance for Residence and Barrier must be rounded up to nearest \$1,000.

County: Ala
Route: 880
Kilo Post: 12.3/15.4
Project Exp Auth: 4-112353
Program Code: HE11

Barrier Name or ID	SW1
Barrier Height (meters)	3.7
Critical Design Receiver	S2
Number of benefited Residences	23
New Hwy Construction	Yes
Pre 1978 residences	No
Existing Noise Level	76 dBA
Future Noise Level	77 dBA
Change in Noise Level	1 dBA Increase
Noise Level with Abatement	69 dBA
Barrier Insertion Loss	8 dBA

Continue to Worksheet B

Worksheet A
Example A (2 of 3)
Reasonable Allowance Calculation for Noise Abatement based on Critical Design Receiver

Base Allowance			XXXX
Base Year 2006			\$32,000
1. Absolute Noise Levels		check one	XXXX
69 dBA or less	Add \$2,000		
70-74 dBA	Add \$4,000	√	\$4,000
75-78 dBA	Add \$6,000		
More than 78 dBA	Add \$8,000		
2. Design Year Increase over Existing Noise Levels		check one	XXXX
Less than 3 dBA	Add \$0	√	
3-7 dBA	Add \$2,000		
8-11 dBA	Add \$4,000		
12 dBA or more	Add \$6,000		
3. Achievable Noise Reduction		check one	XXXX
Less than 6 dBA	Add \$0		
6-8 dBA	Add \$2,000	√	\$2,000
9-11 dBA	Add \$4,000		
12 dBA or more	Add \$6,000		
4. New Hwy Construction or Pre 1978 residences?		check one	XXXX
YES on either one	Add \$10,000		
NO on both	Add \$0	√	
Reasonable Allowance for Benefited Residence			\$38,000
Unmodified Barrier Allowance			\$570,000
Adjusted Reasonable Allowance for Benefited Residence			
Adjusted Unmodified Barrier Allowance			

Adjusted reasonable allowance for Residence and Barrier must be rounded up to nearest \$1,000.

County: Ala
Route: 880
Kilo Post: 12.3/15.4
Project Exp Auth: 4-112353
Program Code: HE11

Barrier Name or ID	SW2
Barrier Height (meters)	4.3
Critical Design Receiver	R7
Number of benefited Residences	15
New Hwy Construction	No
Pre 1978 residences	No
Existing Noise Level	73 dBA
Future Noise Level	75 dBA
Change in Noise Level	2 dBA Increase
Noise Level with Abatement	69 dBA
Barrier Insertion Loss	6 dBA

Continue to Worksheet B

Worksheet A
Example A (3 of 3)
Reasonable Allowance Calculation for Noise Abatement based on Critical Design Receiver

Base Allowance			XXXX
Base Year 2006			\$32,000
1. Absolute Noise Levels		check one XXXX	
69 dBA or less	Add \$2,000	☐	
70-74 dBA	Add \$4,000	☐	
75-78 dBA	Add \$6,000	☐	
More than 78 dBA	Add \$8,000	☒	\$8,000
2. Design Year Increase over Existing Noise Levels		check one XXXX	
Less than 3 dBA	Add \$0	☒	
3-7 dBA	Add \$2,000	☐	
8-11 dBA	Add \$4,000	☐	
12 dBA or more	Add \$6,000	☐	
3. Achievable Noise Reduction		check one XXXX	
5 dBA	Add \$0	☐	
6-8 dBA	Add \$2,000	☒	\$2,000
9-11 dBA	Add \$4,000	☐	
12 dBA or more	Add \$6,000	☐	
4. New Hwy Construction or Pre 1978 residences?		check one XXXX	
YES on either one	Add \$10,000	☒	\$10,000
NO on both	Add \$0	☐	
Reasonable Allowance for Benefited Residence		\$52,000	
Unmodified Barrier Allowance		\$1,716,000	
Adjusted Reasonable Allowance for Benefited Residence			
Adjusted Unmodified Barrier Allowance			

Adjusted reasonable allowance for Residence and Barrier must be rounded up to nearest \$1,000.

County: Ala
Route: 880
Kilo Post: 12.3/15.4
Project Exp Auth: 4-112353
Program Code: HE11

Barrier Name or ID	SW3
Barrier Height (meters)	5.0
Critical Design Receiver	R5
Number of benefited Residences	33
New Hwy Construction	No
Pre 1978 residences	Yes
Existing Noise Level	79 dBA
Future Noise Level	80 dBA
Change in Noise Level	1 dBA Increase
Noise Level with Abatement	72 dBA
Barrier Insertion Loss	8 dBA

Continue to Worksheet B

Worksheet B
Example B (1 of 1)
Noise Barrier Reasonable Allowance Calculation

County: Ala Route: 880 Kilo Post: 12.3/15.4 Program Code: HE11
 Project EA: 4-112353

Construction cost without abatement: \$3,800,000

From Worksheet A				Adjusted Barrier Allowance vs Construction Cost	Percentage of Total Barrier Allowance	Modified Barrier Allowance	Modified Allowance Benefit Resider
Barrier ID	Adjusted Allowance for Critical Design Receiver	Number of Benefited Residences	Adjusted Unmodified Barrier Allowance		(col 4: A/ΣA)	(A/ΣA x .5 x Const Cost)	(col 7/cc)
SW1	35,000	23	1,196,000	The total unmodified barrier allowance (column 4) is greater than 50% of the construction cost without abatement, therefore allowance must be modified as shown in columns 6, 7 and 8.	33.5%	635,814	27,6
SW2	22,000	15	593,000		16.6%	315,249	21,6
SW3	37,000	33	1,785,000		49.9%	948,937	28,1
	Totals	71	\$ 3,574,000		100.0%	\$ 1,900,000	
1	2	3	4	5	6	7	8

23 Code of Federal Regulations 772

SUBCHAPTER H - RIGHT-OF-WAY AND ENVIRONMENT

PART 772 - PROCEDURES FOR ABATEMENT OF HIGHWAY TRAFFIC NOISE AND CONSTRUCTION NOISE

Section

772.1 Purpose.

772.3 Noise standards.

772.5 Definitions.

772.7 Applicability.

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Table 1 - Noise Abatement Criteria

Appendix A - National Reference Energy Mean Emission Levels as a Function of Speed

AUTHORITY: 23 U.S.C. 109(h), 109(i); 42 U.S.C. 4331, 4332; sec.
339(b), Pub. L. 104-59, 109 Stat. 568, 605; 49 CFR 1.48(b).

(Source: 47 FR 29654, July 8, 1982; 47 FR 33956, Aug. 5, 1982, and 62 FR 42903, August 11, 1997)

Sec. 772.1 Purpose.

To provide procedures for noise studies and noise abatement measures to help protect the public health and welfare, to supply noise abatement criteria, and to establish requirements for information to be given to local officials for use in the planning and design of highways approved pursuant to Title 23, United States Code (U.S.C.).

Sec. 772.3 Noise standards.

The highway traffic noise prediction requirements, noise analyses, noise abatement criteria, and requirements for informing local officials in this regulation constitute the noise standards mandated by 23 U.S.C. 109(i). All highway projects which are developed in conformance with this regulation shall be deemed to be in conformance with the Federal Highway Administration (FHWA) noise standards.

Sec. 772.5 Definitions.

- (a) Design year. The future year used to estimate the probable traffic volume for which a highway is designed. A time, 10 to 20 years, from the start of construction is usually used.
- (b) Existing noise levels. The noise, resulting from the natural and mechanical sources and human activity, considered to be usually present in a particular area.
- (c) L10. The sound level that is exceeded 10 percent of the time (the 90th percentile) for the period under consideration.
- (d) L10(h). The hourly value of L10.
- (e) Leq. The equivalent steady-state sound level which in a stated period of time contains the same acoustic energy as the time-varying sound level during the same time period.
- (f) Leq(h). The hourly value of Leq.
- (g) Traffic noise impacts. Impacts which occur when the predicted traffic noise levels approach or exceed the noise abatement criteria (Table 1), or when the predicted traffic noise levels substantially exceed the existing noise levels.

(h) Type I projects. A proposed Federal or Federal-aid highway project for the construction of a highway on new location or the physical alteration of an existing highway which significantly changes either the horizontal or vertical alignment or increases the number of through-traffic lanes.

(i) Type II projects. A proposed Federal or Federal-aid highway project for noise abatement on an existing highway.

Sec. 772.7 Applicability.

(a) Type I projects. This regulation applies to all Type I projects unless it is specifically indicated that a section applies only to Type II projects.

(b) Type II projects. The development and implementation of Type II projects are not mandatory requirements of 23 U.S.C. 109(i) and are, therefore, not required by this regulation. When Type II projects are proposed for Federal-aid highway participation at the option of the highway agency, the provisions of Subsec. 772.9(c), 772.13, and 772.19 of this regulation shall apply.

Sec. 772.9 Analysis of traffic noise impacts and abatement measures.

(a) The highway agency shall determine and analyze expected traffic noise impacts and alternative noise abatement measures to mitigate these impacts, giving weight to the benefits and cost of abatement, and to the overall social, economic and environmental effects.

(b) The traffic noise analysis shall include the following for each alternative under detailed study:

- (1) Identification of existing activities, developed lands, and undeveloped lands for which development is planned, designed and programmed, which may be affected by noise from the highway;
- (2) Prediction of traffic noise levels;
- (3) Determination of existing noise levels;
- (4) Determination of traffic noise impacts; and
- (5) Examination and evaluation of alternative noise abatement measures for reducing or eliminating the noise impacts.

(c) Highway agencies proposing to use Federal-aid highway funds for Type II projects shall perform a noise analysis of sufficient scope to provide information needed to make the determination required by Sec. 772.13(a) of this chapter.

Sec. 772.11 Noise abatement.

(a) In determining and abating traffic noise impacts, primary consideration is to be given to exterior areas. Abatement will usually be necessary only where frequent human use occurs and a lowered noise level would be of benefit.

(b) In those situations where there are no exterior activities to be affected by the traffic noise, or where the exterior activities are far from or physically shielded from the roadway in a manner that prevents an impact on exterior activities, the interior criterion shall be used as the basis of determining noise impacts.

(c) If a noise impact is identified, the abatement measures listed in Sec. 772.13(c) of this chapter must be considered.

(d) When noise abatement measures are being considered, every reasonable effort shall be made to obtain substantial noise reductions.

(e) Before adoption of a final environmental impact statement or finding of no significant impact, the highway agency shall identify:

(1) Noise abatement measures which are reasonable and feasible and which are likely to be incorporated in the project, and

(2) Noise impacts for which no apparent solution is available.

(f) The views of the impacted residents will be a major consideration in reaching a decision on the reasonableness of abatement measures to be provided.

(g) The plans and specifications will not be approved by FHWA unless those noise abatement measures which are reasonable and feasible are incorporated into the plans and specifications to reduce or eliminate the noise impact on existing activities, developed lands, or undeveloped lands for which development is planned, designed, and programmed.

Sec. 772.13 Federal participation.

(a) Federal funds may be used for noise abatement measures where:

(1) A traffic noise impact has been identified,

(2) The noise abatement measures will reduce the traffic noise impact, and

(3) The overall noise abatement benefits are determined to outweigh the overall adverse social, economic, and environmental effects and the costs of the noise abatement measures.

(b) For Type II projects, noise abatement measures will only be approved for projects that were approved before November 28, 1995, or are proposed along lands where land development or substantial construction predated the existence of any highway. The granting of a building permit, filing of a plat plan, or a similar action must have occurred prior to right-of-way acquisition or construction approval for the original highway. Noise abatement measures will not be approved at locations where such measures were previously determined not to be reasonable and feasible for a Type I project.

(c) The noise abatement measures listed below may be incorporated in Type I and Type II projects to reduce traffic noise impacts. The costs of such measures may be included in Federal-aid participating project costs with the Federal share being the same as that for the system on which the project is located.

(1) Traffic management measures (e.g., traffic control devices and signing for prohibition of certain vehicle types, time-use restrictions for certain vehicle types, modified speed limits, and exclusive land designations).

(2) Alteration of horizontal and vertical alignments.

(3) Acquisition of property rights (either in fee or lesser interest) for construction of noise barriers.

(4) Construction of noise barriers (including landscaping for aesthetic purposes) whether within or outside the highway right-of-way.

(5) 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. This measure may be included in Type I projects only.

(6) Noise insulation of public use or nonprofit institutional structures.

(d) There may be situations where severe traffic noise impacts exist or are expected, and the abatement measures listed above are physically infeasible or economically unreasonable. In these instances, noise abatement measures other than those listed in paragraph (c) of this section may be proposed for Types I and II projects by the highway agency and

approved by the FHWA on a case-by-case basis when the conditions of paragraph (a) of this section have been met.

Sec. 772.15 Information for local officials.

In an effort to prevent future traffic noise impacts on currently undeveloped lands, highway agencies shall inform local officials within whose jurisdiction the highway project is located of the following:

- (a) The best estimation of future noise levels (for various distances from the highway improvement) for both developed and undeveloped lands or properties in the immediate vicinity of the project,
- (b) Information that may be useful to local communities to protect future land development from becoming incompatible with anticipated highway noise levels, and
- (c) Eligibility for Federal-aid participation for Type II projects as described in Sec. 772.13(b) of this chapter.

Sec. 772.17 Traffic noise prediction.

(a) Any analysis required by this subpart must use the FHWA Traffic Noise Model (FHWA TNM), which is described in “FHWA Traffic Noise Model” Report No. FHWA-PD-96-010, including Revision No. 1, dated April 14, 2004, or any other model determined by the FHWA to be consistent with the methodology of the FHWA TNM. These publications are incorporated by reference in accordance with 5 U.S.C. 552(a) and 1 CFR part 51 and are on file at the National Archives and Record Administration (NARA). For information on the availability of this material at NARA call (202) 741-6030, or go to http://www.archives.gov/federal_register/code_of_federal_regulations/ibr_locations.html. These documents are available for copying and inspection at the Federal Highway Administration, 400 Seventh Street, SW., Room 3240, Washington, DC 20590, as provided in 49 CFR part 7. These documents are also available on the FHWA’s Traffic Noise Model Web site at the following URL: <http://www.trafficnoisemodel.org/main.html>.

Sec. 772.19 Construction noise.

The following general steps are to be performed for all Types I and II projects:

- (a) Identify land uses or activities which may be affected by noise from construction of the project. The identification is to be performed during the project development studies.

(b) Determine the measures which are needed in the plans and specifications to minimize or eliminate adverse construction noise impacts to the community. This determination shall include a weighing of the benefits achieved and the overall adverse social, economic and environmental effects and the costs of the abatement measures.

(c) Incorporate the needed abatement measures in the plans and specifications.

Table 1: Noise Abatement Criteria (NAC) Hourly A-Weighted Sound Level - decibels (dBA)*

Activity Category	Leq(h)	L10(h)	Description of Activity Category
A	57: Exterior	60: 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	67: Exterior	70: Exterior	Picnic areas, recreation areas, playgrounds, active sports areas, parks, residences, motels, hotels, schools, churches, libraries, and hospitals.
C	72: Exterior	75: Exterior	Developed lands, properties, or activities not included in Categories A or B above.
D	—	—	Undeveloped lands.
E	52: Interior	55: Interior	Residences, motels, hotels, public meeting rooms, schools, churches, libraries, hospitals, and auditoriums.

* Either L10(h) or Leq(h) (but not both) may be used on a project.

Appendix D

References Cited

California Department of Transportation. 1998b. *Traffic Noise Analysis Protocol for New Highway Construction and Highway Reconstruction Projects*. October.

———. 1998a. *Technical Noise Supplement*. October. Sacramento, CA: Environmental Program, Noise, Air Quality, and Hazardous Waste Management Office. Available: <<http://www.dot.ca.gov/hq/env/noise/pub/Technical%20Noise%20Supplement.pdf>>.

———. 2003. Noise and Vibration Studies. Available: <<http://www.dot.ca.gov/hq/env/noise/publications>>.

———. 2006. Caltrans Standard Environmental Reference. Revised: April 28, 2006. Available: <<http://www.dot.ca.gov/ser/>>.

Federal Highway Administration. 1995. *Highway Traffic Noise Analysis and Abatement—Policy and Guidance*. June. Washington, DC: Office of Environment and Planning, Noise and Air Quality Branch.

———. 2003. Noise Tidbits. Revised: November 5, 2003. Available: <http://www.fhwa.dot.gov/cadiv/docs/noise_tidbits.htm>.

———. 2006. Roadway Construction Noise Model . February, 15, 2006. Available: <<http://www.rcnm.us/>>.

Federal Transit Administration. 2006. *Transit Noise and Vibration Impact Assessment*. April. Washington, DC. Office of Planning.