Oregon Department of Transportation

Technical Services Branch **Geo-Environmental Section**

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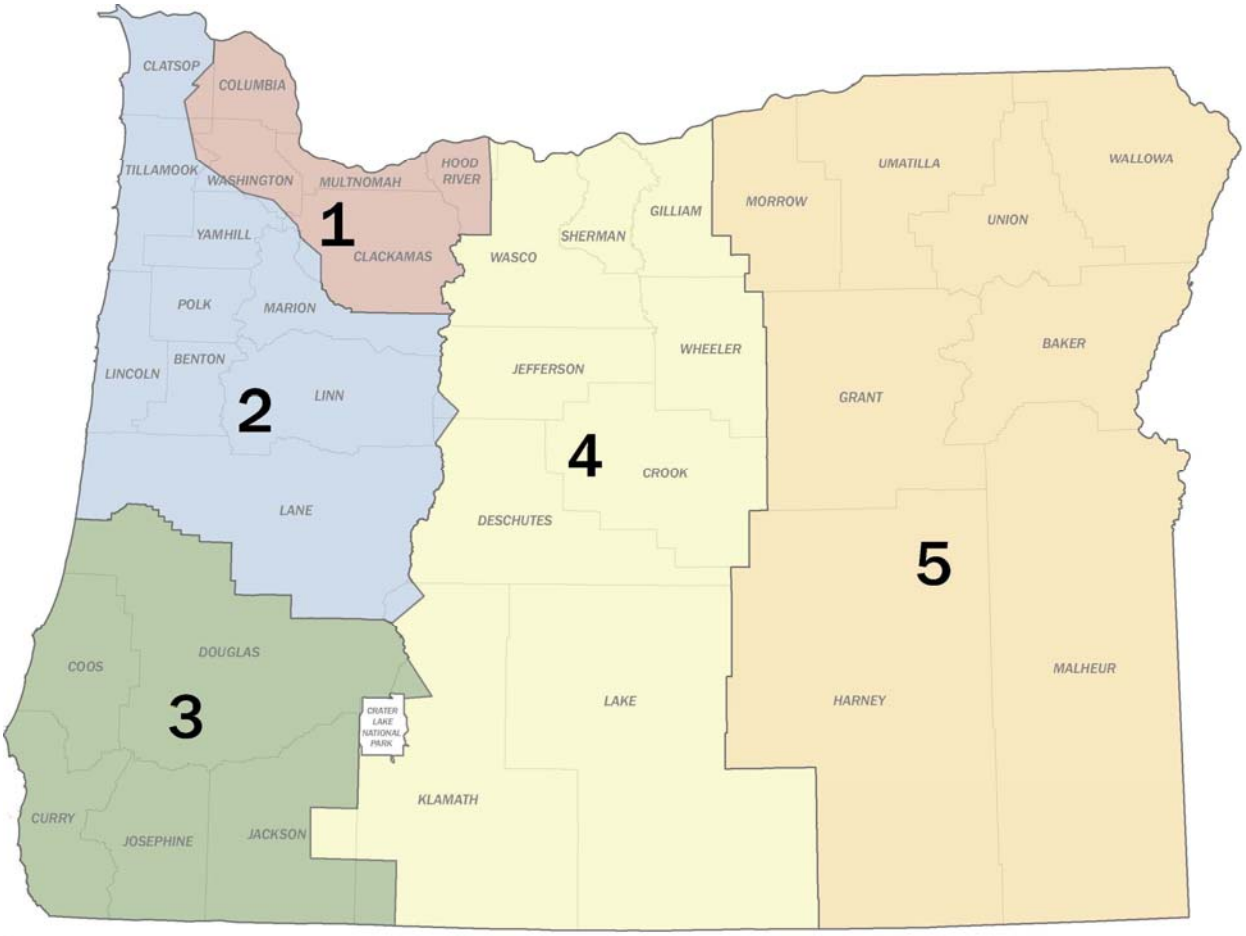

Noise Manual

Oregon Department of Transportation

U.S. Department of Transportation
Federal Highway Administration

Oregon Division

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July 13, 2011

In Reply Refer To:
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Mr. Hal Gard
Geo-Environmental Manager
Oregon Department of Transportation
4040 Fairview Industrial Drive, SE MS#6
Salem, OR 97302-1142

Attention: Carole Newvine

Dear Mr. Gard:

On July 13, 2010, in the Federal Register, Federal Highway Administration (FHWA) published an amended 23 CFR Part 772, *Procedures for Abatement of Highway Traffic Noise and Construction Noise*. The intent of the amended regulation was to update and improve consistency and clarity of the existing regulation. One outcome of the amended regulation was that all state Departments of Transportation were required to revise their traffic noise policies to comply with the provisions of the new rule by July 13, 2011.

FHWA's Oregon Division Office, Resource Center and Headquarters staffs have reviewed drafts of Oregon Department of Transportation's (ODOT) 2011 updated noise policy. The final version of ODOT's noise policy meets the requirements of 23 CFR Part 772 and is hereby approved for use.

We very much appreciate the outstanding efforts of Carole Newvine in developing the revised ODOT noise policy. She is particularly deserving of credit and recognition for her role in this important task. Please contact me at Michelle.Eraut@dot.gov or 503-316-2559 if you have any questions.

Sincerely,

Michelle Eraut

Michelle Eraut
Environmental Program Manager

ME/rm

cc: Catherine Nelson (ODOT)

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Oregon Department of Transportation
Noise Manual

1.0 INTRODUCTION

During the rapid expansion of the Interstate Highway System and other roadways in the twentieth century, communities began to recognize that highway traffic noise and construction noise had become important environmental impacts. In the 1972 Federal-Aid Highway Act, Congress required the Federal Highway Administration (FHWA) to develop a noise standard for new federal-aid highway projects. While providing national criteria and requirements for all highway agencies, the FHWA noise standard gives highway agencies flexibility that reflects state-specific attitudes and objectives in approaching the problem of highway traffic noise and construction noise. Appendix A contains highway traffic noise terminology and basic concepts.

In addition to defining traffic noise impacts, the FHWA noise standard requires that noise abatement measures be considered when traffic noise impacts are identified for Type I federal-aid projects. Noise abatement measures that are found to be feasible and reasonable must be constructed for such projects. Feasible and reasonable noise abatement measures are eligible for federal-aid participation at the same ratio or percentage as other eligible project costs.

1.1 Background

The first edition of the Oregon Department of Transportation's (ODOT's) *Noise Manual* was distributed in January 1990. An update, which received FHWA approval July 18, 1996, addressed the FHWA *Traffic Noise Analysis and Abatement Policy and Guidance* (Noise Standard).

On July 13, 2010, the FHWA published an update to the federal traffic noise rule. All states are required to update their noise policies to reflect the changes in the updated rule by the effective date of the rule (July 13, 2011). This edition of the ODOT *Noise Manual* (Manual) meets this requirement.

1.2 Purpose

The ODOT policy contained in this document defines highway traffic noise impacts, the evaluation of noise abatement, and how noise abatement decisions are made. This Manual describes ODOT's implementation of the requirements of the FHWA Noise Standard. This Manual also provides policy and guidance for ODOT's non-federally funded Retrofit Program and for responding to traffic noise complaints.

2.0 NOISE STANDARDS

This Manual outlines ODOT's program to implement the FHWA Noise Standard found in 23 CFR 772, which includes traffic noise prediction requirements, noise analyses, noise

abatement criteria, and requirements for informing local officials. All highway projects that are developed in conformance with this Standard will be deemed to be in accordance with the FHWA Noise Standard. The following describe some of the regulations pertaining to highway traffic noise studies.

2.1 National Environmental Policy Act of 1969

The National Environmental Policy Act (NEPA) established a national policy on the environment and created the Council on Environmental Quality. The purpose of NEPA is to inform decision making, disclose impacts from federal actions, and allow the public an opportunity to comment. Many environmental laws and regulations embody principles to avoid, minimize, and mitigate environmental impacts caused by actions funded or taken by the federal government. NEPA provides broad authority and responsibility for evaluating and considering mitigation for adverse environmental impacts, including highway traffic noise. While the FHWA Noise Standard does not require comparing future no-build noise levels with future build levels, ODOT requires that traffic noise impact analyses compare the future no-build scenario with the future build scenario.

2.2 Federal-Aid Highway Act of 1970

This law was a mandate to the FHWA to develop a noise standard for highway traffic noise. The law requires traffic noise level criteria for various land use activities. The law further provides that the FHWA not approve the plans and specifications for a federally aided highway project unless the project includes adequate noise abatement to comply with the standards. This requirement is codified in 23 U.S.C 109(i).[1]

2.3 Procedures for Abatement of Highway Traffic Noise and Construction Noise

The FHWA Noise Standard outlines FHWA procedures for abatement of highway traffic noise and construction noise and sets noise abatement criteria. As mandated by 23 U.S.C. 109(i), all federal-aid highway projects are to be developed in conformance with this regulation.

The FHWA Noise Standard outlines the items that must be included in traffic noise studies for highway construction projects. The regulation defines when noise impacts occur and when noise abatement must be considered. The regulation also requires that information be given to local officials for use in land use planning. Appendix B of this manual contains the text of 23 CFR 772.

[1] https://www.govinfo.gov/content/pkg/USCODE-2011-title23/pdf/USCODE-2011-title23-chap1-sec109.pdf

2.4 Oregon Department of Environmental Quality Noise Regulations

The Oregon Department of Environmental Quality (ODEQ) has noise regulations that govern the noise from airports and commercial sites. The commercial regulations limit the amount of allowable noise from stationary sources (e.g., a permanent rock crusher). Highway maintenance stations may also be covered under ODEQ regulations. Noise-generating activities from stationary sources in the highway right-of-way (ROW) (e.g., electrical inverters for solar highway projects) could be subject to ODEQ regulations. For more information, contact the ODOT Noise Program Coordinator. Motor vehicles in parking lots are not regulated by the commercial noise regulation. ODEQ also has regulations that establish maximum allowable noise levels for new vehicles and in-use vehicles to be sold in Oregon[2] .

2.5 Local Ordinances

Local jurisdictions (municipalities and counties) often have their own ordinances regulating noise from sources to receivers. Local requirements are incorporated into the traffic noise study and become part of the project construction specifications.

3.0 DEFINITIONS

Benefited Receptor: The recipient of an abatement measure that receives a noise reduction of at least 5 dBA, regardless of whether or not the receptor is impacted.

dBA: A unit of measurement for traffic noise, "dB" refers to decibel and "A" refers to the frequency scale. The "A-scale" is a frequency weighing system that closely represents the average human hearing response. See Appendix A for a discussion of basic noise concepts.

Date of Public Knowledge: The date the FHWA approves the Categorical Exclusion (CE), the Finding of No Significant Impact (FONSI), or the Record of Decision (ROD) as defined in 23 CFR 771.

Design Year: The future year that is used to estimate the probable traffic volumes for which a highway is designed.

Feasible Abatement: Abatement that has been judged to be effective at lowering noise levels and is possible to construct based on acoustical and engineering factors. For an abatement measure to be feasible, ODOT requires that a simple majority of impacted receptors receive a minimum reduction of 5 dBA in noise levels. Engineering factors that are considered include barrier height, safety, topography, drainage, utilities, and access.

Impacted Receiver: In Oregon, a receiver is considered to be impacted when the future build alternative noise level is 2 dBA less than the corresponding FHWA noise abatement criteria

[2] https://secure.sos.state.or.us/oard/displayDivisionRules.action;JSESSIONID_OARD=Aoa4PDgfgEj6rxgb-p7tXefoqw-7nLHdWB0cSDyXTaR5wfOhMfTC!681140154?selectedDivision=1455

(NAC). Oregon also calls this type of an impact an "absolute" or "noise abatement approach criteria" (NAAC) impact. A receiver can also be impacted when there is at least a 10 dBA increase for the future build scenario over existing noise levels (also called substantial increase impact).

Noise Abatement Approach Criteria (NAAC): ODOT's noise levels for abatement consideration for noise sensitive receivers. The NAAC are 2 dBA less than the FHWA NAC levels.

Noise Reduction Design Goal: The optimum desired dBA noise reduction determined from calculating the difference between future build noise levels with abatement to future build noise levels without abatement. In Oregon, one benefited receptor must achieve the noise reduction design goal of 7 dBA.

Reasonable Abatement: An abatement measure that has been determined to be cost effective, approved by a simple majority of property owners and residents, and is able to achieve ODOT's noise reduction design goal. These are the minimum requirements for reasonable abatement per the FHWA Noise Standard.

Receiver: Modeling or measurement location that represents noise sensitive land uses; can represent multiple receptors or equivalent units.

Receptor: An activity or unit represented by a measured or modeled receiver, also called an equivalent unit (subset of receiver).

Retrofit Program: Process of analyzing and abating highway traffic noise impacts not associated with federally-funded highway projects. ODOT uses this process to investigate traffic noise complaints.

Simple Majority: More than 50 percent.

Substantial Noise Increase: One of two types of highway traffic noise impact. In Oregon, a substantial increase impact is an increase of at least 10 dBA in the design year over the existing noise level and is independent of the absolute noise level.

Substantial Alteration or Modification of a Highway: Highway projects that alter an existing alignment by significantly changing either the horizontal or vertical alignment or increasing the number of through traffic lanes.

- A substantial horizontal alignment change means that the distance between the highway and the noise sensitive receiver is halved in the design year.
- A substantial vertical alignment change means shielding has been removed, therefore exposing the line-of-sight between the receiver and the traffic noise source. The exposure of the line of sight results from altering the vertical alignment of the highway or altering the topography between the highway traffic noise source and the receiver.

Type I Project: A Type I project can include the following projects:

- The construction of a highway on new location
- The physical alteration of an existing highway where there is either a substantial horizontal or vertical alteration
- The addition of a through-traffic lane(s), including 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 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 area, ride-share lot, or toll plaza

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

Type II Project: Oregon does not have an FHWA-approved Type II program. State and local funding may be provided in response to noise complaints through ODOT's non-federally funded Retrofit Program. See Retrofit Program.

Type III Project: A federal or federal-aid highway project that does not meet the classification of a Type I or Type II project. Type III projects do not require a noise analysis.

4.0 APPLICABILITY

The policies contained in this Manual and the FHWA Noise Standard apply to all Type I federal-aid highway projects in the state of Oregon; that is, any project that receives federal-aid funds or is otherwise subject to FHWA approval. This requirement includes any federal-aid project that is administered by local public agencies (LPAs) as well as ODOT.

If there are any questions about whether a project is subject to this policy or the FHWA Noise Standard, contact ODOT's Noise Program Coordinator. Due to the long lead time to complete a traffic noise study, contact early during the project scoping process is advised.

Response to traffic noise complaints and ODOT's non-federally funded Retrofit Program are also subject to ODOT noise policies contained in this Manual and the FHWA Noise Standard.

5.0 TRAFFIC NOISE PREDICTION

This section discusses some specific guidelines for noise model inputs for Oregon traffic noise analyses. The model inputs include pavement type, analysis years, traffic volumes and speeds, number of lanes, acoustical barriers, and acceptable uses of traffic noise contours.

5.1 Traffic Noise Model

Traffic noise predictions must be made using the latest version of the FHWA Traffic Noise Model (TNM) (currently version 2.5) or other models found acceptable to the FHWA as noted in the FHWA Noise Standard. The noise analyst should use the methodology described in the FHWA user's guide for TNM[3], or any other model determined by FHWA to be consistent with that methodology. Noise levels must be predicted for the design year for all build and no-build alternatives under consideration in the NEPA document. The future build noise predictions should be made based on traffic volumes and conditions for the future design year.

5.2 Pavement Type

In Oregon, the average pavement type must be used for predicting future noise levels in TNM modeling, unless prior FHWA approval has been obtained. For additional information regarding the FHWA TNM, please visit the FHWA website[4].

5.3 Noise Contour Lines

Noise contour lines can only be used for project alternative screening when agreed upon in advance with the FHWA Oregon Division office or for land use planning purposes to provide information to local officials (23 CFR 772.17); noise contour lines cannot be used to determine highway traffic noise impacts. Using contours for undeveloped land uses is permitted for Type I projects. See section 6.6.1 for details for predicting noise levels for Activity Category G uses.

5.4 Worst Case Noise Hour

When determining noise impacts, traffic noise predictions must be made for the worst case noise hour (generally during level of service [LOS] C or D[5] with high heavy truck volumes and speeds close to the posted speed limit or design speed). The worst case noise hour is typically the peak vehicular truck hour but may be the peak vehicular volume hour. A comparison should be made between the peak truck hour and the peak vehicular hour to determine which hour results in the worst case noise levels. An alternative method to derive the peak noise hour can be used but must be justified. Project traffic data must be requested in advance from the project team. An example of the traffic data needed is in Appendix C.

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[3] FHWA Traffic Noise Model User's Guide FHWA-PD-96-009, dated January 1998 and FHWA Traffic Noise Model User's Guide (Version 2.5 Addendum) dated April 2004.

[4] https://www.fhwa.dot.gov/environment/noise/traffic_noise_model/

[5] Level of service (LOS) is a measure used by traffic engineers to determine the quality of service on a highway based on speed, travel time, density, and delay as perceived by drivers and passengers; designated as LOS A through F, with LOS A being the best traffic-operating conditions and LOS F being the worst. LOS C describes at or near free-flow operations; LOS D describes decreasing free-flow levels.

5.5 Travel Lanes

Preferably each travel lane should be modeled separately. However, there are instances that may call for a different approach, depending on the distance of the receiver to the outside travel lane or restrictions on trucks using the inside lanes. Pavement associated with shoulders and medians must be accounted for in the TNM model. When setting up roadways for modeling, the analyst is to rely on professional judgment to accurately represent the noise environment or consult with the ODOT Noise Program Coordinator.

5.6 Prediction Sites

5.6.1 Residential Receivers

Prediction sites should be located at all measurement sites. For projects with sparsely located residences, predictions should be made at every residence. A traffic noise prediction at every residence is not necessary for projects with densely located residences; however, sufficient noise predictions must be made to accurately represent the predicted noise conditions.

When selecting prediction sites, primary consideration is to be given to outdoor activity areas of frequent human use. Prediction sites, as well as measurement sites, are typically located 15 feet from the face of the residence between the residence and the ROW. The prediction site is subject to change if that location is not feasible, or if the outside activity area is better represented by another location. Most outdoor activity areas are near the residence. For single family residences, the outdoor property immediately surrounding the residence is usually considered to be frequently used. When both front and back yards are present, the analyst should use the most conservative prediction location. For example, placing prediction sites where the residence shields them from the highway noise is not an appropriate prediction location when there is a frequently used area that faces the ROW. For single family residences with both front and back yards, ODOT uses the yard that faces the ROW and the highway.

For apartment complexes, prediction sites should be located in the exterior frequently used area that is closest to the highway. When there are both balconies and a swimming pool present at an apartment complex, the noise analyst should locate prediction sites at the most conservative location (whichever is closest to the highway). For multi-level apartments with balconies, all levels should be modeled if they face the ROW.

5.6.2 Nonresidential Receivers

For nonresidential receivers, prediction sites are limited to frequently used outdoor areas. Sidewalks and parking lots are not considered frequently used. For hotels and motels, receiver locations could be near an outdoor swimming pool; for commercial property, the frequently used outdoor area could be an employee break area. For parks, golf courses, schools, hospitals, and recreational areas, receivers could be located near seating areas or congregating locations (e.g., holes at golf courses) where people are expected to frequent and spend at least one hour.

Amphitheaters, auditoriums, public rooms, places of worship, and similar locations that have outdoor use areas, prediction sites should be placed similar to residential receivers; the receptor

should be placed at the outdoor use area that is between the structure and the ROW. For these locations (see section 6.6.1, Activity Category D) where there are no exterior areas of frequent human use and where a noise barrier is not feasible and reasonable, the interior noise levels will need to be determined in the design year.

For other activities without distinct structures, outdoor activity areas need to be identified and, using professional judgment, prediction sites should be placed on the edge of the activity area boundary that is closest to the highway. The number of receptors needed to define the location will depend on various factors such as topography, extent of impact area, and distance from adjacent roadways. This information can be obtained from mapping and the facility owners or managers.

5.6.3 Receivers on Undeveloped Land

For undeveloped land, receivers should be located at 50-foot intervals from the centerline of the roadway out to a distance where the noise levels approach the abatement criteria levels of 65 and 70 dBA. This information will be used in the "Information to Local Jurisdictions" section in the noise technical report to describe or graph the noise levels over distance.

5.7 Removal of Shielding

For other model inputs, attention should be given to acoustic barriers such as buildings, fences, or dense stands of evergreen vegetation that will be removed as part of the project's construction. Such physical barriers may serve to reduce traffic noise, and their removal could increase noise levels.

5.8 Vehicle Speed

When selecting the vehicular speeds to be used in the modeling, either the posted speed or the operating speed must be used. The operating speed should be used as a model input if it is determined to be consistently higher than the posted speed limit.

6.0 ANALYSIS OF TRAFFIC NOISE IMPACTS

This section explains how traffic noise impacts are defined and analyzed. Noise impact analyses must include the characterization of the existing noise environment and land use, noise measurements, model verification, identification of noise impacted property by means of prediction modeling, evaluation of abatement measures, and documentation of approved noise mitigation.

6.1 Existing Noise Levels

For noise studies conducted for Type I projects, the existing noise environment must be characterized and compared with the future conditions. Existing conditions must include all sound that makes up the background noise environment, which can include aircraft and rail noise.

Determining existing noise levels must be done with TNM modeling and field noise measurement. For projects that involve existing alignments, existing conditions can be established via model prediction. For new alignments, noise measurements are required to establish existing noise conditions in areas not currently dominated by traffic noise but which will be dominated by traffic noise in the future.

Abatement criteria for noise impacts are based on land use. Therefore, when existing conditions are analyzed, land use needs to be determined adjacent to and in the immediate area of the project. The zoning and comprehensive land use plan designations for the project area also need to be investigated. Land use covered by the noise study must include existing activities, developed lands, and undeveloped lands. Undeveloped lands that have building permits by the date of public knowledge (i.e., the FHWA approval date of a CE, FONSI or ROD) need to be included in the traffic noise impact analysis. Current land uses and future changes must be documented in the noise study, along with project displacements due to project construction.

6.2 Noise Measurements

Noise measurements must be conducted according to the protocol described in FHWA's *Measurement of Highway-Related Noise* with an American National Standard Institute (ANSI) rated Type 1 or Type 2 sound level meter on the A-weighted decibel setting. Noise measurement sites should be chosen that are representative of land use activity areas around the proposed project. Noise measurements should be conducted at a time that the traffic volumes collected can be used to validate the model, where speeds and volumes are at optimum operating levels (LOS C, or free flow conditions). Noise measurements can also provide information on unusual shielding conditions that must be accounted for in the modeling. Field measurements are also used to verify the ability of the prediction model to accurately characterize the noise environment in the project area.

During field measurements, the locations, description of the measurement sites, days of the week, time of day, concurrent traffic counts, and traffic speeds should be documented. More information concerning field measurement procedures can be found in Appendix D along with an example of a measurement log. The noise measurement data must be included in the noise study. Noise measurement sites must be shown on either a 1 inch:100 feet or 1 inch:200 feet map when presented in the noise technical report.

Other reasons for conducting noise measurements that are not associated with Type I noise studies include providing the public with measured rather than predicted noise levels in cases of traffic noise complaints, providing litigation support, and determining the effectiveness of noise abatement measures. Measurements conducted as a result of noise complaints are discussed in section 11.0.

6.3 Model Validation

To test the accuracy of TNM in characterizing the noise environment of the project area, the model output is compared to field measurements at the same locations. The noise analyst should use the concurrent traffic counts and vehicle mix data gathered during field measurement as inputs to the model. The modeling results must agree with the measured data within ±3 dBA; if

not, the analyst must investigate to determine the reasons for the correlation error. Usually, differences greater than ±3 dBA can be attributed to land features not accounted for in the model such as shielding by topography or structure and non-traffic noise sources (e.g., aircraft flyovers during measurement). No adjustments to model output accounting for errors in verification are allowed without concurrence from the ODOT Noise Program Coordinator. Model verification results, along with the traffic data used, must be documented in the noise studies.

6.4 Noise Study Area

The area of potential noise impacts is not the same as the general project area of potential impact (API). The area of potential noise impacts is to be determined by predictive modeling. In other words, the noise analyst must examine all noise impacts from the project, even if they are beyond the limits of construction or a general project API. The project area to be examined for noise impacts must include all areas impacted by the project, not just the areas adjacent to the project components that meet the definition of a Type I project.

When determining and abating traffic noise impacts, primary consideration is to be given to outdoor activity areas of frequent human use. Mitigation will usually be necessary only where frequent human use occurs and a lowered noise level would be beneficial.

6.5 Modeling Project Alternatives

All project alternatives that are incorporated into the NEPA document, as well as the no-build and existing conditions, must be modeled. Noise measurements are acceptable for identifying existing conditions in locations where there is no existing roadway. Land use activity categories (defined in Table 1 of the FWHA Noise Standard) found in the project area must be modeled.

6.6 Identification of Traffic Noise Impacts

Federal noise regulations state that a highway traffic noise impact occurs when 1) the projected highway traffic noise levels approach or exceed the NAC in the FWHA Noise Standard or 2) the future project highway traffic noise levels substantially exceed existing highway traffic noise levels in an area.

The FHWA provides flexibility to States when selecting criteria for defining noise impacts. Regulations state that the abatement criteria must be at least 1 dBA less than the federal level for the same land use activity category. In Oregon, traffic noise "approach" impacts (i.e., the NAAC) begin to occur when the predicted traffic noise levels for the future build scenario are 2 dBA less than the FHWA NAC. Table 1 illustrates noise sensitive land use activity categories, the NAC, and the ODOT NAAC associated with these land use activities.

Traffic noise impacts can also occur when the future predicted noise levels substantially exceed the existing noise levels. In Oregon, a substantial increase in noise is considered to be an increase of 10 dBA or more, even if this increase results in a noise level less than the Oregon NAAC. For example, a project that results in the noise levels increasing from 43 dBA under existing conditions to 53 dBA for the future build condition has a substantial increase impact.

When appropriate, receivers can represent many receptors of various land use categories (Table 1).

Table 1. Federal Highway Administration Noise Abatement Criteria—Oregon Department of Transportation Noise Abatement Approach Criteria Hourly A-Weighted Sound Level Decibels (dBA)

Activity Category	Activity Criteria[a] Leq (h)		Evaluation Location	Land Use Activity Description
	FHWA NAC[b]	ODOT NAAC[c]		
A	57	55	Exterior	Lands on which serenity and quiet are of extraordinary significance and serve an important public need and where preserving those qualities is essential if the area is to continue to serve its intended purpose.
B[c]	67	65	Exterior	Residential
C[c]	67	65	Exterior	Active sports 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	50	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[c]	72	70	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

[a.] The Leq(h) Activity Criteria values are for impact determination only and are not design standards for noise abatement measures.
[b.] Federal Highway Administration noise abatement criteria
[c.] Oregon Department of Transportation noise abatement approach criteria
[c.] Includes undeveloped lands permitted for this activity category

6.6.1 Activity Categories

The noise analysis must analyze each land use activity category that is present in the project study area. The following section discusses special considerations for analysis for each land use activity category.

Activity Category A (lands on which serenity and quiet are of extraordinary significance and serve an important public need): Any lands designated as Category A must be agreed upon before analysis. The analyst should contact the ODOT Noise Program Coordinator prior to assigning this designation. ODOT is required to submit justification of such a designation and the procedure for analysis to the FHWA on a case-by-case basis prior to starting the impact analysis. There are no previously assigned Activity Category A receivers in Oregon but, according to FHWA guidance, some likely candidates include monasteries, a facility's outdoor prayer area, and amphitheaters. In any case, before assigning Activity Category A to a location, prior approval must be obtained from FHWA Division. Such requests for approval are coordinated through ODOT's Noise Program Coordinator.

Activity Category B (exterior areas of single- and multifamily homes): This activity category includes the exterior impact criteria for single- and multifamily residences (e.g., apartments, condominiums). Impacts should be determined for above-ground dwelling units as well. When analyzing areas with multifamily dwelling units, the analyst should choose an exterior area such as a patio, playground, or picnic area between the highway and the actual building if one exists. For all Activity Category B uses, ODOT's policy is to select the most conservative locations for impact analyses when multiple locations that could be analyzed exist. Section 5.6.1 describes locations for residential receivers for single and multifamily homes.

Activity Category C (exterior areas of nonresidential lands such as schools, parks, and cemeteries): This activity category includes the exterior impact criteria for a variety of land use facilities. Category C includes the exterior areas of a variety of nonresidential land uses not specifically covered in Categories A and B. This category may include public or private facilities.

The time and area of use of the property should be considered when determining traffic noise impacts for certain activity categories since noise impacts may not exist if the time of high traffic noise levels does not coincide with the time of use of that facility. For example, places of worship may be used on days of the week or during hours when traffic volumes are low. Parks are an example. The frequently used portion of the park may not coincide with the area exposed to high noise levels or noise impacts may not exist when the portion of the park exposed to high noise levels is infrequently used. Some facilities may have multiple uses at different times of the day or week, such as a synagogue that includes a school. The noise analyst must identify these uses and analyze impacts and abatement accordingly. See section 5.6.2 for placing prediction sites for nonresidential receivers.

Activity Category D (interiors of Category C facilities): This activity category includes the interior impact criteria for certain activity descriptions listed in Activity Category C that may have interior uses. ODOT considers the interior levels at these land uses after fully completing an analysis of the outdoor activity areas or determining that exterior abatement measures are not feasible or reasonable. An indoor analysis is conducted only after exhausting all outdoor analysis and abatement options. Activity Category D is used as the basis for determining noise impacts for analyses where no exterior activities are 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.

To determine interior noise levels, the noise analyst should first predict the exterior noise levels for the Activity Category D receivers, and then use the building noise reduction factors listed in Table 6 of the FHWA's *Highway Traffic Noise: Analysis and Abatement Guidance* [6].

Activity Category E (exteriors of developed lands that are less sensitive to highway noise): Activity Category E includes the exterior criteria for motels, hotels, offices, and other developed lands not included in A–D or F. Hotels and motels may cause some confusion when determining the appropriate land use category since all or part of some hotels and motels function as apartment buildings. The context and use of hotels and motels should be carefully considered when identifying the appropriate land use category.

Although only exterior use analysis is required by the FHWA for Category E, ODOT requires that the analyst predict noise levels for Category E properties that do not have frequently used outdoor areas. Placement of modeling receivers should follow the procedure for Category G receivers. These noise levels will be shared with the local jurisdictions for purposes of decision making about land use changes that could occur. Abatement would not be considered for Category E land uses unless they contain exterior areas of frequent human use and noise impacts are predicted.

Activity Category F (land uses that are not sensitive to highway traffic noise): No highway noise analysis is required under the FHWA Noise Standard for this type of land use. However, Category F designated lands must be identified in the noise technical report. This activity category includes developed lands that are not sensitive to highway traffic noise. There are no FHWA impact criteria for land use facilities in this activity category and noise impact analysis is not required.

If a proposed project is required to conduct a noise impact and abatement analysis, ODOT requires that Activity Category F uses identified in the project area be modeled. Placement of modeling receivers should follow the procedure for Category G receivers. These noise levels will be shared with the local jurisdictions for purposes of decision making about land use changes that could occur.

If the proposed project has only Activity Category F uses, then only a memo is required, stating that no impact analysis is required for Activity Category F uses (state the land use) according to 23 CFR 772.

Activity Category G (undeveloped land): Activity Category G includes undeveloped lands. Although consideration of mitigation is not required under 23 CFR 772, ODOT must determine and document highway traffic noise levels and provide this information to local officials. The minimum information required is the distance to the impact threshold of each land use category. By providing local government with the best estimate of future noise levels, ODOT may place responsibility for noise abatement on local government and/or property owners.

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[6] https://www.fhwa.dot.gov/environment/noise/regulations_and_guidance/analysis_and_abatement_guidance/revguidance.pdf

Land that is permitted for development (i.e., a building permit has been issued on or before the date of public knowledge), must be analyzed under the Activity Category for that type of development. Abatement that is determined to be feasible and reasonable will be constructed.

For land that is not permitted for development by the date of public knowledge, ODOT must determine future noise levels according to 23 CFR 772.17(a). The results must be documented in the project environmental documentation and in the noise technical report. At a minimum, the analysis should report the distance measured from the proposed edge of the traveled way to the ODOT NAAC for all exterior land use categories. Any noise abatement for such lands (unpermitted, undeveloped) is not eligible for federal-aid participation.

Using contours to describe noise levels for undeveloped unpermitted land is allowed for Type I projects. Noise analysis for Activity Category G can be accomplished by placing receivers in 50-foot intervals from the edge of the roadway pavement until the 65 and 70 dBA contours can be established. Noise levels for these intervals, or the location of the 65 and 70 dBA contours, will be reported in the noise technical report.

6.6.2 Comparing Alternatives

The noise impact analysis should include comparisons between the existing condition and the future no-build and build conditions; impacts must be summed by activity category (A–F) and by alternative (existing, no-build, and build). Appendix E has an example of a results table that compares alternatives.

7.0 ANALYSIS OF NOISE ABATEMENT

When traffic noise impacts are identified, ODOT must consider feasible and reasonable noise abatement measures. For abatement, primary consideration is given to frequently used exterior areas. When traffic noise impacts are identified, ODOT is, at a minimum, required to analyze barrier walls (section 7.2).

7.1 Types of Noise Abatement Measures

Once a noise impact has been identified, all types of noise abatement measures should be considered. Several forms of abatement that may be eligible for federal funding are included in the measures described below.

7.1.1 Traffic Management Measures

Truck Restrictions

Truck restrictions can effectively mitigate traffic noise for some locations. Such restrictions are not recommended where they conflict with the designated use of the roadway or create unreasonable delays or hardship to the motoring public. ODOT's policy is to not restrict trucks on a State highway.

Speed Restrictions

Speed restrictions may be evaluated to mitigate traffic noise where they do not conflict with the roadway's designated use or create unreasonable delays or hardship to the motoring public.

7.1.2 Highway Design

Alignment Changes

Changes in roadway grade and alignment can effectively avoid or reduce a noise impact. Typically alignment and grade changes are not an effective method for mitigating noise along an existing alignment due to the cost involved in acquiring additional ROW and potential impacts to other environmental resources including wetlands. Changes in alignment can also add inconveniences to the public, such as longer trip lengths, relocations of businesses, and adverse approach grades. Therefore, alignment changes may rarely be a mitigation option.

Depressed Roadway

A depressed roadway cut section can effectively reduce traffic noise. If a project needs additional fill material, a lower roadway grade may be a cost-effective method to provide the fill material and reduce traffic noise. Temporary and permanent dewatering requirements, and impacts associated with dewatering, are other considerations to include when exploring the potential of depressing a roadway.

7.1.3 Noise Barrier Construction Types

Earth Berms

Earth berms are an aesthetically pleasing and effective form of mitigation where sufficient area exists for their placement. Earth berms are generally 3 dBA more effective in reducing traffic noise than walls of the same height due to the propagation of the noise over the soft, more sound-absorbing vegetative surface. In addition, earth berms sometimes cost less, making them more cost effective. Earth berms do, however, require more ROW than walls. Landscaping and associated maintenance may also be needed. An earth berm in an urban area may also require access control fencing.

Concrete Walls

Concrete walls come in three basic design types:

a) *Pre-cast post and panel*

   The posts are generally a form of H-beam configuration set in predrilled holes with concrete. The panels are lowered in place and held between the H-beam posts. Because of the length of the posts and the various heights that may be required for a noise wall, sufficient overhead clearance must exist to allow for placing the posts. For this reason, low overhanging wires can cause installation problems and must be considered. One of the benefits of this type of wall is that minimal foundation work

is required. Pre-cast post and panel walls allow placement near trees, bushes, or structures. This design can also act as a retaining wall if the fill is 1–3 feet tall. This type of wall has a relatively long service life and functions well.

b) Block walls

Block walls may be used when overhead clearance is low or where an existing retaining or noise wall must be extended in height. Spread footings are required to support this type of wall. As a result, foundation work may disturb the root system of nearby trees or bushes.

c) Cast-in-place concrete

This type of wall also requires spread footings for support. As with block walls, foundation work may disturb the root system of nearby trees or bushes. The advantage of this wall is the versatility to extend retaining walls and to create special surface features.

When roadways are on fill sections, concrete shoulder barriers may be used to provide partial benefits through small noise reductions. Since concrete shoulder barriers generally will not substantially reduce noise, they are not considered noise barriers.

Wood Walls

Wood walls have been installed in several varieties: wooden I-beam post and plank, wooden post with double tongue and groove planks, and wooden post with plywood panels. The major concern with wood walls is a short life span and added maintenance. Wood walls may warp, which creates gaps in the wall and reduces their effectiveness. Specifications should state the allowable moisture content, coloring, and surface treatment. Certain wood preservatives may be toxic and inappropriate for use in residential areas or near wetlands or waterways.

Metal Walls

Metal walls come in a variety of types and configurations. Metal walls may be more susceptible to denting and vandalism but have the advantage of being lightweight. This characteristic may be needed when noise walls are to be placed on structures.

7.1.4 Architectural Mitigation (Noise Insulation)

Architectural treatment for noise mitigation may be used for public or nonprofit institutional buildings such as schools, places of worship, libraries, and some commercial activities (see land use activities under Activity Category D in Table 1) when a traffic noise impact has been identified. Providing ventilation, storm windows, or air conditioning for residences may be more cost effective than building a noise wall.

Ventilation Systems

In buildings where windows are used for ventilation, noise impacts may occur. Closing the windows is often sufficient for reducing interior noise levels below the impact level. Ventilation systems are needed to re-establish the ventilation provided by the windows. A forced-air ventilation system can re-establish proper air circulation while providing effective noise mitigation. The air intakes should be on the north side of the building or near the windows. Air intakes on the roof or on the south side of the building may take in abnormally hot air and should be avoided.

Storm Windows

Installing storm windows is often coupled with a ventilation system to provide increased noise reduction. Storm windows also reduce winter heat losses. The money saved in heating should offset any operation or maintenance costs associated with the ventilation system.

Air Conditioning

Air conditioning may be used in place of ventilation systems if it can be installed at the same or lower cost. Air conditioners, however, generate their own noise levels and may negate the traffic noise reductions. Ventilation systems can also be designed so the property owners can later add air conditioning.

7.1.5 Land Use Controls

Appropriate zoning or development restrictions can eliminate or reduce noise impacts to future development.

7.1.6 Noise Buffer Zones

Buffer zones can preempt development that could otherwise be impacted by traffic noise. Land acquired for buffer zones is normally unimproved property. Federal funding is available for land acquisition for buffer zones.

7.2 Noise Barriers

For abatement analyses, ODOT must give primary consideration to exterior areas where frequent human use occurs. Although federal funding is available for the above mentioned types of abatement, at a minimum ODOT is required to consider noise abatement in the form of a noise barrier [23 CFR 772.13(c)(1)].

7.2.1 Level of Design Detail

The initial analysis and recommendation for noise abatement measures are generally completed during the initial environmental process such as developing a draft Environmental Impact Statement (EIS) or Environmental Assessment (EA) or when a noise study is conducted for a CE. This analysis occurs before detailed topography or design information is available. Project designs at this stage are often preliminary and subject to change. For that reason, determining

the final elevation and location of the noise barrier may not be possible. The statement of abatement likelihood in the noise technical report is an important reminder that the final design may result in changes to the abatement recommendation (see section 7.6). The final noise barrier design is often completed during the final design phase of the project. At that time, finished elevations for the top of a wall will be provided based on accurate survey and design information.

7.2.2 Location of Noise Barriers

Where possible, noise barriers should be located as close to the highway ROW line as practical.

The construction of noise mitigation on private land may be advantageous. Constructing noise barriers off the highway ROW may also be preferred when a railroad or power transmission lines are adjacent to the road. In such cases, the opinion of the noise-impacted residents as to desirability of the mitigation measure and the use of their property for barrier construction must be carefully weighed. While potentially advantageous, locating the wall off ROW can add to the cost of a barrier and result in utility conflicts. Typically, the primary site to consider, and the most desirable location, is on the existing ROW.

Locating noise barriers within a public ROW may not be reasonable or feasible. If so, consideration can be given to locating the noise barriers on private property. Such noise barriers must meet the same requirement of reasonableness and feasibility as mitigation located along an existing public ROW. When barriers are located on private property, a permanent easement is necessary for wall maintenance. Additional restrictions may also be established to prevent present and future property owners from modifying or removing the barrier.

7.2.3 Expected Life and Maintenance of Barriers

The anticipated life span of a concrete wall is 30–50 years or longer. Timber walls have an estimated life of 20–30 years or less. Maintenance requirements for concrete walls are low; maintenance of wood walls can be high if shrinkage, warping, or vandalism occurs. Maintenance of earth berms can be low or high depending on the covering and the slope—mowable grass or non-mowable grass; irrigated landscaping or non-irrigated landscaping, or bark.

7.2.4 Noise Barrier End Treatments

Wing walls may be added to the ends of straight runs of walls to minimize the effect of flanking noise around the ends of the walls. Such wing configurations should not be allowed to affect the safe sight distance of drivers. Wing walls are usually only installed at cross streets where public ROW is present. Installation at private driveways, while typically not considered, may be considered on a case-by-case basis.

Where sufficient material and ROW is available, the end of the wall can be buried in an earth berm. However, burying the end of the wall in a berm can pose a hazard if children are present. Children may consider the buried end as easy access to the top of the wall and a convenient place to climb and play. The ends of walls should not be lower than 6 feet tall if there is potential for children to play or climb on the wall.

7.3 Feasibility Criteria for Abatement

Feasibility or constructability of an abatement measure includes acoustical and engineering factors. For abatement to be feasible, The FHWA requires that noise-impacted receptors achieve at least a 5-dBA reduction in noise levels. The FHWA requires that States identify the number of impacted receptors that must get a 5-dBA reduction. For abatement to be feasible, ODOT requires that a simple majority of impacted receptors achieve at least a 5-dBA reduction in noise levels.

ODOT also considers engineering factors such as barrier height, safety, topography, drainage, utilities, and access issues when determining feasibility. Abatement must be able to be constructed using the American Association of State Highway Transportation Officials (AASHTO) Green Book[7].

7.3.1 Barrier Height

When determining feasibility, ODOT will consider all heights. However, standard design codes (Uniform Building Code [UBC] and AASHTO) allow 2000 pounds per square foot (psf) as a standard design criterion for 16-foot walls. Additional design codes require testing of loads that exceed those specifications. ODOT will analyze noise walls up to heights of 25 feet using the cost estimating technique detailed in section 7.4.2.

Wall heights greater than 25 feet could require a custom wall design, which may result in typical wall costs being irrelevant. Wall heights exceeding 25 feet may be proposed, but the estimate of cost for such walls must be done on a case-by-case basis. The noise analyst will consult with ODOT's Noise Program Coordinator or the Project Roadway Designer before recommending or analyzing barriers over 25 feet tall. Walls higher than 25 feet would likely exceed the reasonable criteria for cost effectiveness.

7.3.2 Safety

Barriers can create shadow effects on the roadway that could contribute to icy conditions. Barriers close to the roadway can also make snow removal difficult. Safe sight distance is another safety design factor to consider when a wall or berm is considered for horizontal curve sections of highways and at locations where a barrier terminates near a highway or intersection with another roadway.

7.3.3 Topography and Drainage Control

Topography in the area of proposed abatement may include complex terrain or geography features that may limit the constructability of a barrier wall. In such cases, the Project Roadway Designer should be consulted before continuing with the abatement analysis. The placement of

[7] A Policy on Geometric Design of Highways and Streets, 5th Edition—The Green Book .

the barrier must consider existing ditches and water runoff. Any situation where a noise barrier would act as an undesirable dam or barrier to normal runoff should be avoided.

7.3.4 Utilities

Current or future placement of underground or overhead utilities can limit the placement of a noise barrier. The noise analyst should consult the Project Roadway Designer for location of utilities before analyzing the reasonable criteria for the noise barrier.

7.3.5 Access

If breaks are needed in the noise barrier to allow for existing driveway access, the effectiveness of the barrier will be decreased. Access to the noise barrier for maintenance purposes as well as access to properties adjacent to the barrier must be accounted for when considering constructability.

7.4 Reasonableness Criteria for Abatement

In assessing reasonable noise abatement, to meet minimum federal requirements, ODOT must consider the viewpoints of the residents and property owners that benefit from the proposed abatement, the cost-effectiveness of the abatement measure, and the ODOT noise reduction design goal for abatement. All three criteria must be met to satisfy the reasonableness requirement. Assessing reasonable criteria will be done only after the proposed abatement has been determined to be feasible.

7.4.1 Viewpoints of the Property Owners and Residents

Noise abatement survey letters to the benefited residents and property owners must be sent out to determine the viewpoints of the affected noise receptors. A simple majority (51 percent of all responding benefited residents and property owners) is needed to build noise abatement. A log should be kept to indicate the percentage of total responses. The polling should occur during the preparation of the revised EA (REA) (or prior to a FONSI if an REA is not issued) or FEIS but could occur while preparing the EA or EIS or just prior to final design for CE projects. The Region Environmental Project Manager (EPM), the Region Environmental Coordinator (REC), or the Region Environmental Unit Manager should ensure that the noise abatement survey letters are sent out and returned via a preaddressed, postage-paid envelope.

The noise abatement survey letter briefly explains the project and the noise impacts and provides a graphic or explanation of where the abatement will be located. The abatement survey letter must also explain the likelihood of abatement (see "Statement of Likelihood", section 7.7). The residents are then polled to see if they want abatement. If less than 50 percent of the benefited residents and property owners respond to the survey, a second survey will be sent out to the benefited receivers who did not respond to the first survey. The result of the second survey, combined with the results of the first survey, will be considered the opinion of the benefited receivers, even if less than a 50 percent response is obtained. Percent yes is calculated as follows:

Percent yes = (total yes votes) / (total of yes and no votes returned) x 100

Votes from those responding to the noise abatement survey will be counted according to the following manner:

- Each property owner gets one vote.
- Benefited residents in multi-unit complexes (such as apartments) get one collective vote after those individual votes are tallied. A collective vote results in one yes vote or one no vote.
- The property owner of the multi-unit complex gets one vote.
- In the case of condominium complexes where some of the units are owner-occupied and some are rented, the owner-occupied unit gets one unique vote, the renters get a collective vote, and the offsite owners get one vote each.
- For mobile home and trailer parks, each resident gets a unique vote and the property owner gets one vote.
- A renter of a single-family property gets one vote and the owner gets one vote.

7.4.2 Cost Effectiveness of the Abatement Measure

In the past, ODOT has not participated in cost-averaging abatement over locations that have been determined to be within the same noise environment. However, ODOT may decide to pursue cost averaging with future projects. This decision will be made in consultation with the FHWA Oregon Division.

Residential Areas

To determine cost effectiveness for residential areas, all benefited residences must be considered in calculating a noise barrier's cost per residence. A benefited residence is any impacted or nonimpacted residence that receives a noise reduction of 5 dBA or more.

A reasonable cost is considered to be a maximum of $25,000 per benefited residence. This cost is based on $20 per square foot for a post and panel barrier up to 16 feet tall. For wall heights from 16 feet to 25 feet, the unit cost increases by 40 percent ($25 per square foot) to cover the additional structural considerations. Estimating costs for noise walls higher than 25 feet must be done on a case-by-case basis. In those cases, the noise analyst is required to consult with the ODOT Noise Coordinator or the Project Roadway Designer.

These costs are based on post and panel sound barrier installation and do not include purchase of ROW, any engineering studies, or any potential utility moves. Assessing all costs at this stage of design (usually less than 30 percent) is not possible. Total abatement costs are not known until the final design; therefore, only the cost for post and panel installation is considered when assessing cost effectiveness of a potential barrier. (There may be unique circumstances that reveal an obvious barrier choice such as a berm at the 30 percent level. There should be flexibility to use best judgment in choosing barrier types at that point in the project's development. The post and panel type could be a fall back.) The statement of abatement likelihood should state all that is known about ODOT's abatement intentions at the time of the noise analysis (see section 7.7).

The typical maximum of $25,000 can be exceeded but shall not be higher than $35,000 per benefited residence. To exceed the allowed $25,000 limit, refer to the Optional Reasonableness Criteria in section 7.4.4.

Nonresidential Areas

Noise abatement measures for schools, parks, places of worship, and other nonresidential developments will consider the total abatement cost. To assess reasonable cost for nonresidential uses (Categories C, D, and E), ODOT uses a method that considers hours of use of the noise impacted area relative to peak hour traffic, total hours of use per day, and number of persons benefiting from abatement. Appendix F details the calculations for assessing cost for Categories C, D, and E land uses in Oregon. ODOT uses this method to determine reasonableness for special use areas such as parks and schools. Florida established a policy in *A Method to Determine Reasonableness and Feasibility of Noise Abatement at Special Use Locations* FL-ER-65-97[8] to evaluate cost reasonableness of nonresidential development. This method evaluates the intensity of use of the facility and assigns a value to each user to determine cost reasonableness.

ODOT Review of Unit Costs for Abatement

At a minimum, the square foot cost for post and panel construction must be reviewed once every 5 years. If adjustments need to be made to the total maximum allowable costs, they are done so after thorough review by the ODOT Noise Program Coordinator.

7.4.3 ODOT Noise Reduction Design Goal

ODOT defines its noise reduction design goal as 7 dBA. The noise reduction design goal is not to be confused with the 5 dBA feasibility criteria (see section 7.3.1). It is ODOT policy that at least one benefited property must receive at least a 7 dBA reduction in noise levels with the proposed abatement measure. The noise reduction design goal results in the construction of more effective barriers.

7.4.4 Optional Reasonableness Criteria

Besides the required reasonable factors (cost, viewpoints of the benefited, and abatement design goals), the FHWA allows States to use other reasonable factors when considering abatement. These factors are used in addition to the required reasonable factors and are used to justify an increase in the cost of abatement of up to $35,000 per residence. The following are other factors that ODOT uses to determine reasonableness after the required criteria in sections 7.4.1–7.4.3 are met. Only one of the optional criteria needs to be satisfied in order to justify the increase in the allowable cost.

[8] https://www.fhwa.dot.gov/Environment/noise/noise_barriers/abatement/reasonableness_2009/met02.cfm

Exposure to Higher Absolute Highway Traffic Noise Levels

When analyzing the reasonableness of abatement, the relationship between the absolute noise levels and the extent of increase over existing noise levels is always considered. Future build noise levels that are at least 65 dBA will warrant mitigation, but higher absolute noise levels of Leq 70 dBA and above may warrant spending more funds than impacted locations with Leq 60–69 dBA.

Date of Development

In the past, ODOT considered development that existed prior to the date of public knowledge of the project as an optional reasonableness criterion. Because ODOT's outreach to local jurisdictions concerning noise compatibility land use issues has been inconsistent over the years and not incorporated into policy, ODOT is not allowed to use this criterion. ODOT must have a statewide outreach program to inform local officials and the public if it wants to consider using the date of development as a criterion for reasonableness when evaluating abatement for Type I projects (23 CFR 772.17(b)).

For ODOT's non-federally funded Retrofit Program, the date of development is used to determine reasonableness.

Mixed Zoning Development

Mitigation may not be appropriate in areas of residential and commercial mixed land use, which can indicate that land use is changing, and long-term land use may be uncertain. Insight from the local land-use authority as to the future land use of the property in question should be sought.

The zoning of the land adjacent to the highway project must be reviewed during the mitigation consideration process. Businesses may rely on visual exposure to the roadway to attract customers. In addition, highways must be consistent with the designated usage shown in the Comprehensive Land Use Plan. Noise barriers are not considered to be consistent with commercial or industrial zoning. Exceptions may exist when a residential area is located in commercial zoning, is well established, and is not expected to convert to commercial use within the design life of the highway project.

The continued future use of the noise-impacted activities should be considered by assessing the expected life of the activity or the chance for redevelopment. Private daycare centers for example, may revert back to residential use or change to another use.

Changes between Existing and Future Build Conditions

Additional consideration is given to areas that experience large increases in traffic noise levels from a project when compared to the existing condition. Often this occurs when a new roadway is constructed.

7.5 Other Considerations

7.5.1 Impacts to Environmental Resources

Environmental impacts associated with the construction of noise abatement measures may include, but are not limited to vegetation removal, disturbance of wetlands or waterways, effects on cultural resources, adverse shading, changes in aesthetics, impairment of viewsheds, and blockage of prevalent wind/breeze flows. A summary of all potential environmental impacts associated with potential abatement measures must be fully disclosed within the NEPA document.

7.5.2 Side Slopes of Earth Berms

When designing earth berms, care should be taken to provide side slopes that can be safely negotiated by a vehicle accidentally leaving the roadway. Normally, 1:3 side slopes within the clear zone can be safely negotiated without the danger of flipping the vehicle. In addition, where possible, 1:3 side slopes are preferred to facilitate maintenance such as mowing. If side slopes steeper than 1:3 are necessary, special landscaping may be needed.

7.5.3 Non-traffic Noise

The issue of non-traffic noise must be considered when analyzing abatement measures. Noise abatement to reduce traffic noise may provide substantial noise reductions even in the presence of non-highway noise sources such as aircraft noise, railroad, or industrial noise; however, if the non-highway noise sources are very loud, they may make highway noise abatement infeasible.

7.5.4 Noise Walls and Existing Fences

When possible, creating isolated pockets of land between noise barriers, access control fences, property lines, or private fencing should be avoided. Such areas act as collection points for litter, provide a location to foster weed growth, and allow trespassing or other unauthorized access or activities. Fences between property lots should be connected to the noise walls to protect privacy and increase security.

7.5.5 Noise Reflection

Parallel Barriers

Parallel barriers that reflect traffic noise may degrade the predicted noise reduction. While the degradation is measurable, it is usually less than what can be perceived with normal hearing.

To avoid reduced performance of parallel reflective barriers, the width to height ratio should be at least 10:1. The width is the distance between the barriers, and the height is the average height of the barrier above the roadway. Thus, two parallel barriers 10 feet tall should be at least 100 feet apart.

Care should be taken to ensure that reflective noise does not degrade the performance of a wall, especially when anticipated noise reductions are small.

Reflected Noise from a Single Noise Barrier

Highway traffic noise levels are not typically increased by the construction of a noise barrier on the opposite side of a highway from a receiver. Studies with measured reflective noise have never shown increases greater than 1–2 dBA.

For a person with average hearing, noise increases of 1–2 dBA are typically not perceptible, especially if a minimum ratio of 10:1 (distance to height) is maintained.

7.5.6 Designing for Ground Floor and Second Floor Receptors

On occasion, a building with more than one floor may be so located and the topography is such that mitigating traffic noise levels to an upper floor is possible by constructing a noise barrier of reasonable height. Mitigation should not be excluded for ground-floor impacts merely because mitigation cannot be provided for upper-floor impacts.

7.5.7 Scenic View of Residences

Residents living adjacent to a highway may have scenic vistas that they wish to maintain. Noise mitigation measures may be designed that effectively mitigate traffic noise while maintaining the scenic vista. Sensitivity should be used when designing noise barriers to determine if it is possible to offer a design compromise that takes into account considers both noise mitigation and the resident's scenic vista without sacrificing effective noise mitigation.

7.6 Noise Barrier Approval Process

The decision for each analyzed potential noise barrier location must be documented. The process for approval usually occurs during final design when abatement survey letters are sent out, but the public involvement part of the process can start during open houses and public meetings (see section 7.4.1). The approval process is outlined below.

1. Noise analyst reviews noise impacts.

2. All impacted areas are evaluated for feasible and reasonable abatement.

3. The "Feasibility" section and items 1 and 2 of the "Reasonableness" section on the *Noise Abatement Evaluation and Recommendation* form (see Appendix G) is completed by the noise analyst for each abatement location under consideration.

    a) The noise analyst completes the "Feasibility" section of the evaluation form. If the abatement does NOT meet the feasibility criteria, the abatement evaluation stops and the proposed abatement is not recommended. If the abatement meets the feasibility requirement, the noise analyst continues the abatement evaluation, examining items 1 and 2 of the "Reasonableness" section on the form.

b) At this point, only feasibility and 2 of the 3 reasonableness criteria (cost effectiveness and noise reduction design goal) can be determined. If the proposed abatement does not meet the cost effectiveness or noise reduction design goal criteria, the evaluation stops and the abatement is NOT recommended.

4. The noise analyst preparing the form, signs the form. The form(s) is then submitted with the draft noise technical report for ODOT review. If the proposed abatement meets the feasibility criteria and 2 of the 3 reasonableness criteria, the analyst will indicate on a map where the benefitted receptors are located so that the ODOT Project Team can determine mailing addresses for the noise abatement survey that must be sent to the benefited residents and property owners. Note that if the abatement does not meet the feasibility criteria, cost effectiveness, or the noise reduction design goal criteria, the abatement evaluation is discontinued and abatement is NOT recommended. If these criteria are met, proceed to Step 5.

5. The draft abatement evaluation form is forwarded to the REC or the EPM, and then to the ODOT Noise Program Coordinator. The Noise Program Coordinator reviews and comments on the feasibility, cost effectiveness, and noise reduction design goal entries on the evaluation form and reviews the noise technical report.

   The ODOT Noise Program Coordinator signs the form to indicate that the evaluation criteria for the proposed barrier have been reviewed and forwards the form to the Project Team (EPM or REC). Copies should also be sent to the ODOT Project Leader or Project Manager, depending on the project.

6. From the information on the form, the Project Team reviews the feasibility and reasonableness of the noise barrier and confers with the noise analyst and the ODOT Noise Program Coordinator for his/her input if necessary. (Note that all feasibility and reasonableness criteria with the exception of the viewpoints of the noise-impacted owners and residents have been determined at this point.)

7. The signed draft abatement evaluation form with the two signatures (Noise Analyst and the ODOT Noise Program Coordinator) is sent back to the noise analyst to be incorporated into the noise technical report with the written caveat that not all of the requirements of the FHWA Noise Standard have been met. Information from Step 6 must be added to the form before all of the requirements are met.

8. Approval by benefiting receptors (see section 7.4.1, "Viewpoints of the Property Owners and Residents) is time consuming; therefore, it is important that the EPM, REC, or Region Environmental Unit Manager poll the benefiting receivers as soon as feasible and reasonable abatement has been reviewed by the Project Team. In some regions, the environmental staff may coordinate the survey work with the Community Affairs staff. As described in section 7.4.1, the benefited residents and property owners are polled using a noise abatement survey letter to determine their viewpoints concerning the proposed abatement measure.

9. After the results of the noise abatement survey (from #8) have been documented, the draft *Noise Abatement Evaluation and Recommendation* form (Appendix G) can be finalized.

    a) Since the final requirement for reasonableness has been met, the decision about abatement can be made. By signing the *Noise Abatement Evaluation and Recommendation* form, the Project Leader or Project Manager indicates that the evaluation for feasible and reasonable abatement has been completed and the abatement decision has been made.

    Copies of the finalized form (with the three signatures) must be sent to the noise analyst, the ODOT Noise Program Coordinator, and the REC or EPM.

    b) The finalized form provides documentation that feasible and reasonable requirements for abatement have been met and shows the data for the abatement decision.

10. If the noise abatement evaluation results in a yes decision, the reasonable and feasible abatement measure will be incorporated into the project design.

11. Committed abatement measures are entered into ODOT's Environmental Commitment Tracking System.

7.7 Statement of Likelihood

During final design, noise abatement recommendations may change due to design changes and actual ROW acquisitions. Construction plans and specifications must include all noise abatement measures that have been found to be reasonable and feasible according to the final design.

The noise technical report and the NEPA CE, FONSI, or final EIS (FEIS) must include a statement that advises the public of the following:

> Based on the noise technical report for this project, ODOT intends to install highway traffic noise abatement measures in the form of a barrier at (name location). The possibility of likely abatement measures are based upon preliminary design work for a barrier cost of approximately $ (indicate dollar amount) that will reduce the noise level by up to (state maximum level of reduction) dBA for (state number) of residences. If during ODOT's final design process these conditions have substantially changed, the abatement measures might not be provided. A final decision of the installation of the abatement measure(s) will be made upon completion of the project's final design, a cost estimating process, and the public involvement processes.

The environmental document shall also identify locations with noise impacts that have no feasible or reasonable noise abatement alternative.

7.8 Federal Funding for Abatement

In Oregon, federal funding is only available for feasible and reasonable abatement proposed for Type I projects. ODOT's non-federally funded Retrofit Program is not a Type II program and, therefore, is not eligible to receive federal funds. For abatement activities that are federally funded, the federal share will be the same as for the facility where the project is located.

Federal funding is available for

- construction of noise barriers, including acquisition of ROW,
- traffic management measures such as traffic control devices,
- signage for prohibition of certain vehicle types,
- time-use restriction for certain vehicle types,
- modified speed limits
- lane use restrictions,
- alteration of the horizontal or vertical alignment,
- acquisition of property for buffer zones to pre-empt development that would adversely be impacted by traffic noise, and
- noise insulation of Activity Category D land use facilities listed in Table 1. Post-installation maintenance and operational costs are not eligible for federal funding.

Landscaping is not considered abatement; therefore, federal funding is not available for landscaping related to noise abatement purposes.

Federal funding is also available for noise abatement on privately held land. As mentioned above (section 7.2.2), the preferred location of barriers is on the ODOT ROW; however, locating barriers on the ODOT ROW may not always be possible. Federal funds can be used for abatement for Activity Categories A, B, and E on private land. Federal funds for noise insulation of privately owned structures is limited to Activity Category D (refer to Table 1 for an explanation of activity categories).

8.0 CONSTRUCTION NOISE

By their very nature, construction noise levels can be difficult to quantify. Construction noise is directly proportional to the level of activity occurring and the sound energy produced by the equipment involved. On a construction project, the level of activity and type of equipment can be ever changing and difficult to predict. For that reason, the range in construction equipment noise is provided in the noise technical report. The table in Appendix H contains the range of noise levels for various types of construction equipment.

Typically, no effort is made to predict the specific level of construction noise. Land use activities that may be affected by construction noise should be noted in the noise technical report. Identifying such land use activities can aid in consideration of construction noise abatement strategies.

Local ordinances may restrict nighttime construction noise levels or high noise levels on the weekend or holidays. Where such restrictions exist or where public concerns are known, special

construction noise studies may be used to quantify the anticipated noise levels and to recommend measures to reduce construction noise. Such studies can be used to obtain special permits or a regulatory variance where needed. Local noise ordinances for night work must be determined; permits and variances are needed before construction begins.

One key to effectively dealing with construction noise is communication with the residents adjacent to the construction and notification of unusual activities that may temporarily generate high noise levels. For example, neighbors should be advised in advance of pile driving or blasting operations. Public involvement can often eliminate or lessen the frequency of noise complaints.

Areas adjacent to the highway ROW can temporarily be exposed to high levels of noise during peak construction periods. The effect of the noise on the local area can be reduced if the hours and days of construction activity are limited to less sensitive time periods. The project construction standard noise specifications help minimize the effects of construction noise. Appendix H contains language that is included in the project construction specifications (290.32). In addition to the construction noise standard specifications, local ordinances could have additional restrictions governing evening and nighttime construction. The noise analyst is required to verify any noise ordinances that might impact project construction. The following special provisions may be incorporated into the construction contract and are incorporated at the end of the construction specification 290.32:

a) Inform the local public in advance of construction activities that may generate particularly high noise levels. ODOT requires 14 days notice before beginning night construction work to allow the Agency to inform noise receptors of upcoming night work.

b) Noise barriers, approved for incorporation into the project, should be constructed as close to the beginning of the project's construction timeline as practical.

c) Noise created by truck movement shall not exceed 88 dBA at a distance of 50 feet.

d) When working between 7:00 P.M. and 10:00 P.M., use “smart alarms” instead of standard reverse signal alarms or use spotters. When working between 10:00 P.M. and 7:00 A.M. use spotters.

e) Have portable noise meters on the job at all times for noise level spot checks on specific operations. Employ an individual trained in the use of noise meters, with working knowledge of sound measurements and their meaning and use as applied to these mitigation/abatement measures.

9.0 INFORMATION FOR LOCAL GOVERNMENT OFFICIALS

To minimize future traffic noise impacts on currently undeveloped lands of Type I projects, ODOT is required to inform local jurisdictions (where the proposed highway project is located) of the following:

1. Noise compatible planning concepts

2. The best estimation of the future design year noise levels at various distances from the edge of the nearest travel lane of the highway, where the future noise levels meet ODOT's definition of "approach" for undeveloped lands or properties within the project limits. At a minimum, the distance to ODOT's exterior NAAC from Table 1 must be identified.

3. For development that occurs after the date of public knowledge, State funds are not available from ODOT's non-federally funded Retrofit Program and federal funds are not available as ODOT does not have a federally approved Type II program. The date of public knowledge is the date of approval of the CE, FONSI, or ROD.

To fulfill these three requirements, at a minimum, ODOT must send a cover letter to local jurisdictions, along with copies of the noise study, explaining noise compatible planning concepts. A face-to-face meeting between ODOT and the local jurisdiction(s) will likely better convey information than only sending a letter with attachments. Face-to-face meetings between ODOT and the local jurisdiction(s) shall be held for those projects on new alignment. The letter must also include a table of future noise levels at specific locations or a figure showing the distances to typical noise levels along the roadway for unpermitted, undeveloped lands in the project area. The letter should encourage local officials to make this information available for disclosure in real estate transactions. Local officials should be made aware that federal funds for traffic noise abatement are not available for development that occurs after the date of public knowledge of the project as explained in the letter.

The letter and copies of the noise technical report must be provided to and reviewed by City and/or County planning departments. The letter and the report should be distributed with the environmental document. The noise technical report should be distributed under the supervision and direction of the EPM or REC. The distribution information, including names and date distributed, and any follow-up contact with local agencies must be documented in the project files.

10.0 DOCUMENTATION OF TRAFFIC NOISE STUDY

The FEIS, the REA, or FONSI or the CE must identify and document the following:

a) Reasonable and feasible noise abatement measures that are likely to be incorporated in the project.

b) Noise impacts for which no apparent solution is available with an explanation of why noise abatement was not recommended. The scope of the noise technical report and the report format needs to be agreed upon by the ODOT Project Team and the ODOT Noise Program Coordinator. The format can be specified in the scope of work signed by the noise consultant.

10.1 Report Format for Type I Project

All environmental documents (CE, EA, and EIS) are subject to the FHWA Noise Standard if the project meets the definition of a Type I project. The format found in Appendix I is to be used for all traffic noise technical reports. Because of the range of alternatives, noise technical reports for EAs and EISs tend to be longer than reports for CE projects. All noise technical reports should contain the elements appropriate to the scale and complexity of the study. The report should be clear, concise, and easy to read.

10.2 Report Format for the Oregon Department of Transportation's Non-Federally Funded Retrofit Program Projects

ODOT's non-federally funded Retrofit Program follows the same format and content as a Type I project where appropriate.

10.3 Report Format for Type III Projects

No analysis is required for Type III projects. For environmental clearance for Type III it is sufficient to state the following:

> The (title) project meets the criteria for a Type III project established in 23 CFR 772. Therefore, the project requires no analysis for highway traffic noise impacts. Type III projects do not involve added capacity, construction of new through lanes or auxiliary lanes, changes in the horizontal or vertical alignment of the roadway, or exposure of noise sensitive land uses to a new or existing highway noise source. A noise analysis will be required if changes to the proposed project result in reclassification to a Type I project.

10.4 Quality Assurance/Quality Control

10.4.1 Qualification for Oregon Department of Transportation Noise Consultants

The lead noise analyst responsible for the assessment of traffic noise impacts, traffic noise abatement, or review and approval of final noise technical reports must, at a minimum, have completed the Bowlby and Associates modeling course for TNM as well as the course, "Traffic Noise Fundamentals." ODOT also requires that analysts attend the FHWA course, "The Fundamentals and Abatement of Highway Traffic Noise," which is taught through the National Highway Institute (NHI).

In addition, the lead analyst must have a minimum of 2 years of experience analyzing impacts and abatement, including performing traffic modeling for transportation projects. This experience must include work on transportation projects requiring NEPA documentation at the level of an EA or higher.

10.4.2 Noise Technical Report

The noise technical report must be reviewed by a senior noise specialist. All data used in the report must be compared against model output, supplied traffic data, roadway design files, and assumptions. For consultant noise studies, senior review and quality control (QC) must be completed before submitting to ODOT for review. The consultant must submit the noise technical report for review to the ODOT Noise Program personnel. Comments and concerns expressed by ODOT must be remedied before the report is stamped by a professional engineer. Appendix I contains a QC checklist for the consultant to identify all elements that must be included with noise technical report.

10.5 Memos and Letters

Noise studies documenting that the project does not meet the definition of a Type I activity and noise studies that are conducted as a result of a public complaint may be documented in a memo or letter.

11.0 OREGON DEPARTMENT OF TRANSPORTATION'S NON-FEDERALLY FUNDED RETROFIT PROGRAM AND NOISE COMPLAINT RESPONSE

11.1 Oregon Department of Transportation Policy on Mitigation for Post-project Traffic Noise Complaints

ODOT acknowledges that there may be circumstances where adjacent land uses may be adversely impacted by traffic noise from ODOT facilities and these uses predate a) the existence of the source highway or b) a major increase in traffic-generated noise. When these noise sensitive uses fall outside the boundaries of a foreseeable transportation project where noise mitigation is a consideration, ODOT will consider implementing a noise mitigation retrofit project. In a potential retrofit circumstance, it is ODOT's policy to only participate in retrofit projects when all of the following criteria are met:

- The mitigation meets ODOT criteria for feasible and reasonable.
- A substantial percentage of the mitigation cost is borne by the local government and/or the benefiting property owners. ODOT's participation in cost sharing is based on State funding available after higher priority State and transportation projects have been funded.
- The affected receivers were in place prior to the construction of the source State highway or prior to a doubling of traffic volumes on the source facility.

11.2 Background

The June 1995 FHWA Policy and Guidance paper advised that Type II abatement projects for new activities and land uses which have come into existence after 1976 will not be approved unless an active land use control program was adopted by the local government prior to the existence of the new activities and land uses.

In 1995, the Federal Highway Appropriations Act eliminated federal funding for Type II projects unless the noise barriers were proposed along lands that were developed or were under substantial construction before approval of the acquisition of ROWs for, or construction of, an existing highway. From this history evolved ODOT's policy for responding to noise complaints from the public who requested noise barriers to lower traffic noise from facilities that were already constructed.

The FHWA revised the Noise Standard in July 2010. With the update to the Standard, the FHWA gave States the flexibility to adopt the federal policy for Type II projects (retrofits), or opt out and conduct their own program. In 2010, ODOT decided to opt out and conduct its own program, the ODOT non-federally funded Retrofit Program.

This section documents ODOT's policy for retrofits and provides a process for handling noise complaints from the public.

11.3 Process

Noise complaint responses and retrofit project noise studies are done at the discretion of the ODOT Region Offices. Noise studies must be conducted for standalone retrofit projects along existing highways and will follow the applicable analysis requirements of the FHWA Noise Standard.

The cost of the retrofit noise study and any subsequent noise mitigation will be determined by the ODOT Region Office involved. If there is to be cost sharing between ODOT, benefitted receptors, and the local government, ODOT's participation will be 50 percent. Cost sharing can only occur for abatement that has been determined to be reasonable and feasible as defined by the FHWA Noise Standard and ODOT policy.

In economic recession years, ODOT funding for retrofit abatement projects is unlikely since abatement projects must compete with other higher priority transportation projects, such as emergency repairs and safety projects. ODOT cannot commit to funding during recession years.

The following steps outline the noise complaint response and the project development process for ODOT's non-federally funded Retrofit Program noise projects:

1. Noise complaint is received.

Noise complaints can come into ODOT in a variety of ways—through the Districts and Areas, the "Ask ODOT" website, public meetings, or direct phone calls. Regardless, the ODOT Region Environmental Manager is the primary contact and assists in determining if ODOT will conduct

a noise study. The District Manager and Area Managers where the noise complaint occurred should also be notified.

If the complaint was not received via "Ask ODOT," "Ask ODOT" must be notified so that the complaint is officially documented by the Agency. "Ask ODOT" enters the complaint and response into a database that provides information to management and tracks information by location.

Some noise complaint situations can be resolved by contacting the complainant and explaining ODOT's policy on retrofit noise barriers (see section 11.1). The ODOT Noise Program Coordinator should be copied on all complaints and complaint responses. If the Region decides to proceed with the noise complaint investigation, the process proceeds to step 2.

2. Noise Study

A) **Screening Study**. A short-term screening study can be conducted by the ODOT Noise Program Coordinator at the request of the Region. This type of study is intended to determine if the noise levels exceed the noise abatement criteria. Preliminary determinations on the feasibility of abatement can be made during the site visit via line-of-sight methods. Short-term measurements (usually 15-minute periods) will be conducted according to FHWA procedures (*Measurement of Highway related Noise*, FHWA, May 1996) and ODOT policy. Results and findings of the screening study will be documented in a memo/email to the Region Environmental Manager, the Area Manager, and the District Manager. "Ask ODOT" should receive a copy of the findings, as well. The screening study memo should discuss the noise measurements in relation to the NAAC, traffic at the time of the noise measurements, site photographs, other pertinent field data, and the likelihood of abatement.

B) **Detailed Noise Impact and Abatement Analysis**. If the Region determines that a more detailed analysis is warranted, then the Region may enter into a cost-sharing agreement with the residents, property owners, and/or the local agency. This type of study is more detailed and can cost $20,000 or more, so any cost-sharing agreement for the noise study and potential abatement must be in place before ODOT can proceed. The estimated dollar amount to be contributed by the local residents and the local government will be determined by the ODOT Region, with assistance by the ODOT Noise Program Coordinator for ODOT-funded projects.

If the benefited residents and property owners agree to pursue abatement, they may seek approval to form a Local Improvement District (L.I.D.) or another means to raise sufficient funds. The local residents, property owners, and the ODOT Region office must agree on the method used to arrange local agency participation. The cost-sharing agreement must be in place and signed by all parties before ODOT will participate in detailed noise impact and abatement analyses.

3. Program Project in the Statewide Transportation Improvement Program (STIP)

Once local funding has been arranged, the ODOT non-federally funded Retrofit Program project needs to go through the STIP process to establish the availability of State funds. A retrofit noise wall project competes with all other ODOT projects for funds on a priority basis.

It may take many years for funding to be available for a retrofit abatement project. ODOT must make clear to the public that a retrofit noise barrier must compete for funding sources like any other STIP project. In recession years, emergency road repairs and safety projects would have higher priority for decision makers than retrofit noise abatement projects.

4. Noise Impact Study and Detailed Mitigation Design

Once the ODOT non-federally funded Retrofit Program project is included in the adopted STIP and the cost-sharing agreement is secured, the retrofit project can proceed with the detailed noise impact and abatement analyses. The noise study includes noise measurements and impact and abatement analyses. The abatement analysis and subsequent field location work will establish the actual sound wall location, profile, and length.

The detailed noise study will be performed by a consultant and includes noise measurements and prediction modeling using FHWA's TNM. This type of study is conducted according to impact analysis and abatement procedures described in the FHWA Noise Standard and ODOT policy for Type I projects.

The study area will be defined and agreed upon by the ODOT Region. Noise measurements are typically taken at the receiver of the complainant and may include other nearby receivers. Noise measurements must be conducted according to FHWA procedures (*Measurement of Highway related Noise*, FHWA, May 1996). Traffic counts at the time of measurement must be obtained, and future traffic projections should be generated from TNM modeling. Noise predictions are made and mitigation feasibility and reasonability are evaluated according to ODOT policy. Roadway design and traffic data will be supplied by ODOT. An estimated mitigation cost is made based upon approximations of the sound wall's required height and length, engineering design, and geotechnical drilling. Only mitigation that has been determined to be feasible and reasonable will be pursued (see section 7.3 for reasonable and feasible criteria).

5. Construction Plans

From the location survey and the noise study, construction plans can be prepared.

12.0 Collection and Reporting of Approved and Constructed Noise Barrier Data

The FHWA abatement measure reporting requirements are outlined in 23 CFR 772.13. In addition, ODOT is placing increased emphasis on Asset Management. To track the information for Asset Management as well as for the FHWA, a database is kept that details all approved and constructed noise mitigation measures.

Appendix J contains the form that is used to solicit abatement information. The Project Leader initially submits the form once the abatement measure has been approved by the Project Team. The ODOT Noise Program Coordinator enters the data for the approved abatement into the database. Once the abatement has been constructed, as-built information is submitted to the ODOT Noise Program Coordinator. As-built information includes pictures and final

coordinates. Any differences between approved and constructed noise mitigation are noted in the database.

13.0 ADDITIONAL RESOURCES

American Association of State and Highway Officials (AASHTO). 1993. *Guide on Evaluation and Abatement of Traffic Noise.* American Association of State and Highway Officials, Washington, DC.

Blum, R.A. 1978. *A Guide to Visual Quality in Barrier Design.* FWHA 77-12. U.S. Department of Transportation, Federal Highway Administration, Washington, DC.

Davy, B.A. and S.R. Skale. Insulation of Buildings Against Highway Noise. Federal Highway Administration Report FHWA-TS-77-202. U.S. Department of Transportation, Federal Highway Administration, Washington, DC.

Federal Highway Administration (FHWA). 1976 (reprint). The Audible Landscape: A Manual for Highway Noise and Landuse. Prepared by Urban Systems Research and Engineering, Inc., Cambridge, MA for the U.S. Department of Transportation, Federal Highway Administration, Washington, DC. https://www.fhwa.dot.gov/Environment/noise/

Federal Highway Administration (FHWA). 1995. Highway Traffic Noise Analysis Abatement Policy and Guidance. U.S. Department of Transportation, Federal Highway Administration, Washington DC.

Federal Highway Administration (FHWA) 2000. Highway Traffic Noise in the United States Problem and Response. U.S. Department of Transportation, Federal Highway Administration, Washington, DC.

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Federal Highway Administration (FHWA). 2011. Highway Traffic Noise: Analysis and Abatement Guidance. U.S. Department of Transportation, Federal Highway Administration, Washington, DC.

Knauer, H.S., S. Pedersen, C.S.Y. Lee, and G.G. Fleming. 2000. FHWA Highway Noise Barrier Design Handbook. FHWA-EP-00-005. U.S. Department of Transportation Research and Special Programs Administration, John A. Volpe National Transportation Systems Center, Cambridge, MA.

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Menge, C.W., G.S.Anderson, C.S.Y. Lee, and G.G. Fleming. 1998. FWHA Traffic Noise Model Version 1.0: Technical Manual. FHWA-PD-96-010, Final Report. U.S. Department of Transportation Research and Special Programs Administration, John A. Volpe National Transportation Systems Center, Cambridge, MA.

Reagan, J.A. and C.A. Grant. 1977. Special Report, Highway Construction Noise Measurement, Prediction, Abatement. U.S. Department of Transportation, Federal Highway Administration, Washington, DC.

APPENDIX A

Highway Traffic Noise Terminology and Basic Concepts

Traffic Noise Terminology and Basic Concepts

Sound is composed of pressure waves within the atmosphere. The human ear can detect some of these atmospheric disturbances. The weakest pressure wave that can be heard by a person with good hearing in very quiet surroundings is 0.00002 Newton per square meter (N/m^2). Very high pressure, about 200 N/m^2 or 200 pascal (Pa), can actually be painful.

A logarithmic scale, the decibel system, has been selected to describe this range of hearing. The measurement unit is the decibel (dB). The equation for this descriptor is

$$\text{decibel} = 10 \log \left(\frac{\text{pressure}}{20\ \mu\text{Pa}} \right)^2$$

Using this scale, the weakest sound which can be heard (20 μPa.) is 0 dB. The pressure creating pain (about 200 Pa) is about 140 dB.

Pressure waves also can vary in frequency; that is, the number of pressure waves generated per second. The unit of measurement for this property is Hertz. One wave per second is equal to 1.0 Hertz, two waves per second is equal to 2.0 Hertz, and so on. The hearing range of most people is 20–20,000 Hertz. People perceive these different frequencies as a change in pitch.

The ear is more sensitive to some frequencies than to others. Because of this, the loudness of a 100-Hertz sound and a 1,000-Hertz sound, both with the same pressure or decibel level, will be perceived differently. The difference between the true sound level and the perceived sound level depends on frequency. The "A-scale" is a frequency weighting system that closely represents the average human hearing response. It has become the most widely accepted frequency system today. A sound level adjusted with this system is called decibels "A-weighted" or dBA.

People cannot usually detect a 1 dBA increase in sound; a 2–3 dBA increase is typically needed before a change can be perceived. A 10-dBA increase, such as from 50 dBA to 60 dBA, is usually perceived as a doubling of loudness. Doubling of the acoustic output of a sound source will increase the sound level by 3 dBA. For example, two 50 dBA sound sources will produce a total sound level of 53 dBA. Thus, a doubling of traffic volumes on a road will create a change in loudness that is just barely noticeable.

Sound levels decrease as the distance from the sound source increases. The reduction rate varies with the type of source. Theoretically, a point source has a rate described as a 6-dBA reduction per doubling of distance. A line source has a 3-dBA reduction per doubling of distance. The reduction rate for highway noise is 3 dBA per doubling of distance. Noise levels can also be reduced by acoustic barriers such as topography, vegetation, buildings, or walls.

Sound levels within the environment often change randomly, which is the case with traffic noise. To describe a varying sound, a measurement system is used that averages the sound pressure levels. This measurement system is called the Leq level. The Leq level is the energy–averaged decibel level. Using Leq levels is a commonly accepted practice in community noise measurements and has been found to correlate well with peoples' perceptions of noise and its affects. The following table illustrates common noise levels in the environment.

Table 1. Indoor and Outdoor Sound Levels

Outdoor Sound Levels	Sound Level (dBA)	Indoor Sound Levels
	110	Rock Band at 5 m (16 feet)
Jet Over-Flight at 300 m (1,000 feet)	105	
	100	Inside New York Subway Train
Gas Lawn Mower at 1m (3 feet)	95	
	90	Food Blender at 1 m (3 feet)
Diesel Truck at 15 m (50 feet)	85	
Noisy Urban Area-Daytime	80	Garbage Disposal at 1 m (3 feet)
	75	Shouting at 1 m (3 feet)
Gas Lawn Mower at 30 m (100 feet)	70	Vacuum Cleaner at 3 m (10 feet)
Suburban Commercial Area	65	Normal Speech at 1 m (3 feet)
	60	
Quiet Urban Area-Daytime	55	Quiet Conversation at 1 m (3 feet)
	50	Dishwasher in Next Room
Quiet Urban Area at Night	45	
	40	Empty Theater or Library
Quiet Suburb at Night	35	
	30	Quiet Bedroom at Night
Quiet Rural Area at Night	25	Empty Concert Hall
Rustling Leaves	20	
	15	Broadcast and Recording Studios
	10	
	5	
Reference Pressure Level	0	Threshold of Hearing

Source: Center for Environmental Excellence by AASHTO-Noise Overview https://environment.transportation.org/environmental_issues/noise/#bookmarkBackground

APPENDIX B

23 CFR 772 Procedures for Abatement of Highway Traffic Noise and Construction Noise

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

Sec.

772.1 Purpose.
772.3 Noise standards.
772.5 Definitions.
772.7 Applicability.
772.9 Traffic noise prediction.
772.11 Analysis of traffic noise impacts.
772.13 Analysis of noise abatement.
772.15 Federal participation.
772.17 Information for local officials.
772.19 Construction noise.

Table 1 to Part 772--Noise Abatement Criteria

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

Sec. 772.1 Purpose.

To provide procedures for noise studies and noise abatement measures to help protect the public's health, welfare and livability, 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 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(1). All highway projects which are developed in conformance with this regulation shall be deemed to be in accordance with the FHWA noise standards.

Sec. 772.5 Definitions.

Benefited Receptor. The recipient of an abatement measure that receives a noise reduction at or above the minimum threshold of 5 dBA, but not to exceed the highway agency's reasonableness design goal.

Common Noise Environment. A group of receptors within the same Activity Category in Table 1 that are exposed to similar noise sources and levels; traffic volumes, traffic mix, and speed; and topographic features. Generally, common noise environments occur between two secondary noise sources, such as interchanges, intersections, cross-roads.

Date of Public Knowledge. The date of approval of the Categorical Exclusion (CE), the Finding of No Significant Impact (FONSI), or the Record of Decision (ROD), as defined in 23 CFR part 771.

Design Year. The future year used to estimate the probable traffic volume for which a highway is designed.

Existing Noise Levels. The worst noise hour resulting from the combination of natural and mechanical sources and human activity usually present in a particular area.

Feasibility. The combination of acoustical and engineering factors considered in the evaluation of a noise abatement measure.

Impacted Receptor. The recipient that has a traffic noise impact.

L10. The sound level that is exceeded 10 percent of the time (the 90th percentile) for the period under consideration, with L10(h) being the hourly value of L10.

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, with Leq(h) being the hourly value of Leq.

Multifamily Dwelling. A residential structure containing more than one residence. Each residence in a multifamily dwelling shall be counted as one receptor when determining impacted and benefited receptors.

Noise Barrier. A physical obstruction that is constructed between the highway noise source and the noise sensitive receptor(s) that lowers the noise level, including stand alone noise walls, noise berms (earth or other material), and combination berm/wall systems.

Noise Reduction Design Goal. The optimum desired dBA noise reduction determined from calculating the difference between future build noise levels with abatement, to future build noise levels without abatement. The noise reduction design goal shall be at least 7 dBA, but not more than 10 dBA.

Permitted. A definite commitment to develop land with an approved specific design of land use activities as evidenced by the issuance of a building permit.

Property Owner. An individual or group of individuals that holds a title, deed, or other legal documentation of ownership of a property or a residence.

Reasonableness. The combination of social, economic, and environmental factors considered in the evaluation of a noise abatement measure.

Receptor. A discrete or representative location of a noise sensitive area(s), for any of the land uses listed in Table 1.

Residence. A dwelling unit. Either a single family residence or each dwelling unit in a multifamily dwelling.

Statement of Likelihood. A statement provided in the environmental clearance document based on the feasibility and reasonableness analysis completed at the time the environmental document is being approved.

Substantial Construction. The granting of a building permit, prior to right-of-way acquisition or construction approval for the highway.

Substantial noise increase. One of two types of highway traffic noise impacts. For a Type I project, an increase in noise levels of 5 to 15 dBA in the design year over the existing noise level.

Traffic Noise Impacts. Design year build condition noise levels that approach or exceed the NAC listed in Table 1 for the future build condition; or design year build condition noise levels that create a substantial noise increase over existing noise levels.

Type I Project. (1) The construction of a highway on new location; or,

(2) The physical alteration of an existing highway where there is either:

(i) 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,

(ii) Substantial Vertical Alteration. A project that removes shielding therefore exposing the line-of-sight between the receptor and the traffic noise source. This is done by either altering the vertical alignment of the highway or by altering 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 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.

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

Type II Project. A Federal or Federal-aid highway project for noise abatement on an existing highway. For a Type II project to be eligible for Federal-aid funding, the highway agency must develop and implement a Type II program in accordance with section 772.7(e).

Type III Project. A Federal or Federal-aid highway project that does not meet the classifications of a Type I or Type II project. Type III projects do not require a noise analysis.

Sec. 772.7 Applicability.

(a) This regulation applies to all Federal or Federal-aid Highway Projects authorized under title 23, United States Code. Therefore, this regulation applies to any highway project or multimodal project that:

(1) Requires FHWA approval regardless of funding sources, or

(2) Is funded with Federal-aid highway funds.

(b) In order to obtain FHWA approval, the highway agency shall develop noise policies in conformance with this regulation and shall apply these policies uniformly and consistently statewide.

(c) This regulation applies to all Type I projects unless the regulation specifically indicates that a section only applies to Type II or Type III projects.

(d) The development and implementation of Type II projects are not mandatory requirements of section 109(i) of title 23, United States Code.

(e) If a highway agency chooses to participate in a Type II program, the highway agency shall develop a priority system, based on a variety of factors, to rank the projects in the program. This priority system shall be submitted to and approved by FHWA before the highway agency is allowed to use Federal-aid funds for a project in the program. The highway agency shall re-analyze the priority system on a regular interval, not to exceed 5 years.

(f) For a Type III project, a highway agency is not required to complete a noise analysis or consider abatement measures.

Sec. 772.9 Traffic noise prediction.

(a) Any analysis required by this subpart must use the FHWA Traffic
Noise Model (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 section 552(a) of title 5, U.S.C. and part
51 of title 1, CFR, 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 https://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, 1200 New Jersey Avenue, SE., Washington, DC
20590, as provided in part 7 of title 49, CFR. These documents are also available on the FHWA's Traffic Noise Model Web site at the following
URL: https://www.fhwa.dot.gov/environment/noise/traffic_noise_model/.

(b) Average pavement type shall be used in the FHWA TNM for future noise level prediction unless a highway agency substantiates the use of a different pavement type for approval by the FHWA.

(c) Noise contour lines may be used for project alternative screening or for land use planning to comply with Sec. 772.17 of this part, but shall not be used for determining highway traffic noise impacts.

(d) In predicting noise levels and assessing noise impacts, traffic characteristics that would yield the worst traffic noise impact for the design year shall be used.

Sec. 772.11 Analysis of traffic noise impacts.

(a) The highway agency shall determine and analyze expected traffic noise impacts.

(1) For projects on new alignments, determine traffic noise impacts by field measurements.

(2) For projects on existing alignments, predict existing and design year traffic noise impacts.

(b) In determining traffic noise impacts, a highway agency shall give primary consideration to exterior areas where frequent human use occurs.

(c) A traffic noise analysis shall be completed for:

(1) Each alternative under detailed study;

(2) Each Activity Category of the NAC listed in Table 1 that is present in the study area;

(i) Activity Category A. This activity category includes the exterior impact criteria for 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 for the area to continue to serve its intended purpose. Highway agencies shall submit justifications to the FHWA on a case-by-case basis for approval of an Activity Category A designation.

(ii) Activity Category B. This activity category includes the exterior impact criteria for single-family and multifamily residences.

(iii) Activity Category C. This activity category includes the exterior impact criteria for a variety of land use facilities. Each highway agency shall adopt a standard practice for analyzing these land use facilities that is consistent and uniformly applied statewide.

(iv) Activity Category D. This activity category includes the interior impact criteria for certain land use facilities listed in Activity Category C that may have interior uses. A highway agency shall conduct an indoor analysis after a determination is made that exterior abatement measures will not be feasible and reasonable. An indoor analysis shall only be done after exhausting all outdoor analysis options. In situations where no exterior activities are 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 highway agency shall use Activity Category D as the basis of determining noise impacts. Each highway agency shall adopt a standard practice for analyzing these land use facilities that is consistent and uniformly applied statewide.

(v) Activity Category E. This activity category includes the exterior impact criteria for developed lands that are less sensitive to highway noise. Each highway agency shall adopt a standard practice for analyzing these land use facilities that is consistent and uniformly applied statewide.

(vi) Activity Category F. This activity category includes developed lands that are not sensitive to highway traffic noise. There is no impact criteria for the land use facilities in this activity category and no analysis of noise impacts is required.

(vii) Activity Category G. This activity includes undeveloped lands.

(A) A highway agency shall determine if undeveloped land is permitted for development. The milestone and its associated date for acknowledging when undeveloped land is considered permitted shall be the date of issuance of a building permit by the local jurisdiction or by the appropriate governing entity.

(B) If undeveloped land is determined to be permitted, then the highway agency shall assign the land to the appropriate Activity Category and analyze it in the same manner as developed lands in that Activity Category.

(C) If undeveloped land is not permitted for development by the
date of public knowledge, the highway agency shall determine noise levels in accordance with 772.17(a) and document the results in the project's environmental clearance documents and noise analysis documents. Federal participation in noise abatement measures will not be considered for lands that are not permitted by the date of public knowledge.

(d) The analysis of traffic noise impacts shall include:

(1) Identification of existing activities, developed lands, and undeveloped lands, which may be affected by noise from the highway;

(2) For projects on new or existing alignments, validate predicted noise level through comparison between measured and predicted levels;

(3) Measurement of noise levels. Use an ANSI Type I or Type II integrating sound level meter;

(4) Identification of project limits to determine all traffic noise impacts for the design year for the build alternative. For Type II projects, traffic noise impacts shall be determined from current year conditions;

(e) Highway agencies shall establish an approach level to be used when determining a traffic noise impact. The approach level shall be at least 1 dBA less than the Noise Abatement Criteria for Activity Categories A to E listed in Table 1 to part 772;

(f) Highway agencies shall define substantial noise increase between 5 dBA to 15 dBA over existing noise levels. The substantial noise increase criterion is independent of the absolute noise level.

(g) A highway agency proposing to use Federal-aid highway funds for a Type II project shall perform a noise analysis in accordance with Sec. 772.11 of this part in order to provide information needed to make the determination required by Sec. 772.13(a) of this part.

Sec. 772.13 Analysis of noise abatement.

(a) When traffic noise impacts are identified, noise abatement shall be considered and evaluated for feasibility and reasonableness.
The highway agency shall determine and analyze alternative noise abatement measures to abate identified impacts by giving weight to the benefits and costs of abatement and the overall social, economic, and environmental effects by using feasible and reasonable noise abatement measures for decision-making.

(b) In abating traffic noise impacts, a highway agency shall give primary consideration to exterior areas where frequent human use occurs.

(c) If a noise impact is identified, a highway agency shall consider abatement measures. The abatement measures listed in Sec. 772.15(c) of this part are eligible for Federal funding.

(1) At a minimum, the highway agency shall consider noise abatement in the form of a noise barrier.

(2) If a highway agency chooses to use absorptive treatments as a functional enhancement, the highway agency shall adopt a standard practice for using absorptive treatment that is consistent and uniformly applied statewide.

(d) Examination and evaluation of feasible and reasonable noise abatement measures for reducing the traffic noise impacts. Each highway agency, with FHWA approval, shall develop feasibility and reasonableness factors.

(1) Feasibility:

(i) Achievement of at least a 5 dBA highway traffic noise reduction at impacted receivers. The highway agency shall define, and receive FHWA approval for, the number of receivers that must achieve this reduction for the noise abatement measure to be acoustically feasible and explain the basis for this determination; and

(ii) Determination that it is possible to design and construct the noise abatement measure. Factors to consider are safety, barrier height, topography, drainage, utilities, and maintenance of the abatement measure, maintenance access to adjacent properties, and access to adjacent properties (i.e. arterial widening projects).

(2) Reasonableness:

(i) Consideration of the viewpoints of the property owners and residents of the benefited receivers. The highway agency shall solicit the viewpoints of all of the benefited receivers and obtain enough responses to document a decision on either desiring or not desiring the
noise abatement measure. The highway agency shall define, and receive FHWA approval for, the number of receivers that are needed to constitute a decision and explain the basis for this determination.

(ii) Cost effectiveness of the highway traffic noise abatement measures. Each highway agency shall determine, and receive FHWA approval for, the allowable cost of abatement by determining a baseline cost reasonableness value. This determination may include the actual construction cost of noise abatement, cost per square foot of abatement, the maximum square footage of abatement/benefited receiver and either the cost/benefited receiver or cost/benefited receiver/dBA reduction. The highway agency shall re-analyze the allowable cost for abatement on a regular interval, not to exceed 5 years. A highway agency has the option of justifying, for FHWA approval, different cost allowances for a particular geographic area(s) within the State, however, the highway agency must use the same cost reasonableness/construction cost ratio statewide.

(iii) Noise reduction design goals for highway traffic noise abatement measures. When noise abatement measure(s) are being considered, a highway agency shall achieve a noise reduction design goal. The highway agency shall define, and receive FHWA approval for, the design goal of at least 7 dBA but not more than 10 dBA, and shall define the number of benefited receptors that must achieve this design goal and explain the basis for this determination.

(iv) The reasonableness factors listed in Sec. 772.13(d)(5)(i), (ii) and (iii), must collectively be achieved in order for a noise abatement measure to be deemed reasonable. Failure to achieve Sec. 772.13(d)(5)(i), (ii) or (iii), will result in the noise abatement measure being deemed not reasonable.

(v) In addition to the required reasonableness factors listed in Sec. 772.13(d)(5)(i), (ii), and (iii), a highway agency has the option to also include the following reasonableness factors: Date of development, length of time receivers have been exposed to highway traffic noise impacts, exposure to higher absolute highway traffic noise levels, changes between existing and future build conditions, percentage of mixed zoning development, and use of noise compatible planning concepts by the local government. No single optional reasonableness factor can be used to determine reasonableness.

(e) Assessment of Benefited Receptors. Each highway agency shall define the threshold for the noise reduction which determines a benefited receptor as at or above the 5 dBA, but not to exceed the highway agency's reasonableness design goal.

(f) Abatement Measure Reporting: Each highway agency shall maintain an inventory of all constructed noise abatement measures. The inventory shall include the following parameters: type of abatement; cost (overall cost, unit cost per/sq. ft.); average height; length; area; location (State, county, city, route); year of construction; average insertion loss/noise reduction as reported by the model in the noise analysis; NAC category(s) protected; material(s) used (precast concrete, berm, block, cast in place concrete, brick, metal, wood, fiberglass, combination, plastic (transparent, opaque, other); features (absorptive, reflective, surface texture); foundation (ground mounted,
on structure); project type (Type I, Type II, and optional project types such as State funded, county funded, tollway/turnpike funded, other, unknown). The FHWA will collect this information, in accordance with OMB's Information Collection requirements.

(g) Before adoption of a CE, FONSI, or ROD, the highway agency shall identify:

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

(2) Noise impacts for which no noise abatement measures are feasible and reasonable.

(3) Documentation of highway traffic noise abatement: The environmental document shall identify locations where noise impacts are predicted to occur, where noise abatement is feasible and reasonable, and locations with impacts that have no feasible or reasonable noise abatement alternative. For environmental clearance, this analysis shall be completed to the extent that design information on the alterative(s) under study in the environmental document is available at the time the environmental clearance document is completed. A statement of likelihood shall be included in the environmental document since feasibility and reasonableness determinations may change due to changes in project design after approval of the environmental document. The statement of likelihood shall include the preliminary location and physical description of noise abatement measures determined feasible and reasonable in the preliminary analysis. The statement of likelihood shall also indicate that final recommendations on the construction of an

abatement measure(s) is determined during the completion of the project's final design and the public involvement processes.

(h) The FHWA will not approve project plans and specifications unless feasible and reasonable noise abatement measures are incorporated into the plans and specifications to reduce the noise impact on existing activities, developed lands, or undeveloped lands for which development is permitted.

(i) For design-build projects, the preliminary technical noise study shall document all considered and proposed noise abatement measures for inclusion in the NEPA document. Final design of design-build noise abatement measures shall be based on the preliminary noise abatement design developed in the technical noise analysis. Noise abatement measures shall be considered, developed, and constructed in accordance with this standard and in conformance with the provisions of 40 CFR 1506.5(c) and 23 CFR 636.109.

(j) Third party funding is not allowed on a Federal or Federal-aid
Type I or Type II project if the noise abatement measure would require the additional funding from the third party to be considered feasible and/or reasonable. Third party funding is acceptable on a Federal or Federal-aid highway Type I or Type II project to make functional enhancements, such as absorptive treatment and access doors or aesthetic enhancements, to a noise abatement measure already determined feasible and reasonable.

(k) On a Type I or Type II projects, a highway agency has the option to cost average noise abatement among benefited receptors within common noise environments if no single common noise environment exceeds two times the highway agency's cost reasonableness criteria and collectively all common noise environments being averaged do not exceed the highway agency's cost reasonableness criteria.

Sec. 772.15 Federal participation.

(a) Type I and Type II projects. Federal funds may be used for noise abatement measures when:

(1) Traffic noise impacts have been identified; and

(2) Abatement measures have been determined to be feasible and reasonable pursuant to Sec. 772.13(d) of this chapter.

(b) For Type II projects. (1) No funds made available out of the
Highway Trust Fund may be used to construct Type II noise barriers, as defined by this regulation, if such noise barriers were not part of a project approved by the FHWA before the November 28, 1995.

(2) Federal funds are available for Type II noise barriers along lands that were developed or were under substantial construction before approval of the acquisition of the rights-of-ways for, or construction of, the existing highway.

(3) FHWA will not approve noise abatement measures for locations where such measures were previously determined not to be feasible and reasonable for a Type I project.

(c) Noise Abatement Measures. The following noise abatement measures may be considered for incorporation into a Type I or Type II project 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) Construction of noise barriers, including acquisition of property rights, either within or outside the highway right-of-way.
Landscaping is not a viable noise abatement measure.

(2) 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.

(3) Alteration of horizontal and vertical alignments.

(4) 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.

(5) 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.

Sec. 772.17 Information for local officials.

(a) To minimize future traffic noise impacts on currently undeveloped lands of Type I projects, a highway agency shall inform local officials within whose jurisdiction the highway project is located of:

(1) Noise compatible planning concepts;

(2) The best estimation of the future design year noise levels at various distances from the edge of the nearest travel lane of the highway improvement where the future noise levels meet the highway agency's definition of ``approach'' for undeveloped lands or properties within the project limits. At a minimum, identify the distance to the exterior noise abatement criteria in Table 1;

(3) Non-eligibility for Federal-aid participation for a Type II project as described in Sec. 772.15(b).

(b) If a highway agency chooses to participate in a Type II noise program or to use the date of development as one of the factors in determining the reasonableness of a Type I noise abatement measure, the highway agency shall have a statewide outreach program to inform local officials and the public of the items in Sec. 772.17(a)(1) through (3).

Sec. 772.19 Construction noise.

For all Type I and II projects, a highway agency shall:

(a) Identify land uses or activities that 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 that 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 costs of the abatement measures.

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

Table 1 to Part 772--Noise Abatement Criteria [Hourly A-Weighted Sound Level--decibels (dBA)[1]]

Activity Category	Activity Leq(h)	Criteria[2] L10(h)	Evaluation	Activity description
A	57	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[3]	67	70	Exterior	Residential.
C[3]	67	70	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	55	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[3]	72	75	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] Either Leq(h) or L10(h) (but not both) may be used on a project.

[2] The Leq(h) and L10(h) Activity Criteria values are for impact determination only, and are not design standards for noise abatement measures.

[3] Includes undeveloped lands permitted for this activity category.

APPENDIX C
Traffic Noise Study – Data Needed

TRAFFIC DATA

Project _____ Location_____ Alternative _____

HIGHWAY SECTION	DIST.	YEAR	AVERAGE DAY			PEAK HOUR				AVG HOUR-PK 8 HR.			PEAK TRUCK HOUR			
			VOLUME	TRUCKS	SP.	AUTO	M.T.	H.T.	SP.	VOLUME	TRUCKS	SP.	AUTO	M.T.	H.T.	SP.

Abbreviations: SP. = Speed of Vehicles (average)
Auto = Passenger Cars, Pick-ups, Panels, & Lt. Trucks
M.T. = Medium Trucks (two axels, six tires)
H.T. = Heavy Trucks (three or more axels)
Vol. = Traffic Volume (Veh/day or Veh/hour. – two way)

Analyst: _____

Date: _____

APPENDIX D
Noise Measurement Methodology and Field Data Record

Noise Measurement Methodology

Before taking field measurements, the noise specialist must contact the Oregon Department of Transportation (ODOT) Region Environmental Coordinator (REC) or Environmental Project Manager (EPM) to determine the process for right-of-entry. In most cases, the noise specialist will be given a fact sheet to share with interested property occupants about the highway project (if appropriate), a brief description about what the noise measurement entails, and an ODOT contact person if there are questions. The guidance below should be followed when conducting noise measurements:

a) Field measurements must be taken consistent with the guidelines contained in the Federal Highway Administration's (FHWA's) manual, *Measurement of Highway Related Noise* (noise measurement guide), May 1996, and accepted professional judgment (https://www.fhwa.dot.gov/environment/noise/measurement/measure.cfm)

b) Noise measurements should be taken during free flow traffic and generally during daylight hours when traffic is highest. The number of measurements depends on the size of the project, topography of the area, distance of receivers from the roadway, and whether or not the project involves new alignment. The analyst will coordinate a noise measurement plan with ODOT staff that describes the location and number of noise measurements proposed for each project prior to performing any field work.

c) Noise measurements should be taken with Type 1 or Type 2 sound level meter on the A-weighted decibel setting.

d) The sound level meter should be calibrated at the beginning and end of each measurement session and whenever changes are made to the system configuration. Calibrating the meter once per hour is a good rule of thumb. The meter should also be calibrated per product specifications once per year by a certified laboratory. This certification needs to be kept on file and included in any noise analysis where measurements are presented.

e) Meteorological conditions should be recorded during measurements, and measurements should only be taken if wind speeds are 12 mile/hour or less and when the pavement is dry.

f) Traffic counts, which include vehicle class identification and measurements under free flow conditions, should be taken during the measurement period. Average vehicle speed should be measured using a radar gun or equivalent method as discussed in the FHWA noise measurement guide.

g) Noise measurements should be conducted in flat open spaces free of large reflective surfaces and located within 100 feet of the roadway when possible. The meter should be placed 5 feet above the plane of the pavement. Measurement locations for Activity Category B (see Table 1 in the ODOT *Noise Manual*) should be between the ROW and the residential structure, facing the ROW, unless there is no outdoor use facing the ROW. This procedure is intended to eliminate inappropriate use of shielding. All other measurements for activity categories from Table 1 in the *Noise Manual* will be conducted in areas of frequent human use, as appropriate.

h) Noise measurements should be sufficiently long such that the resulting noise level is noise exposure at location. Generally, for non-steady fluctuating noise, a 15 to 20 minute interval is sufficient. Where noise sources vary or are intermittent, longer noise measurement periods are recommended.

i) An adequate number of photographs of the site should be taken to document the conditions at the measurement site and to aid in relocating the sound level meter should follow-up measurements be needed.

j) Noise measurements for new alignments should be planned out before going into the field. The future peak noise hour must be determined and measurements conducted at that time. It is important that other background noise sources are documented during measurements so appropriate comparisons can be made for the future build scenario(s).

k) For Activity Category D, the interior location should be a completely enclosed space with, preferably, its largest dimension no greater than twice its smallest. During measurements, all other noise-generating activities in the room should be quieted. In addition, the interior ambient level should be at least 10 dB below the lowest-anticipated, vehicle pass-by, maximum A-weighted sound-pressure level (LAFmx).

l) The locations, description of the measurements sites, days of the week, time of the measurements, traffic counts, and traffic speeds during the measurements should be documented. An example of the noise measurement log that can be used for field noise measurements is given on the following pages. Noise measurement sites must be shown on either a 1 inch:100 feet or 1 inch:200 feet map when presented in the noise technical report.

OREGON DEPARTMENT OF TRANSPORTATION

HIGHWAY DIVISION – GEO-ENVIRONMENTAL SECTION

NOISE MEASUREMENT RECORD
(USING AN INTEGRATING SOUND LEVEL METER)

MEASUREMENT NO:_____
PROJECT NAME: _____ DATE_____
ADDRESS:_____ COUNTY: _____
KEY NUMBER: _____GPS COORDINATES:_____ENGINEER: _____
WEATHER CONDITIONS: _____WIND SPEED: _____ WIND DIRECTION:_____
TEMPERATURE:_____ RELATIVE HUMIDITY: _____ OTHER:_____
INSTRUMENT_____SERIAL#_____CALIBRATOR_____SERIAL#_____
START TIME: _____ STOP TIME: _____ CALIBRATION TONE _____dB _____HZ

LENGTH OF MEASUREMENT: _____LEQ RANGE: _____MICROPHONE HEIGHT: _____
OPTIONAL **LEQ:_____**

LEQ @ 5 MIN _____ LEQ@ 25 MIN _____ LEQ@ 45 MIN _____

LEQ @ 10 MIN _____ LEQ@ 30 MIN _____ LEQ@ 50 MIN _____ SEL - LEQ: = _____

LEQ @ 15 MIN _____ LEQ@ 35 MIN _____ LEQ@ 55 MIN _____

LEQ @ 20 MIN _____ LEQ@ 40 MIN _____ LEQ@ 60 MIN _____ TIME FROM TABLE: _____

TRAFFIC:	ROADWAY: _____		ROADWAY: _____		ROADWAY: _____	
COUNTED	HR. EQUIV.	COUNTED	HR. EQUIV.	COUNTED	HR. EQUIV.	
AUTOS:_	_____ =	_____	_____ =	_____	_____ =	_____
MED. TRUCKS:	_____ =	_____	_____ =	_____	_____ =	_____
HEAVY TRUCKS:	_____ =	_____	_____ =	_____	_____ =	_____
BUSES:	_____ =	_____	_____ =	_____	_____ =	_____
MOTORCYCLE:	_____ =	_____	_____ =	_____	_____ =	_____
SPEED:	_____		_____		_____	

SKETCH OF SITE

Photograph Numbers:_____

(SHOW DISTANCES TO IMPORTANT FEATURES i.e. centerline, buildings, driveways etc)
SEE BACK OF THIS PAGE FOR ANY ADDITIONAL COMMENTS

PAGE 2

NOISE MEASUREMENT FORM

SUPPLEMENTARY INFORMATION

COMMENTS:

_____

_____

_____

_____

DISTANCE TO CENTERLINE_____

ANGLE LEFT AND RIGHT: _____

NUMBER OF TRAVEL LANES: _____

MEDIAN WIDTH AND TYPE: _____

BARRIERS: _____

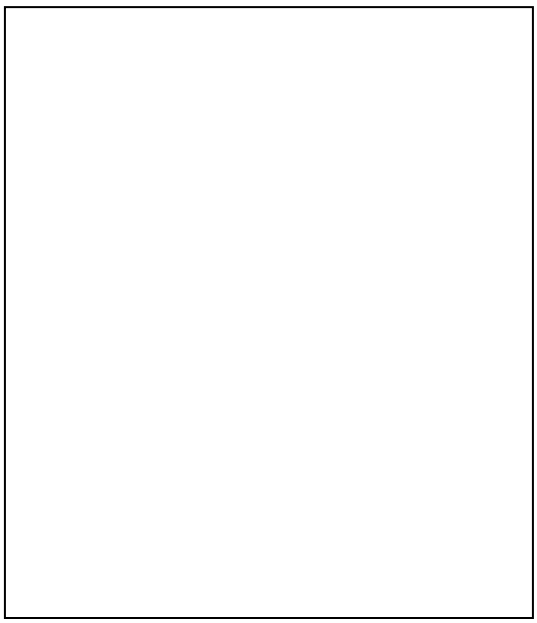
NOISE SOURCES OTHER THAN TRAFFIC NOISE: _____

RELATIONSHIP TO NEARBY STRUCTURES: _____

ARE OVERHEAD POWER LINES OR UNDERGROUND UTILITIES APPARENT THAT WOULD INTERFERE WITH MITIGATION? YES_____ NO _____

ELEVATION OF ROADWAY IN RELATION TO ELEVATION OF GROUND AT MEASUREMENT SITE: _____

PHOTO



APPENDIX E
Example of Comparison of Alternatives: Table of Results

Table of Results: Existing, No-Build, and Build Alternative Noise Levels (Leq in dBA)

					Existing Conditions	No-Build Alternative		Build Alternative			
Receiver ID	Land Use Activity	Equivalent Units	Distance to Roadway (feet)	Oregon NAAC	Noise Level[1]	Noise Level[1]	Increase over Existing	Noise Level[1]	Impacts	Increase over Existing	Increase over No-build
R1	B	1	130	65	61	62	1	62	0	1	0
R2	B	2	140	65	64	**65**	1	**65**	**2**	1	0
R3	B	1	125	65	62	64	2	64	0	2	0
R4	B	1	80	65	**69**	**70**	1	**70**	**1**	1	0
R5	B	1	200	65	58	60	2	60	0	2	0
R6	B	1	150	65	59	60	1	60	0	1	0
R7	B	1	180	65	59	60	1	60	0	1	0
R8	B	1	98	65	**70**	**71**	1	**72**	**1**	2	1
R9	C	1	59	70	**72**	**75**	3	**75**	**1**	3	0
Summary			Minimum		**55**	**56**		**56**			
			Maximum		**70**	**71**		**72**			
			NAAC Impacts						**5**		
No substantial increase impacts (10 dBA or more above existing conditions) are expected with the project											

Notes:

1. Predicted peak noise hour levels in L_{eq} dBA from FHWA TNM version 2.5; prediction values >/= Oregon NAAC in **Bold** typeface

APPENDIX F

Oregon Department of Transportation Abatement Cost Factors for Activity Categories C, D or E

ODOT Abatement Cost Factors for Activity Categories C, D, or E

The following table, reasonable cost matrix, is used to determine if the cost of a barrier wall is reasonable for a noise-impacted special use area. The cost matrix and the methodology follow the steps described in Florida DOT's, *A Method to Determine Reasonableness and Feasibility of Noise Abatement at Special Use Locations* (1997), Section III. Following Table 1 is the methodology used for developing the cost limit.

Table 1 Reasonable Matrix: Cost of Abatement

	Criteria	**Input (English units)**
1	Enter length of proposed barrier	ft
2	Enter height of proposed barrier	ft
3	Multiply item 1 by item 2	ft^2
4	Enter the average amount of time that a person stays at the site per visit	hours
5	Enter the average number of people that use this site per day that will receive at least 5 dBA benefit from abatement at the site	people
6	Multiply item 4 by item 5	person-hr
7	Divide item 3 by item 6	ft^2/person-hr
8	Multiply $25,000 by item 7	$/person-hr/$ft^2$
9	Does item 8 exceed the "abatement cost factor" of: English units = **$518,758/person-hr/$ft^2$**?	
10	If item 9 is no, abatement meets reasonable criteria	
11	If item 9 is yes, abatement does not meet reasonable criteria	

Methodology for Barrier Cost Limits for Activity Categories C, D or E (from the FDOT document, Section II "Cost Abatement Factor")

Preliminary Cost Factor

$25,000/residence × residence/2.52 persons × usage/24 hr/day = $415.01/person-hr

Assume 2.52 persons/Oregon household (avg) from 2010 census:

Abatement Cost Factor (Reasonable Cost Effectiveness):

$25,000/residence × residence/2.5 × useage/24 hrs × 12.5 ft × 100 ft **= $518,758/person-hr/ft^2**

Assume Avg width of residential property bordering barrier = 100 ft
Avg wall ht of barrier for residential property = 12.5 ft*

*based on ODOT cost limit of $25k/residence, $20/ft^2 for concrete post-beam construction, 100 ft width: Ht = 100 ft × $20/ft^2/$25,000

$25,000/residence abatement cost limit (from ODOT Noise Manual)

See Example on Next Page:

Reasonable Matrix: Cost of Abatement for Golf Course

	Criteria	Input (English units)	19th Street Parameter	Comment
1	Enter length of proposed barrier	ft	2,250	east side of the golf course facing ROW
2	Enter height of proposed barrier	ft	10	
3	Multiply item 1 by item 2	ft^2	22,500	
4	Enter the average amount of time that a person stays at the site per visit	hours	0.5	Assumptions: 15 minutes per hole; time spent on two impacted greens.
5	Enter the average number of people that use this site per day that will receive at least 5 dB(A) benefit from abatement at the site	people	192	Assumptions: 7 am to 7 pm; 15 minutes per hole; 4 golfers per group
6	Multiply item 4 by item 5	person-hr	96	
7	Divide item 3 by item 6	ft^2/person-hr	234	
8	Multiply $25,000 by item 7	$/person-hr/$ft^2$	5,859,375	
9	Does item 8 exceed the "abatement cost factor" of: English units = $518,758/person-hr/ft2?		Yes	
10	If item 9 is no, abatement meets reasonable criteria			
11	If item 9 is yes, abatement does not meet reasonable criteria		**Does not meet**	

APPENDIX G

Noise Abatement Evaluation and Recommendation Form

Noise Abatement Evaluation and Recommendation Form

(A separate form is completed for each noise abatement measure being considered.)

Project _____ Key Number_____
Highway _____ County_____
Barrier ID (from Noise Technical Report) _____
Noise Analyst (and Firm) _____

FEASIBILITY			
Number of Impacted Receptors:			
Number of Impacted Receptors Receiving 5 dBA Noise Reduction			**(If not simple majority (a), evaluation stops here)**
Site Constructability Issues (if any):			
Proposed Barrier Meets Feasibility Criteria	**Yes**	**No**	**If no, abatement evaluation stops**

REASONABLENESS				
1. NOISE REDUCTION DESIGN GOAL	Number of Benefited Receptors Meeting Noise Reduction Design Goal of 7 dBA:		**(if not at least one, evaluation stops here)**	
2. COST BENEFIT	Total Cost of Barrier:		Cost per Benefited Receptor:	
(Cannot be greater than $25k/receptor or if one of the optional reasonableness criteria is met, cannot be greater than $35k/receptor) **(if not, evaluation stops here)**				
Optional Reasonableness Criteria – used only to justify cost/benefited Receptor between $25K and $35K (Section 7.4.4 of the Noise Manual)				
Absolute Highway Traffic Noise Levels for Build Condition (from modeling)				
Zoning	Current Use:		Future Use:	
Changes in Noise Levels Between Existing and Future Build Conditions	Existing Noise Level:		Future Noise Level;	
Date of Development (for Retrofit Abatement Projects only)				
Analyst's Signature & Date:			Date:	
ODOT Noise Program Coordinator's Signature & Date (after Review)			Date:	
Original to REC, or EPM and copies of signed form to PL, Noise Program Coordinator, and Consultant Noise Analyst				

3. COMMUNITY SUPPORT (See Section 7.4.1 of the Noise Manual, *Viewpoints of the Property Owners and Residents*)

	Renters	Owners	
Total Number of Votes from returned surveys			
Total Number of Actual No Votes			
Total Number of Actual Yes Votes:			% Yes Vote (b):
Community Support for Abatement (% yes or no must be greater than 50%)	Yes	No	

Proposed Barrier Meets 3 Required Reasonableness Criteria (noise reduction design goal, cost benefit, support of community)	**Yes**	**No**

Barrier meets Feasible and Reasonable Criteria and will be part of Project Design (If yes, the abatement measure must be incorporated into the project design)	**Yes**	**No**

Signature of PM or PL, acknowledging the recommendation for abatement		Date:

Calculations

a) Calculations for Noise Abatement Evaluation and Recommendation Form

Feasibility: Noise analyst indicates the number of impacted receptors at the location of the proposed noise barrier. A simple majority the impacted receptors must receive a 5-dBA reduction in sound levels for the noise abatement to be feasible. A simple majority is calculated as follows:

Theoretical Majority = 1 + (total number of impacted receptors/2)

Actual number of receptors receiving 5-dBA reduction must be ≥ the Theoretical Majority

Example: There are 10 impacted receptors that could potentially benefit from the proposed noise barrier; abatement analysis shows that 7 receptors would receive a 5-dBA reduction in sound levels:

Theoretical Majority = 1 + (10/2)

= 6

Since 7 > 6, the abatement for this location is feasible.

b) Community Support (Viewpoints of the Property Owners and Residents)

Percent yes calculation:

Percent yes = (total yes votes) / (total of yes and no votes returned) x 100

APPENDIX H

Construction Equipment Noise Level Ranges

Mitigation for Construction Noise Impacts

CONSTRUCTION EQUIPMENT NOISE LEVEL RANGES

		Equipment type	Noise Level (dBA) at 50 feet	Noise Level (dBA) Average at 50 feet[a]	Noise Level (dBA) Average at 50 feet[b]
Equipment Powered by Internal Combustion Engines	Earth Moving	Front Loaders	72–84	78	85
		Backhoes	72–93	83	83
		Tractors	77–96	87	85
		Scrapers	80–93	87	87
		Graders	80–93	84	84
		Pavers	86–89	88	—
		Trucks	82–94	88	—
	Materials Handling	Concrete Mixers	75–88	82	—
		Concrete Pumps	81–84	83	—
		Cranes, Movable	75–88	82	79
		Cranes, Derrick	86–89	88	—
	Stationary	Pumps	68–72	70	—
		Generators	71–82	77	—
		Compressors	74–87	81	73
	Impact Equipment	Mounted Breakers (Hoerams)	76–94[c]	85	—
		Pneumatic Wrenches	82–89	86	—
		Jackhammers & Rock Drills	81–98	90	—
		Impact Drivers (Peak)	95–106	101	—
	Other	Vibrator	69–81	75	—
		Saws	72–82	77	—

[a] From the Colorado Construction Noise Symposium, Construction Noise Ranges Chart

[b] From Highway Construction Noise: Measurement, Prediction and Mitigation. U.S. Department of Transportation, Federal Highway Administration, HH1-22/R10-91(200)EW

[c] From Allied Construction Products, Cleveland, OH 1999

Mitigation for Construction Noise Impacts

ODOT includes standard project specifications (290.32) for all projects to mitigate for construction noise impacts. The following construction measures reflect current ODOT standard specifications:

- No construction shall be performed within 1,000 feet of an occupied dwelling unit on Sundays, legal holidays, or between the hours of 10 p.m. and 6 a.m. on other days without the approval of the ODOT construction project manager.
- All equipment used shall have sound-control devices no less effective than those provided on the original equipment. No equipment shall have unmuffled exhaust.
- All equipment shall comply with pertinent equipment noise standards of the U.S. Environmental Protection Agency.
- No pile driving or blasting operations shall be performed within 3,000 feet of an occupied dwelling unit on Sundays, legal holidays, or between the hours of 8 p.m. and 8 a.m. on other days without the approval of the ODOT construction project manager.
- The noise from rock crushing or screening operations performed within 3,000 feet of any occupied dwelling shall be mitigated by strategic placement of material stockpiles between the operation and the affected dwelling or by other means approved by the ODOT construction project manager.

If a specific noise impact complaint is received during construction of the project, the contractor may be required to implement one or more of the following noise mitigation measures at the contractor's expense, as directed by the construction project manager:

- Locate stationary construction equipment as far from nearby noise-sensitive properties as feasible.
- Shut off idling equipment.
- Reschedule construction operations to avoid periods of noise annoyance identified in the complaint.
- Notify nearby residents whenever extremely noisy work will be occurring.
- Install temporary or portable acoustic barriers around stationary construction noise sources.
- Operate electrically powered equipment using line voltage power or solar power.

APPENDIX I

Noise Study Report Outline

Noise Study Quality Control Report Review Checklist

NOISE TECHNICAL REPORT OUTLINE

(Examples of noise technical report tables and documents are available on the Oregon Department of Transportation website: https://www.oregon.gov/ODOT/HWY/GEOENVIRONMENTAL/air_noise.shtml)

Draft and final copies of the noise technical report must have a professional engineering stamp.

I. SUMMARY

a. Concise project description
b. Noise levels and noise impacts (include distance to NAC levels for undeveloped lands)
c. Abatement considerations and commitments
d. Construction noise
e. Information for local officials

II. INTRODUCTION

Purpose of report (Why is this Type I study?)

III. PROJECT DESCRIPTION

Detailed project description (Include figure identifying project location and existing and proposed alignment on mapping)

IV. LAND USE

a. Existing land use
b. Future zoning and comprehensive land use plan designation
c. Displacements due to project construction

V. METHODOLOGY

a. Defining area of potential effect
b. Regulatory Setting (FHWA and ODOT noise policies, local ordinances)
c. Measurement procedures and equipment
d. Analysis procedures/model/version/model inputs/analysis years
e. Selection of noise sensitive receivers
f. Basis for determining worst-case noise condition (peak hour or peak truck hour)
g. Noise abatement requirements

VI. EXISTING NOISE LEVELS

a. Noise measurements
b. Model validation/calibration process and results
c. Non-transportation related noise sources in project area
d. Modeled existing noise levels

VII. FUTURE NOISE LEVELS

a. No-build future and build future noise levels and comparisons, increase over existing levels
b. Predicted distances to Leq 65 dBA and 70 dBA for Category G

VIII. TRAFFIC NOISE IMPACTS

a. Noise levels of existing and future no-build and build conditions approaching or exceeding NAC
b. Substantial increase impacts
c. Summary of total number of impacts by alternative and location
d. Identification of non-impacted receptors

IX. EVALUATION OF NOISE ABATEMENT MEASURES

a. Considered noise abatement measures
b. Feasible/reasonable criteria met and determinations
c. Locations of noise impacts where noise abatement measures are not recommended (unavoidable impacts)
d. Findings and recommendations
e. Viewpoints of neighbors will be delayed until final design but no later than final environmental clearance document
f. Design Goal met

X. CONSTRUCTION NOISE ANALYSIS

a. Construction noise levels and impacts
b. Abatement measures: Standard Construction Specifications for Noise Control
c. Construction phases, if present

XI. INFORMATION FOR LOCAL GOVERNMENT OFFICIALS

XII APPENDICES

Appendix A:	Noise measurement data sheets and photographs
Appendix B:	Calibration certificates
Appendix C:	Traffic data used in the noise analysis
Appendix D:	TNM modeling files on CD, including model verification runs for both draft reports and final reports
Appendix E:	Special use area worksheet (if applicable)
Appendix F:	Feasible/reasonable worksheets (if applicable)

NOISE STUDY QC AND REPORT REVIEW CHECKLIST

Project Name: _____
Noise Analyst: _____
Senior Reviewer: _____
Date Reviewed: _____

For checkboxes that are missing or not applicable, please write in explanations.

□ Table of Contents (optional)

Summary

□ Concise project description
□ Noise levels ranges, by year, and alternative and noise impacts (include distance to Oregon NAAC levels for undeveloped land)
□ Abatement considerations and commitments
□ Construction Noise
□ Information to local officials (1–2 sentences)

Introduction

□ Purpose of the report (Why is this a Type 1 study?)

Project Description

□ Description of proposed construction
□ Existing alignment and proposed alignment shown on mapping
□ Number of existing and proposed travel lanes

Land Use

□ Existing houses, apartments, schools, places of worship, parks, businesses, etc. shown on 1:100 or 1:200 mapping
□ Identification of all activity categories in project area
□ Future Zoning and Comprehensive Land Use Plan designations shown on mapping
□ Displacements due to project construction

Methodology

□ Defining area of potential effect
□ Regulatory setting
□ Tables of NACs (include Oregon approach levels)
□ Measurement procedures and equipment
□ Analysis procedures/model/version/model inputs/analysis years
□ Selection of noise sensitive receptors
□ Basis for worse-case noise condition (peak hour or peak truck hour)
□ Noise abatement requirements

Existing Acoustic Environment

 Selection of noise sensitive receptors including the number of equivalents units selected.

Noise Measurements:

 Summary of each noise measurement location which includes noise sources present during monitoring
 Figure of monitoring locations shown on 1:100 or 1:200 mapping
 Table summarizing date and time of measurements, traffic counts per vehicle type and direction, speed, and Leq level, distance of monitoring site from roadway.
 References to noise monitoring sheets and photographs of monitoring locations

Model Calibration:

 Table of model calibration including measured and FHWA Traffic Noise Prediction Model modeled noise levels and difference
 Modeling files for a calibration that include only traffic counts and speeds observed during monitoring.
 Statement confirming that measured and monitored noise levels differ by less than 3 dBA.
 References to modeling files.

Traffic Noise Analysis

Predicted Leq Levels:

 Comparison for worse case between peak hour and peak truck hour
 Table of predicted noise levels for Existing
 Table of predicted noise levels for No-Build Future
 Tables of predicted noise levels for Build Future, all alternatives
 Figures of prediction sites shown on 1:100 or 1:200 mapping
 Discussion in text of noise levels ranges for exist, no-build and future build.

Note: The number of tables used to summarize project noise levels will depend on size of project

Traffic Noise Summary

 Summary table of Existing, No-Build Future, and Build Future noise levels that approach or exceed NAC for each alternative
 Noise Abatement Criterion discussed and noise impacts using this criterion identified
 Substantial Increase Criterion discussed and noise impacts using this criterion identified
 Existing, No-Build Future, Build Future noise level that approach or meet NAC shown on 1:100 or 1:200 mapping

Noise Level Contours for Undeveloped land:

 Predicted distances to Leq 65 dBA and 70 dBA for Category G
 Use 50-foot intervals or discrete locations
 Contour maps (optional if discrete Activity G receivers were reported in text)

Evaluation of Noise Abatement Measures

 Discussion of alternative noise abatement measures: Alignment shifts, speed restrictions, grade changes, buffer zones, truck restrictions, etc.

Noise Abatement Measures

 Number of equivalent-unit impacts mitigated per impacted receiver
 Predicted noise levels without mitigation for each impacted receiver
 Predicted noise levels with mitigation for each impacted receiver
 Noise level reductions due to mitigation for each impacted receiver
 Percent of first-row receivers achieving 5 dBA reduction
 Total number of benefited receivers/units
 Total number of benefited units receiving 7 dBA reduction in noise levels
 Design goal requirements
 Total cost as calculated in section 7.4.2 and cost per unit
 Summary table of noise levels without barrier, with barrier, and noise reductions per receiver
 Barrier summary table: length, height, area, cost, cost per equivalent unit, and recommendation
 Locations of barriers shown on 1:100 or 1:200 map and marked as recommended for construction
 Noise abatement likelihood statement
 Noise Evaluation and Recommendation form for each noise abatement measure considered
 Discussion of unavoidable impacts (by receiver as necessary)

Construction Noise Analysis

 Typical construction noise levels
 Mitigation measures: Standard Noise Control Specifications
 Nature and duration of construction noise
 Local ordinances relating to construction noise
 Land use of activities that may be affected by construction noise

Information for Local Government Officials

 Discussion of noise compatible planning concepts
 Discussion of design year noise levels and distance to NAC criteria or NAC contours for undeveloped land
 Discussion of unavailability of federal funding for abatement after the date of public knowledge

Appendices

 Traffic data used in the noise analysis
 Electronic copies of all TNM modeling files, including TNM model calibration and mitigation files
 Noise measurement field sheets and photographs (should include traffic counts taken in field)
 Special use area worksheets
 Abatement worksheets for recommended abatement

Other

Analyst should keep the following records on file:

- Calibration certificate of noise measurement equipment
- Worksheets showing cost per residence calculation

APPENDIX J
Noise Abatement Reporting Database Entry Form

Noise Abatement Reporting
Database Entry Form

Wall Inventory #* _____

Key # _____

Project _____ Project Type ☐ Type I ☐ ODOT Retrofit
Program Project
City _____ Route _____
County, State _____
Region _____ Year of Construction _____

Physical Description:

Type Abatement _____
Material** _____ Features _____ Foundation _____
Average Height _____ Length _____

Location: Highway Name and Number _____
Beginning & End MP _____ to _____ ☐Left ☐ Right
Engineering Station*** _____ to _____ ☐ Left ☐ Right
Latitude _____ Longitude _____

Cost:

Funding Source ☐ Federal ☐ State ☐ County ☐ Tollway ☐ Other ☐ Unknown
Estimated Cost _____
Overall Actual Cost _____
Unit Cost per sq ft. _____

Acoustical Specialist _____
ODOT Roadway Designer _____
ODOT Project Team Leader _____

Insertion Loss:

Calculated by Model _____ NAC Category protected _____

Status:

Approved ☐
Constructed ☐ Date _____
Deleted ☐

Comments:

_____

_____

Photos Received (date) _____
Aerial Provided (date) _____

*Salem Geo-Environmental enters the wall inventory number
** Berm, block, cast in place concrete, brick, metal, wood, fiberglass, combination plastic, (transparent, opaque, other)
*** Engineering stations are only needed for new roadways where mile points have not been assigned