General

The purpose of this chapter and the noise abatement policy is to provide a means by which the Washington State Department of Transportation (WSDOT), in conjunction with other programs, can fairly and uniformly accommodate citizens seeking relief from the traffic noise generated by the vehicular use of state highways.

References

National Highway System Designation Act of 1995


Priority Study for Noise Abatement of Existing State Highways, 1985, WSDOT, Northwest Region


Design Manual M 22-01, WSDOT

Environmental Manual M 31-11, Chapter 446, WSDOT


Standard Plans for Road, Bridge, and Municipal Construction M 21-01, WSDOT

Resources:

HQ Environmental Affairs Office.
http://www.wsdot.wa.gov/environment/eao/air_noise/default.htm

The region’s Environmental Office

The region’s Materials Engineer

The region’s Landscape Architect Office
Definitions

**decibel**  A decibel is a unit used to measure and describe the intensity of sound. A decibel is one-tenth of a Bel. A Bel is defined as the common logarithm of the ratio of two powers. Mathematically, a decibel is defined as:

\[
\text{dB} = 10 \log_{10} \left( \frac{P_1}{P_2} \right),
\]

Where \( P_2 \) is the reference pressure and is equal to \( 2 \times 10^{-5} \text{ N/m}^2 \) (0.0002 µ bars).

**dBA (A-Weighted Sound Level)**  The sound pressure levels in decibels measured with a frequency weighting network corresponding to the A-scale on a standard sound level meter as specified by ANSI S1.4-1971. The A-scale tends to suppress lower frequencies (below 1,000 Hz) and best approximates the sound as heard by the normal human ear.

**insertion loss**  The actual acoustical benefit derived from a noise barrier.

**Leq**  A statistical descriptor that provides a single number to describe the varying traffic noise levels. It is a constant, average sound level that, over the specified period of time, contains the same amount of sound energy as the varying levels of the traffic noise.

**receiver**  Any human that could potentially experience wayside noise from vehicles on a roadway at a given location.

**receptor**  A coordinate point in three dimensional space for which the decibel level is either measured or calculated. Receptor may also be referred to as a “receiver point”.

Requirements for Noise Analysis

The department considers placing abatement for traffic noise from state highways under two project types, a Type I for new projects, and a Type II for retrofit projects. **Figure 460.1** shows the process involved in the decision to install a noise abatement barrier such as a wall or berm.
**Type I**

- Construct new highway
- Significantly change horizontal or vertical alignment
- Increase number of through lanes
- Projects that significantly alter roadside ground contours

**Type II**

- Neighborhoods predating highway
- WSDOT field and aerial photo review
- Locations that meet age and housing density requirements
- Noise levels exceed minimum requirements

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**Noise Analysis**

- Requirements not met
- Requirements met

**Is abatement feasible?**

- Substantial noise reduction?
- Property access unaffected?
- Safety unaffected?
- List in Design Manual chapter 1140

**Is abatement reasonable?**

- Cost
- Amount of noise abated
- Is land use stable?
- Sufficient number of homes benefited?

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**Prioritization**

- Priority calculated following formula in Directive 22-22
- Locations placed in statewide list

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**Noise Analysis**

- Sufficient noise reduction
- No adverse effects

**No further consideration**

- No

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**Public Involvement**

- Yes

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**Prioritizing Programming Funding Construction**

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**Figure 460.1 Noise Abatement Decision Process**
Type I

A traffic noise analysis is required by law for projects having federal funds, actions, or permits and is required by state policy for other projects that meet any one of the following criteria:

- Involve construction of a new highway.
- Significantly change the horizontal or vertical alignment.
- Increase the number of through traffic lanes on an existing highway.

State policy and federal guidance also requires the review and possible consideration of abatement on projects that substantially alter the ground contours surrounding a state highway.

If analysis shows that noise abatement is feasible and reasonable, then it becomes part of the project. The Acoustics Office or appropriate regional staff conducts the required noise analysis.

Noise barriers are considered where land use is changing rapidly if there is local zoning or ordinances to control the new development of noise sensitive land uses adjacent to transportation corridors.

The date of public knowledge is the date of approval of the Record of Decision (ROD) or Finding of No Significant Impact (FONSI). After this date WSDOT is not responsible for providing noise abatement for new development that occurs adjacent to the proposed highway project. Providing noise abatement becomes the responsibility of local communities and private developers.

Type II (Retrofit)

Type II projects propose noise abatement on existing highways. These are stand-alone projects and construction of these barriers is not necessarily associated with projects that provide capacity improvements. However, communities must meet the conditions of Directive D 22-22, 23 CFR 772 and section 339 (b)(2) of the "National Highway System Designation Act of 1995."

The development and implementation of Type II projects are not mandatory requirements of USC 23.109(i). However, WSDOT maintains a retrofit list in order to provide greater noise abatement, where feasible and reasonable, as funding allows.

Retrofit projects are prioritized in an order reflecting traffic noise levels, number of homes benefiting, cost, and the achievable reductions. Sensitive areas are given extra consideration if most of the buildings existed before the highway.
Barriers for Type II projects are normally constructed in order of their priority but might be constructed as a Type I project or part of some other project.

Requirements for Consideration

Locations that are determined to be impacted by traffic noise levels will be considered for traffic noise abatement. Where abatement eligibility requirements are met, at a minimum, all of the following types of abatement must be considered:

- Traffic management measures, for example: traffic control devices and signing for prohibition of certain vehicle types, time-use restrictions for certain vehicle types, and modified speed limits;
- Change of alignment either vertical or horizontal;
- Construction of noise barriers
- Acquisition of property.

In instances where severe traffic noise impacts occur, noise abatement measures other than those listed above may be proposed for Type I and II projects. These will be reviewed and approved by WSDOT (or the FHWA in the case of projects having federal funds, actions, or permits) on a case-by-case basis when the conditions of 23 CFR 772.13(a) have been met.

When identifying and evaluating noise abatement measures to be incorporated in a project, the relevant criteria to consider are feasibility and reasonableness.

**Feasibility** deals primarily with engineering considerations like: “Can a substantial reduction be made?” or “Will abatement measures affect property access?”

**Reasonableness** assesses the practicality of the abatement measure given a number of factors including:

- Cost;
- Amount of noise reduction; and
- Future absolute traffic noise levels.

It is WSDOT's policy to make final decisions on the construction of noise barriers after final horizontal and vertical alignments are determined and a detailed engineering analysis of the feasibility and reasonableness of noise abatement can be made. Only barriers that meet WSDOT's criteria, as accepted by FHWA, are constructed.
Department directive D 22-22 and the Priority Study for Noise Abatement of Existing State Highways outline the criteria for noise evaluation for Type II projects. A separate list of retrofit site priorities has been updated in 2003.

Feasibility

Noise abatement is considered only where noise impacts have been identified. Noise impacts are defined in 23 CFR 772 as "impacts which occur when the predicted traffic noise levels approach or exceed the noise abatement criteria (NAC), or when the predicted traffic noise levels (design year) substantially exceed the existing noise levels." The department considers “approach” to be “within 1 decibel of” and “substantially exceed” to be “10 or more decibels above.”

Every reasonable effort is made to attain a 10 dBA (or greater) insertion loss at the first row of receivers. However, for a barrier to be included in a Type I study as feasible a majority of the first row of receivers must get a minimum of a 5 dBA insertion loss and at least one receiver must have at least a 7 decibel reduction.

Safety factors to consider in the feasibility assessment of the noise abatement include the following:

- Maintaining a Design Clear Zone
- Redirection of errant vehicles
- Adequate sight distance
- Fire and other emergency vehicle access

Barrier placement must also consider potential environmental impacts to wetlands, historic properties, park lands, property access, utility placement, and other sensitive sites.

Though some noise might be reflected from a barrier placed on one side of the roadway to the unprotected side, studies have shown that any measured increases in noise levels have been less than can be perceived by normal human hearing. Little benefit is derived from making the wall absorptive.

Multiple reflections of noise between two parallel plane surfaces, such as noise barriers or retaining walls on both sides of a highway, can theoretically reduce the effectiveness of individual barriers and contribute to overall noise levels. There are designs available to mitigate this problem such as battered walls; however, they can be costly and their use can cause sound to travel to other locations. In this case, it might be appropriate to consider noise absorptive
treatments or to change wall orientation. Coordinate with the Acoustics office when considering alternate designs.

Studies have suggested making the width-to-height ratio of the roadway section to the barriers at least 10W:1H to avoid a reduction in the performance of parallel reflective noise barriers. The width is the distance between the barriers, and the height is the average height of the barriers above the roadway. This means that two parallel barriers 3 m tall would be at least 30 m apart. Where this ratio cannot be achieved, consider other methods for at least one face.

**Individual and Local Agency Participation**

Where abatement costs would exceed the allowable limits as set in the department policy, individuals or the local government agency may be offered the option to share in the cost of abatement. This will only be allowed where such an offer is not in violation of other department or state policy or other regulation or law. Such an offer may be made under the following conditions:

- The department's share does not exceed the amount determined in this and other policy documents.
- The participating individuals or local agency pay the department the same amount as that determined to exceed the allowable costs as set forth in this or other policies.

**Reasonableness**

Once a noise barrier has been determined to be feasible, the department determines whether its construction is reasonable. The decision to recommend or not recommend a noise barrier is normally the responsibility of the Acoustic program manager or Acoustic program staff with concurrence from design personnel.

Reasonableness is determined based on the following factors:

- Noise level in the design year approaches or exceeds the noise abatement criteria in Table 1 of 23 CFR 772 or qualifies as a substantial exceedance.
- A majority of the first row of receivers obtain a minimum 5 dBA insertion loss and at least one receiver has at least a 7 decibel reduction.
- The noise mitigation cost per residence (or residential equivalent\(^1\)) is determined by counting all residences (including owner-occupied, rental units, mobile homes) benefited by the noise barrier in any subdivision or given development, and

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\(^1\) For residential equivalent calculations see D 22-22.
dividing that number into the total cost of the noise abatement measure. Each unit in a multifamily building is counted as a separate residence. Refer to the *Environmental Manual*.

- The date of development is an important part of the determination of reasonableness. More consideration is given to developments that were built before the highway. For the purposes of definition, "most" will be defined as at least 50%.

- More consideration is also given to areas with larger increases over existing noise levels. This gives greater consideration to projects for highways in new locations and for major reconstruction than it does to projects of smaller magnitude.

- Severe noise impacts (either a predicted design year increase of at least 15 dBA over existing noise levels, or an absolute traffic noise level of 75 dBA Leq or more) receive additional consideration and might be allowed to exceed the above mentioned cost per household.

All human use areas, including those in areas zoned for commercial use, are included in a traffic noise analysis.

Normally, only outdoor areas of frequent human use are considered for noise abatement. Indoor locations may be considered if the noise levels of such areas approach or exceed the FHWA noise criteria per 23 CFR 772 and outdoor activities do not exist. Establishment of indoor noise levels is done in accordance with the conditions in the FHWA publication "Measurement of Highway-Related Noise."

Normally, noise abatement built pursuant to this policy will be constructed within the highway right of way. There can be cases in which department right of way is not the most prudent location for abatement, but abatement can be reasonable if constructed on adjacent property. In these cases:

- The department's cost is limited to normal cost for abatement on department right of way.

- The adjacent property owners allow access and easements as necessary to construct and maintain the barrier and the cost of such access if factored into the reasonableness calculation.

Primary consideration is given to ground floor outdoor activity areas. Design of noise mitigation measures for other than ground floor receivers often results in a wall that must be very high and would likely not meet the criteria (costs, visual impacts, and so forth). In addition, walls that are constructed tall enough to break the line of sight for higher receivers are seldom acceptable to ground floor residents. On occasion, a building with more than one floor might be
located so that it is possible to mitigate traffic noise levels to an upper floor by constructing a noise barrier of reasonable height.

Mitigation is not excluded for ground floor impacts merely on the basis that mitigation cannot be provided for upper floor impacts.

The use of the property is included when considering the reasonableness of abatement. For example, churches, schools, and parks might be in use only during specific hours or days of the week. These same facilities generally have a greater number of receivers than if simply counted as a residence. In these cases, residential equivalents (usage factor multiplied by the number of users [see D 22-22, page 4]) are used. The residential equivalents in D 22-22 are used when including general use facilities in an analysis, whether for a Type I or Type II project.

The relationship of the location of a noise barrier to the receptors to be protected is considered in making a reasonableness determination. Very tall barriers located very close to the receptors can have a significant negative visual impact.

When the Acoustics program determines that noise abatement is reasonable, the costs of enhancing environmental or visual quality are not taken into consideration. Aesthetic improvements for wall placement, landscaping, and/or texture is outside the cost allowance for the reasonableness criteria and would be reviewed and approved on its own merits by the design team.

**Extenuating Circumstances**

Any special circumstances will be evaluated to determine whether to provide noise abatement. This could include the historical significance of an area or the presence of any long term efforts to maintain the character or cultural value of a sensitive area.

**Public Involvement**

Public involvement procedures are in the *Design Manual*. The design office and the noise abatement manager decide the appropriate level of public involvement for each project. The purpose of the public involvement is to assure that the wishes of the affected communities are known to the department and that every effort to provide noise abatement to an impacted community is made.

The opinions of the residents are incorporated in the design of the noise abatement. Where a location meets the eligibility requirements for noise abatement, the opinions of the public, and particularly those of adjacent property owners are used in determining whether a barrier or other practicable mitigation is implemented; the location, height, length of a barrier; and, where practicable, the composition and finish.
of a barrier. Opinions of the residents are also considered in the reevaluation of the assumptions used in applying reasonableness criteria.

Public involvement is also necessary to keep the adjacent communities informed of the actions of the department and of what to expect in the future. Depending on the size, controversy, and impact of the project, actions to involve the public might include the following:

- Special open houses
- Mailers
- Workshops
- Joint WSDOT/Citizen committees

Where a community or homeowner's association exists, all correspondence to members of the community will occur through the association to the greatest extent possible. Polls, petitions, or surveys of the communities’ desires will only be considered valid if the following occur in conjunction with other criteria of this chapter:

- Performed by the department or performed by the association under the rules and bylaws of the association.
- Contain the address, signature, and printed name of residents along with their expressed wishes concerning abatement.

Residents living adjacent to a highway might have scenic vistas that they wish to maintain. Noise mitigation measures might be designed that effectively mitigate traffic noise while maintaining the vista. This issue is considered when assessing mitigation measures. If it is not reasonably possible to both effectively mitigate traffic noise and maintain the scenic view, the opinion of the majority of the residents determines whether abatement is placed.

Noise abatement will not be planned if it is obvious that the majority of the affected people are in opposition to or have no desire for noise mitigation.

The design office is responsible for ensuring that the desires of each community are known to the department and that correspondence is complete. This means, for instance, that the same people surveyed will in the same manner be apprised of the department's decision regarding abatement. Where barriers are proposed, this includes the approximate height, length, and alignment of barriers.
Coordination with Local Officials

Control of land use surrounding high traffic corridors is the most effective means of preventing impacts to residents. This control, however, is in the hands of local officials. For this reason, the department assists the local government by providing information that will help them recognize the incompatible land uses near the state highways.

WSDOT apprises local officials as well as political representatives through the department's public involvement process as outlined in the Design Manual, through participation in Metropolitan Planning Organization (MPO) and Regional Transportation Planning Organization (RTPO) planning sessions, and may take additional measures as determined on a case-by-case basis. Local officials are invited to all community meetings, noise related meetings, and open houses.

The department also provides officials with information regarding the anticipated noise levels to abutting properties for the purpose of reducing or eliminating future impacts to wayside residential use areas caused by traffic related noise.
Design

The two basic types of noise barriers are noise walls and earth berms. See the Design Manual for considerations in selecting the type of noise barrier, considerations in locating noise barriers, and design procedures. Noise berms are preferred where right of way widths and corridor continuity allow for their construction. An earthen noise berm can be constructed to full height or to partial height in conjunction with a noise wall to reach the required height. Refer to Division 7 for information on earth berms. An alternative to noise barriers is realignment or lowering of highway profiles.

Once the height and location of a noise barrier have been determined in the noise report, they cannot be changed without affecting the abatement level. Therefore, any changes to height or location during design will require further noise analysis.

Departmental Coordination

When noise mitigation is recommended for a project, coordination between various offices is necessary. The Acoustics program makes the determination for a noise wall or berm. The Project Engineer’s office determines whether a berm is appropriate given the right of way width, available materials, and other considerations, and then coordinates with other offices in the department as shown in Table 460.2.
<table>
<thead>
<tr>
<th>OFFICE</th>
<th>ROLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Manager</td>
<td>Prepare design using resources needed to add value to the project. See that permits are obtained. Conduct public involvement.</td>
</tr>
<tr>
<td>Real Estate Services</td>
<td>Negotiate acquisitions, easements, and leases.</td>
</tr>
<tr>
<td>Acoustics Program</td>
<td>Noise analysis to determine need, reasonableness and feasibility. Calculate height, location, and orientation of noise barriers.</td>
</tr>
<tr>
<td>Access and Hearings</td>
<td>Assist in public involvement efforts. Assist in obtaining permits (State Design Engineer approval for limited access routes) for all openings in walls.</td>
</tr>
<tr>
<td>Local Programs</td>
<td>Obtain construction permits from local governments (in some regions).</td>
</tr>
<tr>
<td>Materials</td>
<td>Obtain permits and investigate soils.</td>
</tr>
<tr>
<td>Utilities</td>
<td>Consult on utilities issues.</td>
</tr>
<tr>
<td>Surveying</td>
<td>Protect existing monuments. Survey ground breaks for walls with independent alignment.</td>
</tr>
<tr>
<td>Principal Architect</td>
<td>Provide list of acceptable wall designs and surfaces. Approve final wall design and surface selection through the Project Engineer’s Office.</td>
</tr>
<tr>
<td>Structures</td>
<td>Design the wall if appropriate.</td>
</tr>
<tr>
<td>Landscape Architecture</td>
<td>Assist in selection of wall surface to blend within the corridor. Assist in siting the barrier. Design noise berms. Revegetate barriers.</td>
</tr>
<tr>
<td>Construction</td>
<td>Consult on constructibility issues. Administer the contract to construct the mitigation per plans.</td>
</tr>
<tr>
<td>Maintenance</td>
<td>Assist in siting barriers to respond to maintenance concerns.</td>
</tr>
<tr>
<td>Environmental</td>
<td>Consult on wildlife barrier issues. Obtain environmental permits.</td>
</tr>
<tr>
<td>Hydraulics</td>
<td>Consult on drainage issues.</td>
</tr>
<tr>
<td>Design Imaging</td>
<td>Develop proposed barrier images for public presentations.</td>
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<tr>
<td>Service Center</td>
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</tbody>
</table>

**Table 460.2 Coordination for Noise Abatement Measures**
Safety

Provide for construction, maintenance, and emergency vehicle access so that the access road is less noticeable to travelers. Access may also be necessary for utilities. A principal concern is the placement of noise walls relative to nearby housing and pedestrian use. Consider planted setbacks from pedestrian paths to soften the visual impact of noise walls. The following figure illustrates the placement of noise walls relative to residential areas and access to safety elements such as fire hydrants.

![Diagram of noise wall placement with access road, fire hydrant, and emergency access door]

Figure 460.2 Provide Access Where Needed

Do not block fire hydrants with walls. Provide access to fire hydrants from roadway where practical. For example, the figure above shows an access door adjacent to a fire hydrant.

When designing and locating noise walls, consider providing harness tie off points or other safety mechanism where maintenance might be necessary and drop-offs are greater than 3 meters.

Visual Quality

Noise walls are not only seen from the road, they are seen from adjacent neighborhoods. In some cases it is preferable to retain vegetation and use a noise wall rather than to remove mature trees and use a berm.
Where practical, set noise walls back from the road and use vegetation to screen and soften the appearance of the wall as seen in the figure below. Texture can also be used to add visual appeal to noise walls. Vegetation and some textures also have acoustic benefits.

![Textured Noise Wall with Vegetation](image)

**Figure 460.3 Textured Noise Wall with Vegetation**

Consider the aesthetic advantage, to motorists and the community, of the combination of a short wall on top of a landscaped berm. When berms are combined with noise walls the acoustics are affected. Discuss this option with the Acoustics program during the Noise Analysis phase.

Consider use of tiered or stepped walls instead of just one wall. The resulting terraces can be planted with vegetation, which softens the appearance of the wall.

**Construction**

Construction noise is temporary but might adversely affect nearby residents. During project development, the design engineer considers ways to reduce or mitigate the adverse impacts of construction. All reasonable methods are incorporated in the plans and specifications of the contract.

In most cases, daytime noise from construction activities is exempt from local laws. For all other cases, permits from local agencies might be needed. Each local agency is contacted to determine the local regulation and whether a permit is required. Some acoustical analysis might be needed before the local agency will grant the permit. This is done on a case-by-case basis.
These same actions apply to maintenance activities in all but emergency situations. In the latter case, the police department and the local permitting agency are to be contacted and apprised of the situation at the earliest possible opportunity.

**Maintenance**

Maintenance costs might increase when noise walls are used because of the increased cost of maintaining a structure and the cost of graffiti removal.

Locating a noise wall set back from the property line can leave a dead-zone creating a maintenance problem. Real Estate Services can negotiate air space leases to allow for maintenance by adjacent landowners.

Consult with the region’s Maintenance Supervisor and consider maintenance permits with adjacent landowners in this situation. These can be coordinated through the Adopt-a-Highway program. The Northwest Region Noise Wall Construction Problems Report, 1995, provides information regarding these issues.

**Additional Sources of Information**


