3.12 Noise

The existing Corridor produces noise levels that exceed Federal Highway Administration (FHWA) and Colorado Department of Transportation (CDOT) noise abatement criteria (NAC) at many locations along the Corridor. Residents and local agencies have raised noise as an issue at public meetings. In particular, residents have voiced concerns regarding overall, long-term noise levels, as well as short-term peaks from events such as passing trucks and engine compression brake use (commonly referred to as "jake brake").

Noise Issues

Direct impacts:

- Increases in Corridor noise levels from project alternatives due to:
  - Increased traffic volumes
  - Addition of buses and rail systems
  - Construction

Indirect impacts:

- Increased traffic on major access routes to highway interchanges and transit stations
- Noise from growth in general

3.12.1 Affected Environment

3.12.1.1 Noise Concepts and Assessment Methods

Decibels

Noise, often defined as unwanted sound or annoyance, is most commonly described on the decibel scale, which ranges from 0 decibels (dB) (threshold of audibility) to 140 dB (threshold of pain). In addition to level or loudness, sound has a frequency component (pitch). The human ear is more sensitive to high-frequency sounds than to low-frequency sounds. Because of this, the A-weighting network was developed and is applied to measured or predicted noise levels to simulate the relative response of the human ear to frequency. Resulting noise levels are expressed as dB(A). Table 3.12-1 shows the A-weighted noise levels of some common sources. All noise levels discussed in this document are A-weighted decibels.

Table 3.12-1. Typical A-Weighted Noise Levels

Noise Source	Noise Level (dB(A))
Amplified rock band	120
Commercial jet takeoff at 200 feet	110
Community warning siren at 100 feet	100
Busy urban street	90
Construction equipment at 50 feet	80
Freeway traffic at 50 feet	70
Normal conversation at 6 feet	60
Typical office interior	50
Soft radio music	40
Typical residential interior	30
Typical whisper at 6 feet	20
Human breathing	10

Leq

Leq is an abbreviation for "equivalent level." It is essentially the average noise level over a stated time period. The one-hour Leq is used on this and most other environmental noise studies to describe traffic noise levels.

"Loudest Hour" Noise Level

All of the measured and predicted noise levels from Highway and Bus in Guideway alternatives discussed in this report are in terms of the "loudest hour" Leq. This is the average noise level during the hour of peak traffic volumes, provided traffic is traveling at free-flow speeds. Rail with IMC and AGS noise levels were predicted in terms of the loudest hour Leq, which corresponds to the hour of peak service, as well as the Lmax as described below.

Supporting Documentation

- Appendix A, Environmental Analysis and Data

Day-Night Level (Ldn)

The Ldn is a 24-hour time averaged noise level based on the Leq. It is equal to the average of the hourly Leq values over a 24-hour period, with 10 dB(A) added to the Leq values between 10:00 PM and 7:00 AM to account for heightened noise-sensitivity at night. The Ldn is typically applied to airport and transit noise studies and was not used on this project due to the predominance of highway noise in the Corridor.

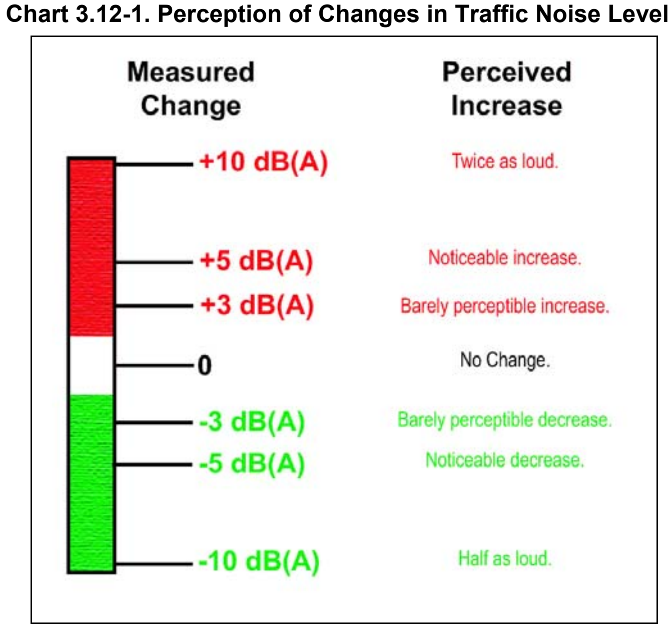
Lmax

The Lmax is the maximum instantaneous noise level. It was used on this project to identify potential impacts from the Rail with IMC and AGS alternatives. The detailed noise emission characteristics of these sources are not completely captured when using an hourly average noise level.

Human Perception of Changes in Noise Levels

As depicted in Chart 3.12-1, increases in noise levels of less than 3 dB(A) are generally considered imperceptible to humans. Increases of 3 to 5 dB(A) are considered noticeable, and increases of 10 dB(A) are perceived as a doubling of loudness. This holds true only when there is no change to the character of noise, which on this project includes the No Action, Bus in Guideway, and Highway alternatives. However, the Rail with IMC and AGS alternatives would involve introducing noise sources with different frequency and time characteristics. Noise from these sources would likely be noticeable even when it is less loud than the highway.

Chart 3.12-1. Perception of Changes in Traffic Noise Levels



Assessment Method

Due to the programmatic nature of this study, noise was analyzed within the following areas: Dowd Canyon; Vail; Dillon Valley; Silver Plume; Lawson, Downieville, and Dumont; Georgetown; and Idaho Springs. The analysis consisted of measuring existing noise levels at representative locations, predicting how much noise each alternative would produce based on projected traffic volumes, bus and train types, and schedules, and predicting the effect of terrain features at one or more representative locations within each town under study. Also addressed, in a qualitative manner, are mitigation strategies, indirect impacts, and construction noise. More detailed, site-specific analyses will be conducted during Tier 2 studies. During the subsequent Tier 2 studies, all communities within those individual study areas will undergo a detailed analysis, not just the communities listed above.

3.12.1.2 Noise Regulations

Three federal agencies have noise regulations that are in some way related to this project: the FHWA, the Federal Transit Administration (FTA), and the Federal Railroad Administration (FRA). For this analysis, which was to characterize the nature of the noise environment along the Corridor, FHWA noise regulations and criteria were used. This was due to the fact that highway noise, being a stronger and more continuous noise source, will dominate in areas where a highway and a transit component are in close proximity. For subsequent Tier 2 analyses, the methodology (FHWA or FTA) that will be used will depend on the nature of the alternatives that will be proposed in a specific area. For areas that will include either highway widening or highway widening plus a transit component, FHWA regulations and criteria are usually used. For areas that will involve only transit improvements (such as Rail and AGS), FTA regulations and criteria normally apply.

FHWA regulations are promulgated in 23 CFR Part 772. CDOT has established procedures that implement the federal regulation (*CDOT Noise Analysis and Abatement Guidelines,* December 2002). CDOT guidelines state that noise mitigation must be considered for any receptor or group of receptors where predicted traffic noise levels, using future traffic volumes and roadway conditions, equal or exceed the NAC shown in Table 3.12-2. Mitigation must also be considered for any receptors where predicted noise levels for future conditions are greater than existing noise levels by 10 dB(A) or more.

Table 3.12-2. CDOT Noise Abatement Criteria

Activity Category	Leq[a] (dB(A))	Description of Activity Category
A	56 (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	66 (Exterior)	Picnic areas, recreation areas, playgrounds, active sports areas, parks, residences, motels, hotels, schools, churches, libraries, and hospitals
C	71 (Exterior)	Developed lands, properties, or activities not included in Categories A or B above
D	N/A	Undeveloped lands
E	51 (Interior)	Residences, motels, hotels, public meeting rooms, schools, churches, libraries, hospitals, and auditoriums

[a] *Hourly A-weighted equivalent level for the loudest hour of the day in the design year*

The consideration of mitigation involves determining the feasibility and reasonableness of proposed measures. Feasibility issues include:

- If a noise barrier is to be constructed, can it be constructed in a continuous manner? (Gaps in noise barriers, such as for driveways, substantially degrade their performance.)
- Can at least 5 dB(A) of noise reduction be achieved at front row receptors?
- Are there any "fatal flaw" maintenance or safety issues involved with the proposed measure?

Reasonableness issues include:

- What is the cost per benefited receptor per dB(A) of reduction?
- How loud are projected noise levels?
- Do a majority of the residents affected by the proposed measure approve of it?
- Is the majority of the development in the area NAC Activity Category B?
- How long has the development under consideration for mitigation been in existence?
- How do future noise levels compare to existing levels?

The discussions of noise impact and the effectiveness of mitigation in this document are general in nature, given that this is a Tier 1 analysis. More detailed analyses and recommendations will be made as part of subsequent Tier 2 studies.

An optional provision of the federal regulation is the programming and funding of the construction of noise barriers on existing highways in the absence of major highway projects. These are referred to as "Type II" noise barrier projects. CDOT does not currently administer a statewide Type II noise barrier program.

3.12.1.3 Measured Noise Levels

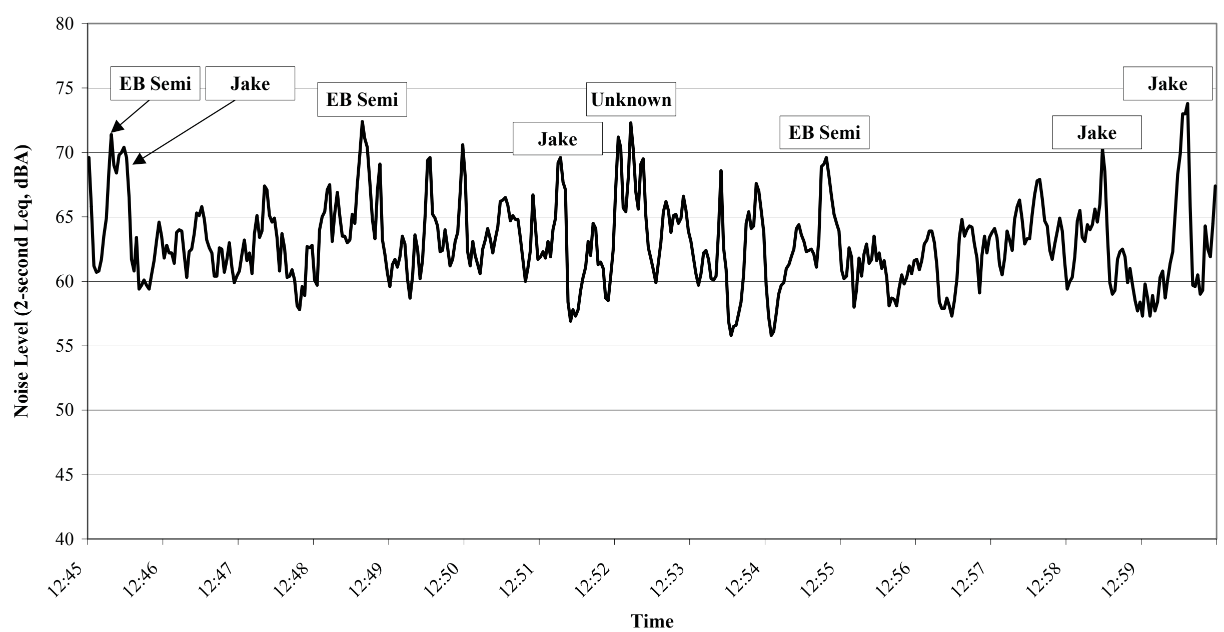
Existing noise levels were measured in each area under study. The measurements were conducted during February and March of 2001, January 2003, and July 2004. Most of the measurements were taken at a distance of 250 feet from the centerline of I-70. The measurement locations are shown as M1-Mx in Figure 3.12-7 through Figure 3.12-12, and the measured levels are shown in Table 3.12-3. From the table, it can be seen that existing peak-hour noise levels along I-70 range from 52 to 72 dB(A). Note that noise levels were measured on various days of the week and during various times of the year, and as such are representative of those times only. Noise impact and mitigation decisions will be made using predictions of existing conditions, which will use "loudest hour" conditions.

Table 3.12-3. Measured Noise Levels, 2001 and 2003

Town	Location	Site No.	Day of Week	Loudest Hour Leq (dB(A))
Dowd Canyon	Creekside Condos	M4	All	62
	Kayak Crossing Condos	M5	All	60
Vail	Golf course	M1	Friday	63
	West side of town, south of I-70	M2	Friday	67
	West side of town, north of I-70	M3	Friday	65
Dillon Valley (before construction of noise wall)	East side of residential area	M1	Wednesday	66
	West side of residential area	M2	Wednesday	61
	Church	M3	Wednesday	69
Silver Plume	Behind existing noise wall	M1	Wednesday	57
	Near interchange	M2	Wednesday	59
	East end of town	M3	Wednesday	68
	RR depot		All	63
Georgetown	Below I-70 bench	M1	Friday	52
	East of interchange	M2	Friday	68
Lawson, Downieville, and Dumont	Lawson: South side of I-70, along Silver Lakes Drive	M1	All	65
	Dumont: South side of I-70, along Stanley Road	M2	All	68
Idaho Springs	Residences on east end of town	M1	Sunday	65
	Downtown	M2	Sunday	65
	Residences on west end of town	M3	Tuesday	64
	Charlie Tayler Water Wheel	M4	All	72

Noise measurements were conducted in various communities in March 2003 to obtain information on passing trucks and "jake brake" use. Results of the measurements taken along Silver Lakes Drive in Lawson are shown on Chart 3.12-2. The average noise level over this time period is 64 dB(A) (Leq). Maximum noise levels from individual eastbound truck pass-bys and from "jake brake" events range from 68 to 74 dB(A). The measurements were taken at a distance of approximately 150 feet from the center of I-70.

Chart 3.12-2. Truck and "Jake Brake" Noise Levels



3.12.1.4 Other Past and Existing Corridor Noise Studies

Eagle Interchange

An interchange connecting the Eagle County Airport to I-70 is proposed. The proposed interchange would accommodate the recent expansion of the airport and anticipated growth among surrounding communities. There are several residences in the valley under the four proposed ramp alternatives, in addition to many proposed commercial receptors along Cooley Mesa Road. A noise assessment was completed for the receptors, according to CDOT requirements. None of the residential receptors were considered affected, as predicted future noise levels neither exceed 66 dB(A) nor increase 10 dB(A) from existing conditions. Many of the commercial receptors were considered affected, but mitigation was deemed unreasonable due to access issues.

Eagle-Vail Half-Diamond

A half-diamond interchange was recently completed at Eagle-Vail area. A noise assessment of the area was completed to determine if noise levels at any of the existing residential or commercial receptors located within the study area exceed CDOT's NAC, and if so, to evaluate the feasibility and reasonableness of implementing mitigation measures. Current land use in the area includes residences, office, and retail. The noise study considered many of these receptors to be affected but deemed mitigation unreasonable due to excessive cost.

Vail Noise Study

The town of Vail commissioned a noise study of the area in 2000. It concluded that approximately 25 percent of the residences in Vail exceed CDOT's 66 dB(A) NAC. The study also concluded that noise walls would be reasonable and feasible in several locations.

Dillon Valley Noise Abatement

As a requirement from a 1996 CDOT project adding an eastbound I-70 acceleration/climbing lane from Dillon to the Eisenhower-Johnson Memorial Tunnels (EJMT), a noise assessment was completed evaluating the impacts on adjacent Dillon Valley homeowners. The noise impacts and "feasibility and reasonableness" criteria justified noise abatement for the segment of eastbound I-70 from mileposts 206.3 to 207.8. A noise berm constructed in 1997 and finished in 2001 fulfilled abatement recommendations for the central portion of the noise-affected area. A noise wall was recently constructed to complete the noise abatement requirements. The 8- to 12-foot tall precast concrete wall was designed to reduce noise levels by at least 5 dB(A) at the first row of residences. Dillon Valley Homeowners Association and residents selected the aesthetic components of the noise wall.

Silver Plume Noise Wall

CDOT constructed the Silver Plume noise wall in 1994, also under the Colorado Type II Noise Wall Program. The wall is unique for its recycled plastic composition and its pocketed design for vegetation. Plant cover was never established on the wall due to the harsh mountain conditions. The 1,200-foot-long wall varies from 9 to 14 feet in height and runs parallel to the westbound shoulder of the interstate and the westbound entrance ramp west of the town center.

Idaho Springs Noise Wall

The noise wall located between westbound I-70 mileposts 239 and 240 in Idaho Springs was constructed as a part of the Type II Noise Wall Program in 1993. The wooden wall is 1,168 feet long and 14 feet tall and provides noise reduction to a residential neighborhood in the west part of town.

Hogback

A noise assessment was completed as part of the Hogback Environmental Assessment, which studied the effects of expanding the existing Hogback Parking Lots 2 and 3. Three receptors (two commercial and one residential) were considered close enough to the project to be affected by increased noise. Roadway noise levels were predicted to increase by 3 to 4 dB(A) as a result of projected traffic increases and the fact that US 40 would be realigned closer to the receptors. Noise levels from the parking lot project were predicted to increase by 5 to 8 dB(A) as a result of the increase in size of the site and the fact that it, too, will be closer to two of the three receptors. Of the three receptors, only the service station/convenience store was considered affected, with a predicted noise level of 71 dB(A). Mitigation was deemed to be infeasible for this receptor because a break would be required in a noise barrier for access, degrading the acoustic performance of the barrier and possibly creating a safety hazard.

3.12.2 Environmental Consequences

The proposed transportation improvements would increase noise levels in the Corridor. The increase at any one location would depend on changes to the source of noise (for example, the addition of a rail system and/or the increase in the number of highway lanes), and on topography (for example, the proximity and relative elevation of homes and businesses to the transportation system, the presence of barriers, and the presence of cliffs). Noise attributes of each alternative based on source are discussed in section 3.12.2.1. These increases apply to all locations without regard to topography. Additional changes to noise levels due to issues such as elevating the highway and AGS, reflections off steep walls and narrow canyons, and the shifting and widening of the highway are discussed in section 3.12.2.2. Section 3.12.2.3 details terrain-specific issues in each of the seven areas analyzed. The indirect impact of stations for all Transit alternatives is discussed in section 0. The remaining sections discuss indirect noise impacts, construction noise, and mitigation strategies.

3.12.2.1 Noise Attributes of Each Alternative

No Action

Traffic volumes are projected to increase under the No Action alternative in all parts of the Corridor due to increased demand. The effect this would have on “loudest hour” noise levels would depend on the capacity of I-70 to absorb additional traffic without congestion occurring. In Clear Creek County, where the highway is presently filled to capacity during peak times, loudest hour noise levels would not increase at all because the increase in traffic volume would be accompanied by a decrease in speeds due to congestion. In Dillon Valley and Vail, the highway could absorb some additional traffic without speeds declining. “Loudest hour” noise levels in these communities would increase by approximately 2 dB(A), respectively, due to increased traffic volume without a corresponding decrease in speed.

When congestion occurs, speeds are reduced considerably and noise levels decrease. The noise levels measured at the Charlie Tayler Water Wheel in Idaho Springs illustrate the effect of congestion on noise levels. The measured levels, which were taken over a 24-hour period during a peak weekend, are shown on Chart 3.12-3. Noise levels would rise from their nighttime lows between 7:00 AM and 8:00 AM as traffic volumes increase. The levels would remain somewhat constant throughout the day, until about 4:00 PM, when they would drop considerably due to the decrease in speed from traffic congestion.

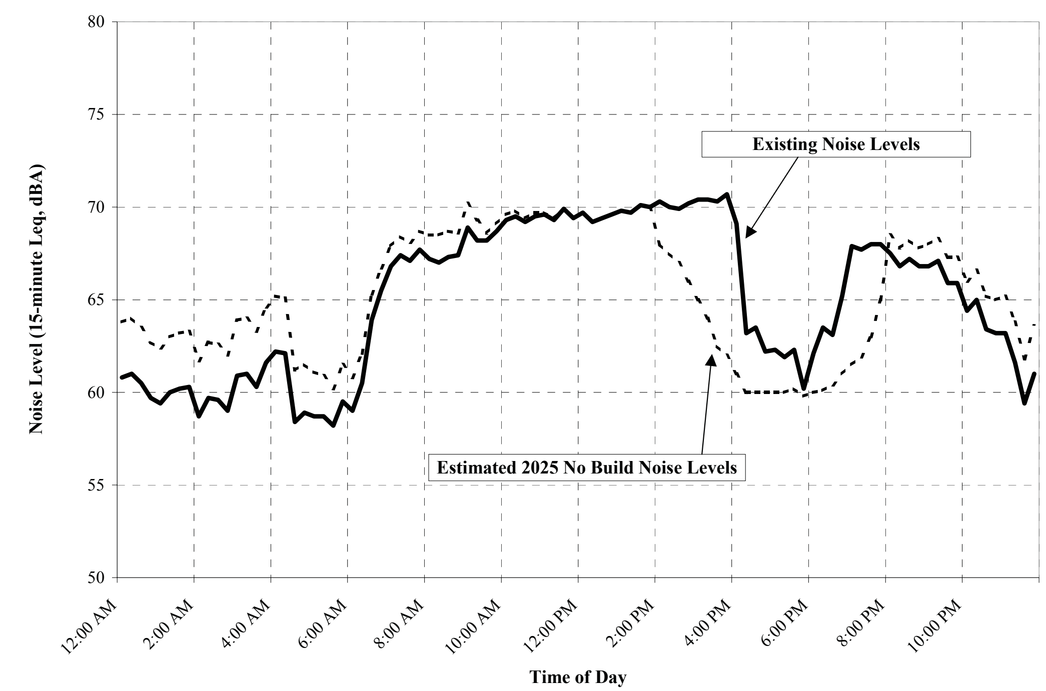
The line labeled “Estimated 2025 No Build Noise Levels” on Chart 3.12-3 illustrates what could happen to the noise levels under the No Action alternative (these are approximations, as the traffic data needed for a detailed study do not exist at this time). At night, during which time I-70 has the capacity to absorb more traffic at free-flow speeds, noise levels would increase by 3 dB(A) if traffic were to double. During the daytime, where some additional capacity exists, noise levels would increase by about 1 dB(A). The length of time the highway would be congested would increase, as would the length of time of lower noise levels. The “loudest hour” noise level, which occurs just before the period of congestion, would not increase.

Overall, increases in noise levels under the No Action alternative would be barely perceptible to most people, provided traffic volumes do not more than double at night. The reason is that the predicted increases would be relatively small, no physical changes would be made to the highway, and there would be no change in the character of the sound.

Minimal Action

The buses in mixed traffic component was the only Minimal Action component analyzed for noise impacts (the impact of the Georgetown climbing lanes would be similar to that of the Highway alternatives). The changes in noise levels under this alternative would, for the most part, be the same as those for the No Action alternative. The only difference would be that approximately 180 buses per hour would be added to the traffic stream during peak times. Standard diesel buses are roughly equivalent to a “semi” in terms of noise. This is predicted to result in an increase of approximately 1 to 2 dB(A) in the “loudest hour” noise level over existing conditions. Again, because this alternative would involve adding more of the same type of noise source that currently exists, and would involve no physical change to the existing highway, the projected noise level increases should be imperceptible to most people.

Chart 3.12-3. Representative Changes Between Existing and No Action Noise Levels



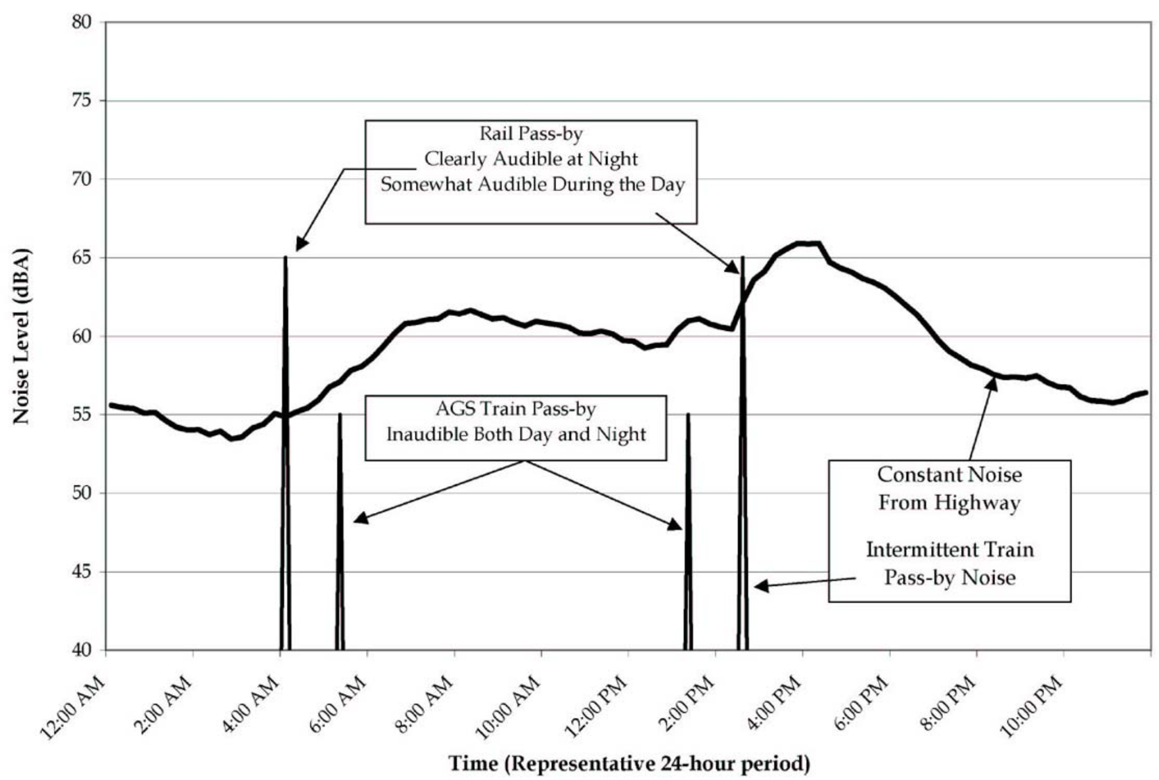
Rail with IMC

Unlike the Bus in Guideway and Highway alternatives, which would involve adding more internal combustion, rubber tire vehicles to the highway, the Rail with IMC alternative would introduce an entirely new and different noise source into the area. On a 1-hour average basis, this alternative would produce relatively little noise compared to that of the existing highway. Assuming 40 trains per hour during peak service, overall noise levels are predicted to increase by 1 to 2 dB(A).

While average train noise levels are used to assess impact according to federal regulations, it is useful to understand the potential annoyance of maximum noise levels. Maximum noise levels occur when a train is directly in front of a receptor, as well as when there is a squeal from the interaction of steel wheels and rails. The impact of these noise events depends on their maximum noise level (Lmax), the time of day during which they occur, and the number of times per day that they occur. Chart 3.12-4 demonstrates the audibility of train noise Lmax levels. Shown is the existing highway noise level over one 24-hour period at a representative location 250 feet from I-70. Also shown is the maximum noise level of both a rail transit train and a maglev train (AGS). Generally, when noise from these new nighttime, when noise from I-70 would be in the 50s (dB(A)), noise from the trains would be clearly audible.

The Rail with IMC alternative would have the potential to create wheel squeal, particularly around curves. These noise events could be relatively loud and particularly annoying due to their high-frequency content. Flat spots and out-of-round wheels could cause a noticeable knocking as the train makes its way down the track. This could be minimized by wheel and track maintenance. The Rail with IMC alternative would be completely grade-separated from surface traffic; therefore, there would be no need for warning signals.

Chart 3.12-4. Lmax Train Noise Audibility



AGS

The AGS alternative would also introduce an entirely new and different noise source into the area. The AGS currently under consideration would be an urban maglev, which would be suspended above the guideway with electromagnetic force. As a result, there would be no noise from the interaction of the train and the guideway. On a 1-hour average basis, this alternative would produce relatively little noise compared to the existing highway. Assuming 40 trains per hour during peak service, overall noise levels are predicted to increase by 1 dB(A) or less. As shown on Chart 3.12-4, the AGS would be generally inaudible at a distance of 250 feet. Because the AGS would also be completely grade-separated from surface traffic, no warning signals would be required.

Dual-Mode Bus in Guideway

Under this alternative, buses would be propelled by electric motors while in the guideway. Electric buses would have the advantage of no engine noise, but tire noise, gear noise, and cooling system noise would still be present. Overall, this alternative is predicted to increase existing loudest hour noise levels by approximately 1 dB(A). When operating outside the guideway, these buses would have noise characteristics similar to those of standard diesel buses.

Diesel Bus in Guideway

Under this alternative, diesel buses would operate in a guideway located in the median of I-70 from Silverthorne to C-470. The operation of the buses would increase "loudest hour" noise levels by 1 to 2 dB(A) over existing conditions, and overall the changes would be similar to the buses in mixed traffic in the Minimal Action alternative. When operating outside the guideway, these buses would have noise characteristics similar to those of standard diesel buses. Physical changes would be made to the existing highway to accommodate this alternative; the effects of which are discussed in section 3.12.2.2.

Highway Alternatives

The amount of noise produced by a highway depends on the volume, speed, and type of traffic traveling on it. Under the Six-Lane Highway (55 mph or 65 mph) and Reversible/HOV/HOT Lanes alternatives, two additional lanes would be added on I-70. This would allow more traffic to travel at free-flow speed and would result in noise level increases of 2 to 3 dB(A) during peak times. Because there is very little difference between the three Highway alternatives in terms of noise impacts, they are for the most part treated together as Highway alternatives. The difference among these alternatives occurs where the alignment of the Six-Lane Highway 65 mph differs from that of the other two. These differences are discussed in section 3.12.2.3.

Aside from average traffic noise levels, there would be the issue of the loud bursts of noise from the use of unmuffled "jake brakes," which are engine compression brakes equipped on many large trucks. From Chart 3.12-2, maximum noise levels from individual truck pass-bys and from "jake brake" events would be 5 to 10 dB(A) above average traffic noise levels.

Combination Alternatives

Each Combination alternative would include three implementation scenarios:

- Build Combination Simultaneously
- Build Transit and Preserve for Highway
- Build Highway and Preserve for Transit

For Combination alternatives where highway and transit components would be built simultaneously, noise impacts would be a total of the Highway alternative impacts and the Transit alternative impacts.

For Combination alternatives where Transit components would be built first, noise impacts would be the same as those under the Transit-only alternatives, until the point in time when the full combination will have been completed.

For Combination alternatives where Highway components would be built first, noise impacts would be the same as those under the Highway-only alternatives, until the time when the full combination will have been completed.

Summary of Source Noise Level Changes Without Regard to Location

Table 3.12-4 summarizes the increases in noise levels expected from each alternative. These levels refer to the "loudest hour," which for Transit alternatives would be the hour of the day when the most trips are planned. For Highway alternatives, it would be the hour of the day when the highway would be at the highest capacity that still would allow traffic to move at a free-flow speed. These increases would occur at all locations, without respect to topography. Additional increases specific to certain locations are also possible, as discussed in section 3.12.2.2.

Table 3.12-4. Increase in Noise Levels From Alternatives Without Regard to Location

Alternative	Increase in Loudest Hour Noise Level (dB(A))	Notes
Existing	N/A	Generally, existing levels range from the mid-50s to the mid-60s (dB(A)) at a distance 250 feet from the center of I-70.
No Action	~ 1	The changes in noise levels under the No Action alternative would depend on growth in travel demand, as well as the capacity of the highway to carry traffic at free-flow speeds.
Minimal Action	1 to 2	Because this alternative would involve adding a small number of buses relative to the existing traffic volume and would involve no physical alterations, its implementation would be barely noticeable.
Rail with IMC	1 to 2	Similar to the AGS alternative; however, wheel-rail contact would be louder, particularly over time as flat spots develop.
AGS	~ 1	Assuming urban maglev design, there would be little increase to loudest hour levels. However, some train noise would be audible, particularly at night.
Dual-Mode Bus in Guideway	~ 1	Electric buses would have a quieter drivetrain but would still create tire noise.
Diesel Bus in Guideway	1 to 2	With the guideway located in the median, impacts from this alternative would be similar to impacts of the Minimal Action alternative.
Highway Alternatives	2 to 3	Noise levels would increase a barely perceptible amount during the loudest hour.
Combination	3 to 5	On an hourly average basis, the Combination alternatives would be a sum of their parts. The increases would be noticeable.

3.12.2.2 Effect of Location and Topography on Noise Propagation

In the previous section, the noise produced by each alternative under study was discussed without regard to location or topography, and the increases in levels discussed therein apply to all locations. For those alternatives that would involve physical changes to the existing highway, or those that would involve adding new systems, location and topography must also be considered. The changes in noise level that topography could create could be as much or more substantial than the source-related changes discussed above. A summary of all the predicted noise level changes is provided at the end of this section. Note that the No Action and Minimal Action alternatives are not discussed, as they do not change the physical relationship between I-70 and nearby receptors. They are included in the summary, however. General implications of location and topography are discussed in this section, while section 3.12.2.3 describes the effect of location and topography specifically in each of the seven areas under study.

Distance and Line of Sight

Once a source creates noise, the two primary factors that determine how much of that noise will reach a business or residence are distance and line of sight.

- As noise propagates away from a source, it decreases at a rate of approximately 4.5 dB(A) for every doubling of distance, provided the sound waves are traveling over "soft" ground (for example, loose soil or grass). For example, a source that produces 65 dB(A) at 250 feet will register 60.5 dB(A) at 500 feet and 56 dB(A) at 1,000 feet. Noise decreases at a rate of 3 dB(A) for every doubling of distance as it propagates through the air such as from an elevated roadway or over "hard" ground such as pavement.
- When a barrier such as a natural hill or a man-made wall just breaks line of sight between a source and a receptor, a 5 dB(A) reduction in noise level occurs. A taller hill or wall can provide as much as 15 dB(A) of reduction but is generally limited to that due to the diffraction of sound waves by atmospheric effects such as wind and temperature.
- Regarding the configuration of interchanges, it would be generally advantageous from a noise perspective to keep I-70 at grade and run cross streets over it. This way, noise from I-70 would be shielded by the overpass and ramps.
- In general, the rail would be less loud than the existing highway on a long-term average basis. If the trackbed were installed between the highway and adjacent residences and could be elevated on retaining walls enough to break line of sight between residences and the highway, a considerable decrease in I-70 noise levels could be achieved. The decrease in I-70 noise would outweigh the increase in noise resulting from the trains. Under the current design, this would not be applicable to the AGS alternative, which would be supported on concrete columns that would not provide appreciable noise shielding. Nor is it applicable to the Bus in Guideway alternatives, which are planned for the median.

Alignment Shift

I-70 would be widened under the Highway and Combination alternatives. Widening would have some effect on noise levels at residences that are relatively close to I-70 but very little effect for distant residences. For example, consider the case where there is currently no median between the eastbound and westbound lanes of I-70. Under Combination alternatives, I-70 would be widened by 12 feet in each direction to accommodate the additional through lanes and would be shifted out an additional 12 feet in each direction to accommodate the 24-foot wide transit guideway in the median. As a result, I-70 would move 24 feet closer to residences adjacent to each side of the highway. For a residence that is currently 100 feet from I-70, this would result in an increase in noise levels of approximately 1 to 2 dB(A). For a residence that is currently 400 feet from I-70, this would result in an increase in noise levels of less than 1 dB(A). These increases would be in addition to the increases resulting from changes in the source strength described in section 3.12.2.1.

Reflections

Noise from the transportation system would have the potential to reflect off hillsides and cliffs in the Corridor. Tall, vertical cliffs located close to the highway would have the most effect. The most prominent cliffs are located in Clear Creek County, notably along Georgetown Hill, and smaller ones exist in Dillon Valley and Vail. The situation is complicated by the mathematics of logarithms and by the location of the sources, cliffs, and receptors. It can be grossly summarized by saying that a large cliff would increase noise levels by 1 to 2 dB(A) opposite the cliff (at most). It should be noted, however, that even a slightly audible echo, or a change in sound frequency, could be perceived as an actual increase in level.

Noise From Engine Braking

The grade of I-70 in much of the Corridor is steep, and engine braking is common. Currently, more than 70 percent of trucks are equipped with an engine brake, and more than 80 percent of the trucks being produced have them. When engaged, it uses pressure from the truck's engine to slow the vehicle. Because the engine brake does not have a separate exhaust, the noise produced by the braking system is vented though the truck's standard muffler. Engine brakes are considered a key safety component, particularly in the Corridor.

The US EPA limits the noise level of trucks manufactured after 1986 to 87 dB(A) at a distance of 50 feet while traveling down the road. This limit applies to all of the noise made by a traveling truck, including the engine brake. Measurements conducted in Vail in August revealed that a tractor-trailer with a functioning muffler registered about 85 dB(A) with the engine brake on. The sound of the engine brake was indistinguishable. A similar truck with the muffler disconnected registered almost 100 dB(A) with the engine brake on, and the brake was distinctly noticeable. Given this, the key to reducing the noise from engine brake use is the inspection of and maintenance of standard mufflers on all large trucks.

The proposed alternatives would not appreciably change engine brake use. It is possible that engine brake use would increase under the No Action alternative because congestion would be more prevalent and congestion causes braking.

Wind and Other Weather Conditions

Atmospheric conditions have a substantial effect on the propagation of noise from the alternatives. Most notable is wind direction. During "downwind conditions," which occur when the wind is blowing from a source toward a receptor and is greater in speed at the earth's surface than aloft, noise levels can increase as sound waves that would have otherwise propagated into the air are bent back toward the ground. Conversely, during upwind conditions noise levels can be reduced by 20 dB(A) or more. Crosswinds have less effect. Noise levels can also increase somewhat during temperature inversions, when the air aloft is warmer than that at the surface. These occur regularly in Colorado, particularly at night. The noise level predictions made on this project represent "typical" sound propagation conditions.

3.12.2.3 Terrain-Specific Issues in Analyzed Areas

Dowd Canyon

On the west end of the Dowd Canyon study area, there is a large condominium development (Kayak Crossing et al.). Presently, I-70 passes within approximately 600 feet of these residences but is shielded by a large landform. "Loudest hour" noise levels here were measured at approximately 60 dB(A) in 2001. See Table 3.12-5 for predicted "Loudest hour" noise level from 250 feet from center line of I-70. The Rail with IMC alternative, which would follow the existing Union Pacific Railroad (UPRR) line in this area, would pass as close as 100 feet to this development. This is predicted to create hourly average noise levels of approximately 67 dB(A), including both Rail with IMC and Highway alternatives. The AGS would travel along the median of I-70 in this area and would be mostly inaudible over existing highway noise levels.

Under the Highway alternatives, I-70 would be either widened in its existing alignment (with minor shifts to account for curve safety modification) or routed through a new tunnel. If widened in its current alignment, noise levels would increase only as a result of the source increases discussed above. The proposed tunnel would daylight approximately 1,000 feet west of the condominium complex and around the corner of a large hillside. Highway noise levels would be reduced by at least 5 to 10 dB(A) as a result.

At the east end of the Dowd Canyon study area, there is residential development along the north side of I-70 (Creekside Condominiums). In this area, the Rail with IMC and AGS alternatives would follow the I-70 median, and only the increases in source noise levels discussed above would result. Under the Six-Lane Highway 65 mph alternative, I-70 would veer away (to the north) from its current alignment and travel into a tunnel. This would provide a substantial noise decrease (5 to 10 dB(A)) for the residents there, which would outweigh any increase in noise levels created by the tunnel portal (1 to 2 dB(A) within 200 feet of the portal).

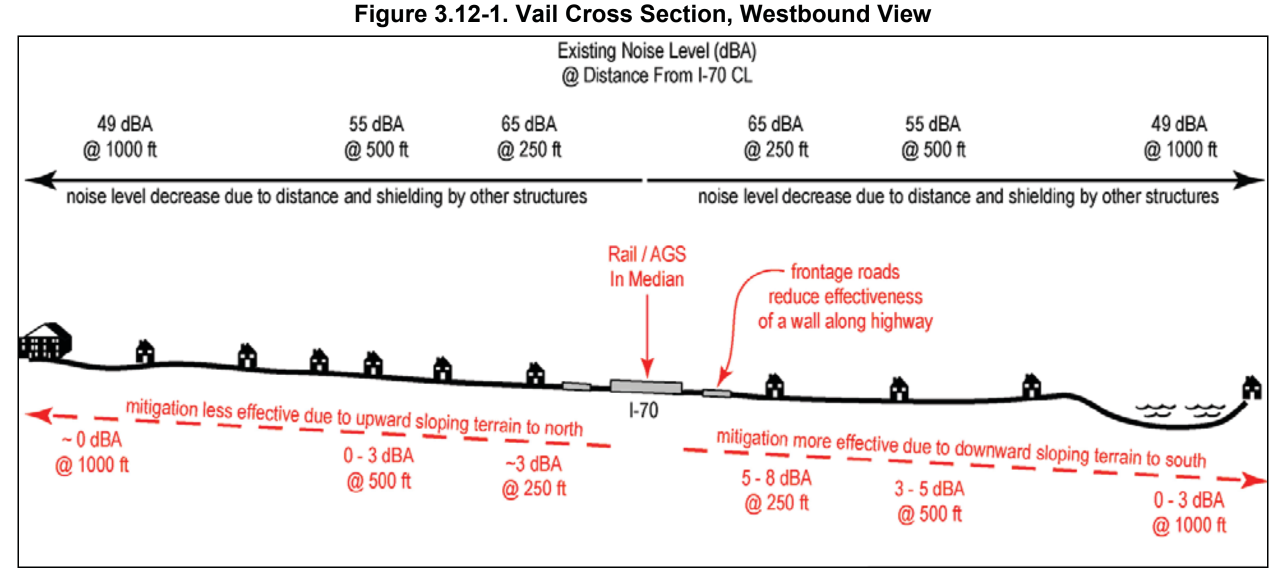
Overall, noise levels at the residences in this area are predicted to be below 66 dB(A). This will need to be verified during Tier 2 analyses.

Vail

The town of Vail is located in a relatively broad valley, as shown in Figure 3.12-7 and Figure 3.12-8. Noise levels were measured in 2001 at the locations shown in the figures (all 250 feet from the center of I-70) and range from 63 to 67 dB(A). I-70 is situated slightly up on the north slope of the valley, as depicted in the typical cross-section shown in Figure 3.12-1. Shown in the cross-section is the fact that, in general, noise would propagate similarly from both sides of the highway in Vail. Levels would drop off at a rate of 4.5 dB(A) per doubling of distance. Additional decrease in noise with distance would result from shielding by buildings (approximately 3 dB(A) per row of buildings). Development to the south would be generally lower in elevation than the highway, and development to the north would be generally higher in elevation. As a result, barriers placed along the highway will generally be more effective on the south side of I-70, as line of sight from residences to the highway would be effectively blocked. Barriers placed on the north side of I-70 would be less effective in many locations, particularly for those receivers located higher up on the slope. Some typical barrier noise reductions are shown in Figure 3.12-1. Another issue related to mitigation is the frontage roads that are prevalent in Vail. A wall placed along I-70 may effectively block noise from the highway, but it would not reduce frontage traffic noise (in some cases, it may reflect frontage road noise). It is typically infeasible to locate a wall on the development side of the frontage road due to access and sight line requirements.

Due to the relatively gentle slope of the valley hillsides, and the lack of rock cliffs close to the highway/rail alignment, reflection should not be substantial in Vail in terms of actual noise level increases. However, as noted above, even a small audible echo could be perceived as an actual, substantial increase in noise level.

Figure 3.12-1. Vail Cross Section, Westbound View



The Rail with IMC alternative is currently proposed to run at grade along the median of I-70. Therefore, terrain would affect the propagation of noise from the rail system in the same way it does currently for the highway. As a result, there would be no terrain-specific increases in average noise levels among the alternatives, only the source noise changes discussed above. The Lmax levels discussed in section 3.12.2.1 would be lower in some locations due to shielding from buildings. The AGS is proposed to run on a 16-foot-tall structure located in the median of I-70. As a result, the view of this system would be greater. However, noise levels from the urban maglev trains would be low relative to I-70.

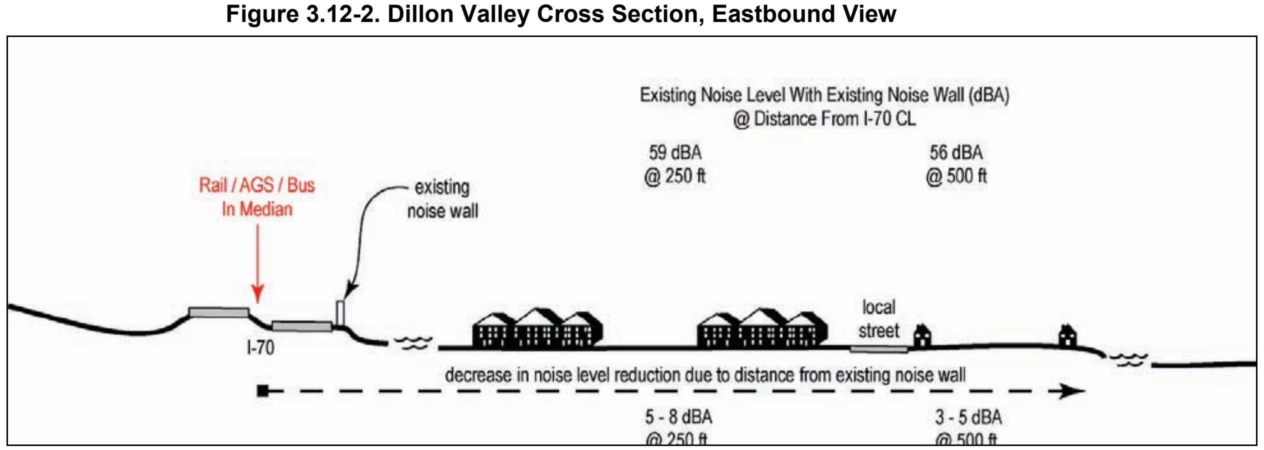
The location of the 66 dB(A) noise level contour is shown for both existing and 2025 "loudest hour" conditions in Figure 3.12-7 and Figure 3.12-8. The existing conditions contour is based on a total I-70 traffic volume of 2,388 vehicles per hour, with 5 percent medium and 5 percent heavy trucks, and a free-flow speed of 65 mph. The future condition predicts the total volume of 3,555 vehicles per hour at a free-flow speed of 65 mph. Noise from the highway would increase by 2 dB(A), which would move the existing dB(A) contour out another 100 feet. Adding a transit system would increase the predicted 2025 noise level by 4 dB(A) for the Rail with IMC alternative and 2 dB for the AGS alternative.

Dillon Valley

As shown in Figure 3.12-9, aside from the Ptarmigan Ranch on the north side of I-70, all of the residences in this area are located to the south. At the east end of the residential development, the highway is located on a bench and is elevated above the residences by as much as 50 feet. Toward the west end of the residential area, the highway becomes level with the homes. Noise levels were measured in 2001 at the locations shown in Figure 3.12-9, and the levels range from 61 to 69 dB(A). Recently, CDOT completed the construction of earthen berms and an 8- to 12-foot-tall noise wall along this entire area. As a result, noise levels are predicted to decrease by at least 5 dB(A) at the homes closest to I-70. Figure 3.12-2 shows a representative cross section of the Dillon Valley area, and the typical noise reductions expected from the wall/berm. Also shown in the figure are the existing noise levels with the wall/berm in place.

The increases in average source noise levels discussed in section 3.12.2.1 would be largely unaffected by topography in Dillon Valley. The reason is that the Rail with IMC and Bus in Guideway alternatives are proposed to be located at grade in the median, and even though the elevated AGS would be visible over the noise wall, it would still not affect average noise levels appreciably. The Lmax levels discussed above for the rail system would be approximately 5 dB(A) lower due to the noise wall. The wall would not affect AGS Lmax levels. Some reflection of transportation noise could occur in Dillon Valley near the west side of the developed area, as there is a large rock cliff on the north side of I-70 in that area.

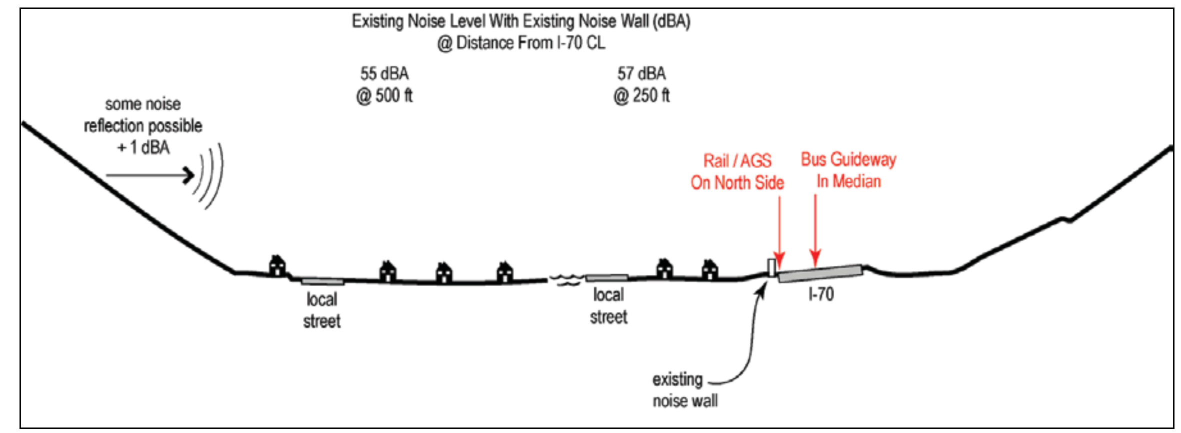
Figure 3.12-2. Dillon Valley Cross Section, Eastbound View



Silver Plume

As shown in Figure 3.12-10, most residences in Silver Plume are on the north side of I-70. As shown in the typical cross section in Figure 3.12-3, the houses adjacent to the highway are generally lower in elevation than the road. The land rises to the north, such that the residences further from I-70 are either at grade with or above the highway. The north wall of the valley in this area is relatively steep and may reflect highway noise in some areas. The slope of the south wall of the valley is gentler and does not likely reflect any substantial amounts of noise. In 1994 CDOT constructed a 1,200-foot-long noise wall along portions of the north side of I-70 in Silver Plume. This wall provides 5 to 10 dB(A) of reduction, based on field observations and its similarity to other walls with known performance.

Figure 3.12-3. Silver Plume Cross Section, Eastbound View



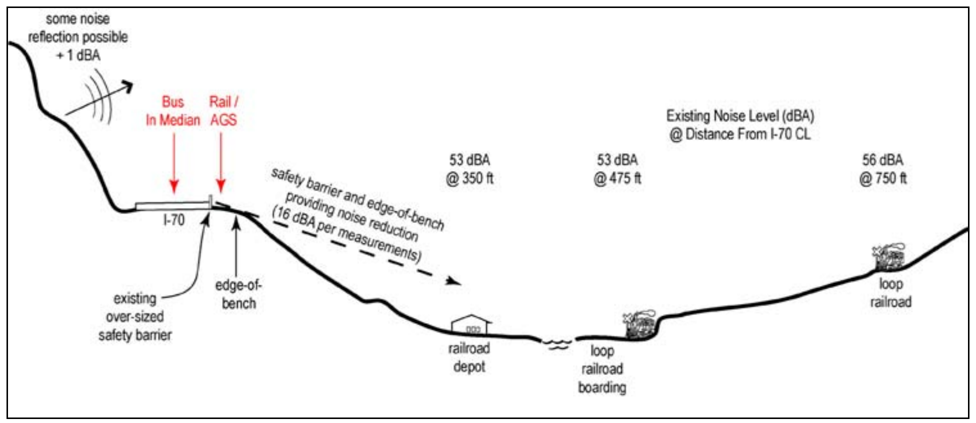
The Rail with IMC alternative would travel over I-70 at the east end of town and along the north side of I-70 through town. If possible, the trackbed should be elevated on a retaining wall to shield I-70 noise. This could result in a 5 to 10 dB(A) decrease in highway noise levels. The AGS would follow the same path but would not act as a shield because it is supported on columns. The Bus in Guideway alternatives would be placed in the median of I-70, which would require a shifting of the highway closer to residents. This would result in an increase in noise levels of approximately 1 to 2 dB(A) over that discussed in section 3.12.2.1. A similar additional increase would occur under the Highway alternatives, as I-70 would be widened to accommodate the additional lane. The 66 dB(A) noise level contours for Silver Plume are shown in Figure 3.12-10. They are approximate, as they will be greatly affected by the placement and elevation of the different transportation modes.

Georgetown

As shown in Figure 3.12-11, I-70 in the Georgetown area is oriented north-south. In the northern portion of Georgetown, residential development is fairly level in elevation with I-70. On the southern end of town, I-70 climbs a steep grade and travels along a bench high above town. There is a relatively tall (approximately 6 feet) solid concrete safety barrier along the edge of the eastbound lanes in this area. As illustrated in Figure 3.12-4, the edge of the bench and the safety barrier act together to reduce noise levels at the foot of the bench. This is reflected in the measured noise levels shown in Table 3.12-3. Measurements at M1 and M2 were taken at the same time, and both at a distance of 250 feet from the highway. However, the levels at M1 (located below the bench) are 16 dB(A) less than those at M2 (which has a clear view of the highway). Predictions indicate that existing noise levels reach the upper 50s (dB(A)) further from the bench before they start to decrease with distance. Also, the wall of the valley along the north side of I-70 consists of a steep rocky cliff that reflects traffic noise and may increase noise levels by approximately 1 dB(A) in Georgetown.

The Rail with IMC and AGS alternatives are proposed to run along the eastbound side of I-70. As a result, the edge of the bench and safety barrier would not reduce noise levels from these sources, and they would increase noise levels to a greater degree than in areas where both the highway and rail/AGS would be directly visible. The AGS would be quiet enough that it would not affect overall noise levels by more than the 1 dB(A) discussed in the source section. With the Rail with IMC alternative, however, overall average noise levels would increase by approximately 5 dB(A) more than the 1 to 2 dB(A) increase discussed in the source section. Because the Bus in Guideway alternatives are proposed for the median, the edge of the bench and safety barrier would affect bus noise in the same manner as it does highway noise, and only the source noise increase discussed in section 3.12.2.1 would occur.

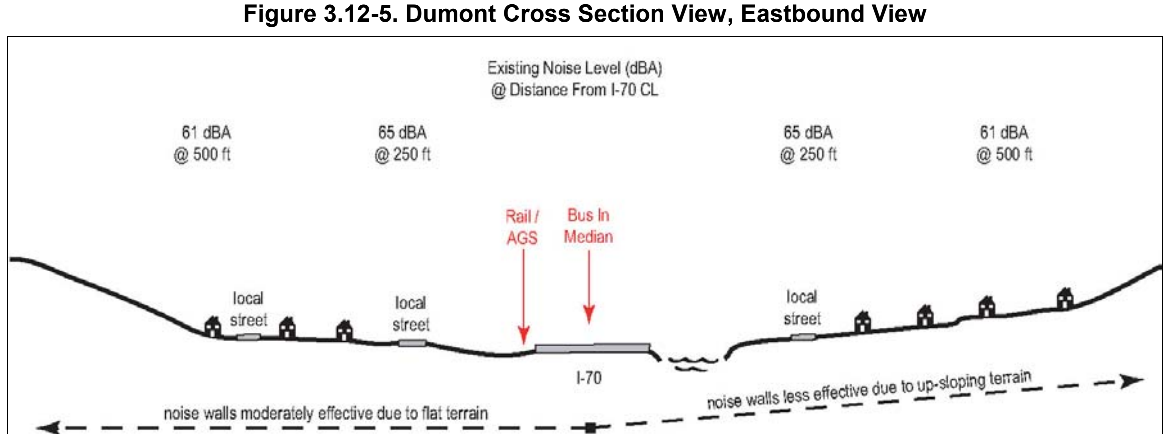
Figure 3.12-4. Georgetown Cross Section View, Eastbound View



Lawson, Downieville, and Dumont

The portion of Lawson located along Alvarado Road is located below the elevation of I-70 and is shielded from some traffic noise by the edge of the highway. The area along Silver Lakes Road has a direct view of the highway. Some residences are located just east of the Downieville exit, on the north side of I-70. These residences are shielded by noise somewhat from the edge of the highway, which is elevated near the interchange. There are homes on both sides of the highway in Dumont, as shown in the representative cross section in Figure 3.12-5. On the north side, the homes are shielded somewhat, as the highway is in a cut. The homes on the south side of I-70 have a clear view of the highway and are elevated somewhat.

Figure 3.12-5. Dumont Cross Section View, Eastbound View



Idaho Springs

Idaho Springs is located in a relatively steep-walled valley. Most of the residential and commercial development is located on the north side of the highway, although there are homes to the south. A number of topographical features in Idaho Springs would affect noise levels, including the elevation of the highway with respect to residences and businesses, the proximity of steep rock cliffs, and the fact that portions of the proposed expanded highway alignment would be placed on an elevated structure. A plan view of Idaho Springs is shown in Figure 3.12-12. Because of the complexity of the situation, the analysis was broken into the four areas discussed below. The effect of elevated lanes is discussed first and then the changes in noise levels in each area.

Elevated Highway Lanes

The proposed structures in Idaho Springs would have three implications to noise: (1) noise from traffic next to and under the structures will reflect off the sides and undersides of the structures, (2) the traffic on the structure will be either more or less visible at area residences, depending on location, and (3) the acoustic ground effect will be lost for traffic on the structure. The magnitude of each of these effects would be location dependent, as discussed below. Note that the increases discussed here would be additive to those discussed above that would be due to any changes in capacity or the addition of transit.

> Noise levels decrease at a rate of approximately **4.5 dB(A)** for every doubling of distance when sound propagates from an at-grade source over "soft" ground (for example, loose soil or grass).
>
> Noise decreases at a rate of **3 dB(A)** for every doubling of distance when sound propagates through the air from an elevated source or over "hard" ground such as pavement.

Reflections. The physics of how sound would bounce around under the structure and reflect back toward town is complex. In general, though, reflections never add more than about 2 dB(A).

Visibility. Noise acts similar to light in that if one can see a highway better one can hear it better (louder) as well. The changes in visibility of the highway or transit facility due to placing it on a structure could either increase or decrease noise levels at adjacent properties. It could decrease noise levels at those residences located at the toe of the slope of the section of I-70 in Idaho Springs that is up on a bench. Standing at this vantage point, one would not be able to see the traffic on the structured lane very well because the edge of the structure, with its 3-foot tall solid safety barrier, would block the view. Noise levels would increase by as much as 5 to 10 dB(A) at those locations in town where the view of I-70 is currently blocked by some building or terrain feature, but the view of the elevated facility would be clear.

Ground Effect. When it travels along "soft" ground, such as grass, noise energy is lost due to interactions of the sound wave with the ground. Noise from the elevated portion of the highway would travel toward town through the air, not along the ground. The "ground effect" would, thus, be lost, which would cause a small (perhaps 2 dB(A)) increase in noise levels for receivers located between 200 to 300 feet of the highway. No substantial change due to this is expected within 100 feet or beyond 300 feet from the highway.

Summary. The implication of the structured lanes is summarized by the results at three typical locations, provided in Table 3.12-5. Note that the increases at 250 feet, which would encompass many residences in town, would be relatively substantial.

Table 3.12-5. Increase in Noise Levels Due to Placing I-70 Up On Structure

	Increase in Hourly Average Noise Level (dB(A))		
	House Located 100 Feet From Highway at Toe of Slope	**House, 250 Feet From Highway**	**House 500 Feet From Highway**
Reflections	1	1	1
Visibility	-3 to 0	0 to 5	0 to 3
Ground effect	0	2	0
Total	-2 to 1	3 to 8	1 to 3

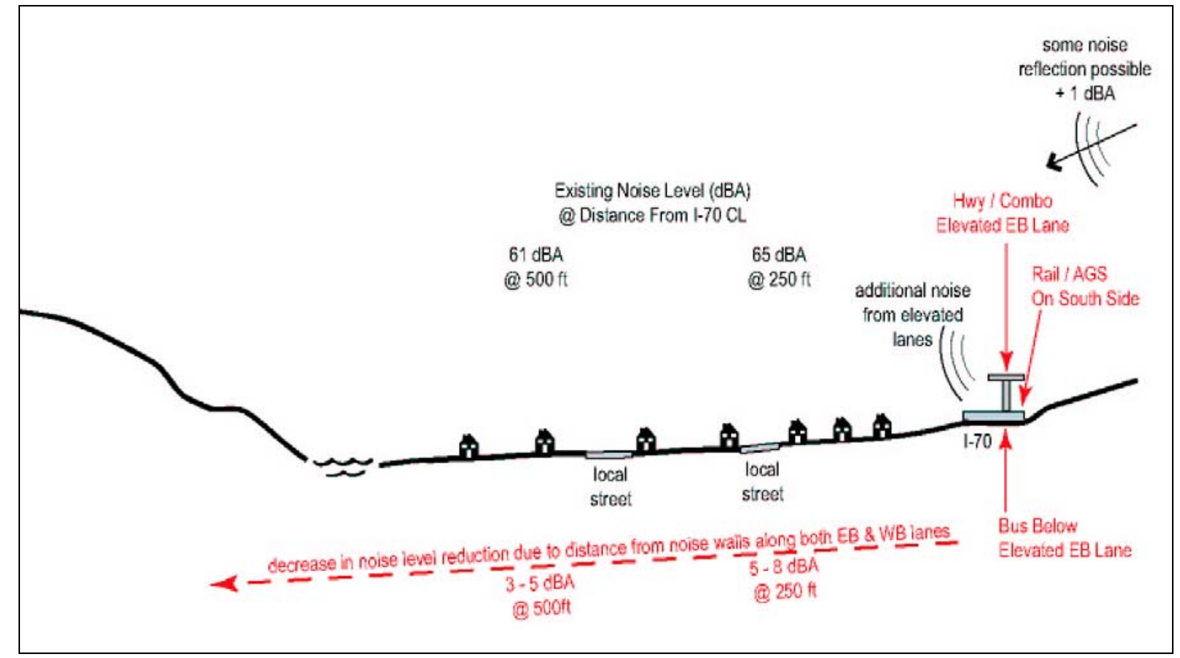
Area 1: East end of town. At the far east end of Idaho Springs, the highway is currently level with homes located across the river. The Rail with IMC and AGS alternatives would run on the south side of the highway near here and would have minimal impact on residences. The Bus in Guideway, Highway, and Combination alternatives would all require widening of the highway and elevating the eastbound lanes. Widening would add about 1 dB(A), and the elevated lanes would increase noise levels another 1 to 2 dB(A) due to the airborne travel of the noise. These increases would be in addition to the source increases discussed in section 3.12.2.1.

Area 2: Safeway area. Traveling west, the highway rises and travels along a bench, with the highest point near the Safeway grocery store. Figure 3.12-6 illustrates a cross section of the terrain in this area. The northern edge of the highway would act as a barrier to noise, such that levels at the toe of the highway embankment could in some cases be lower than those further out (where the edge of the highway does not act as a barrier). Elevating the eastbound lanes would not affect the situation appreciably in this area because the edge of the elevated structure would also act as a barrier.

Area 3: Downtown. Near the downtown area, the highway is coming off the bench to the east, travels directly adjacent to downtown, and climbs again to the west. As a result, a large portion of the highway would be visible from downtown. A wall adjacent to downtown would not substantially reduce noise levels because portions of the highway would be visible over the wall to the east and west where it is climbing in elevation. Exacerbating this situation would be the presence of large cliffs on the south side of the highway, which would have the potential to reflect some noise back toward the downtown area. Structured lanes would increase the visibility, and therefore, the audibility of I-70 from certain locations in town where line of sight is currently blocked by a building or by terrain but would not be with the elevated highway. A wall placed along the elevated roadway would be effective.

Area 4: West end of town. The highway climbs again to the west and is above adjacent residences in some stretches. In general, the ground slopes upward to the north such that residences and businesses further from the highway are higher than those closer to it. There is an existing noise wall on the west end of town between mileposts 239 and 240. The wooden wall is 1,168 feet long and approximately 15 feet tall. The Rail with IMC alternative would benefit from this wall, while the AGS alternative would not. The wall would not reduce noise from the elevated eastbound lanes, resulting in an additional increase of approximately 5 dB(A) unless a wall is constructed along the elevated lanes as well.

Figure 3.12-6. Idaho Springs Cross Section, Eastbound View



Summary of Predicted Noise Levels

Table 3.12-6 summarizes predicted noise levels at seven locations throughout the Corridor. Noise levels were predicted for the "loudest hour" at a distance of 250 feet.

This table provides general quantitative information by alternative for the seven Corridor locations mapped and discussed in this section. Note that a maximum increase of 8 dB(A) is predicted for any alternative.

In general, the AGS is predicted to generate noise at a similar level to the No Action alternative, with the Rail with IMC somewhat higher. The Highway alternatives would result in a greater increase in "loudest hour" noise levels than would the Rail with IMC or AGS alternatives. The Combination Six-Lane Highway with Rail and IMC alternative would result in the greatest increases in "loudest hour" noise levels.

Figure 3.12-7 through Figure 3.12-12 show the location of the 66 dB(A) noise level contour for both existing and future conditions. The future condition shown is that of the loudest alternative (Combination alternatives). All of the area between the highway and the contours has a predicted noise level that equals or exceeds CDOT's 66 dB(A) NAC for residential land use. Also shown in the figures are the noise measurement locations (M1 through M4).

Table 3.12-6. Predicted Noise Levels

Area (West to East)	Alternative	Existing "Loudest Hour" Noise Level 250 Feet from Center of I-70 (dB(A))[1]	2025 "Loudest Hour" Noise Level 250 Feet from Center of I-70 (dB(A))	Comments
Dowd Canyon	No Action	60	62	Assumes transit on existing RR line
	Minimal Action		62	
	Rail with IMC		67	
	AGS		63	
	6-Lane Highway (55 mph) and Reversible/HOV/HOT Lanes		63	
	6-Lane Highway (65 mph)		Decrease*	
	Combination 6-Lane Highway with Rail and IMC		68	
	Combination 6-Lane Highway with AGS		63	
Vail	No Action	65	67	Assumes transit in median
	Minimal Action		67	
	Rail with IMC		69	
	AGS		68	
	Combination 6-Lane Highway with Rail and IMC		**	
	Combination 6-Lane Highway with AGS		**	
Dillon Valley (Assumes construction of noise wall.)	No Action	59	60	All alternatives would be behind the existing noise wall
	Minimal Action		60	
	Rail with IMC		61	
	AGS		60	
	Dual-Mode Bus in Guideway		60	
	Diesel Bus in Guideway		61	
	Combination 6-Lane Highway with Rail and IMC		**	
	Combination 6-Lane Highway with AGS		**	
Silver Plume	No Action	57	58	Assumes existing noise wall remains or is rebuilt
	Minimal Action		58	
	Rail with IMC		59	
	AGS		58	
	Dual-Mode Bus in Guideway		58	
	Diesel Bus in Guideway		59	
	Highway Alternatives		60	
	Combination 6-Lane Highway with Rail and IMC		61	
	Combination 6-Lane Highway with AGS		60	
Georgetown	No Action	53	54	Location
	Minimal Action		56	
	Rail with IMC		55	
	AGS		54	
	Dual-Mode Bus in Guideway		54	
	Diesel Bus in Guideway		55	
	Highway Alternatives		56	
	Combination 6-Lane Highway with Rail and IMC		57	
	Combination 6-Lane Highway with AGS		56	
Lawson, Downieville, and Dumont	No Action	65	66	Assumes transit in median
	Minimal Action		66	
	Rail with IMC		67	
	AGS		66	
	Dual-Mode Bus in Guideway		66	
	Diesel Bus in Guideway		67	
	Highway Alternatives		68	
	Combination 6-Lane Highway with Rail and IMC		69	
	Combination 6-Lane Highway with AGS		68	
Idaho Springs	No Action	65	65	Assumes structured elements
	Minimal Action		65	
	Rail with IMC		67	
	AGS		66	
	Dual-Mode Bus in Guideway		66	
	Diesel Bus in Guideway		67	
	Highway Alternatives		68	
	Combination 6-Lane Highway with Rail and IMC		69	
	Combination 6-Lane Highway with AGS		69	

[1] *Values modeled for year 2000 using year 2000 data, for the purpose of providing an appropriate comparison point.*

* *Noise levels would decrease. The amount of reduction would depend on what becomes of the abandoned section of I-70.*
** *No highway improvements in this area; therefore, the "loudest hour" noise level would be the same as the single-mode alternative.*

Potential to Exceed CDOT Guidelines

As stated previously, CDOT guidelines state that noise mitigation must be considered for any receptor or group of receptors where predicted traffic noise levels, using future traffic volumes and roadway conditions, equal or exceed 66 dB(A) for residences (see Table 3.12-2), and where design year levels are project to be 10 dB(A) or more above existing levels. In general, the latter will not be the case.

The 66 dB(A) contours show that the residences adjacent to I-70 in most towns are affected and will require some sort of mitigation analysis. While it is not feasible to show the differences in the contours for each alternative at this Tier 1 level, it is likely that the number of affected residences will follow the pattern of the predicted levels shown in Table 3.12-6. That is to say, AGS would be similar to No Action and would affect the fewest residences, followed by Rail with IMC. The Highway alternatives would affect a higher number of residences than Rail, and the Combination alternatives would result in the greatest number of residences requiring mitigation analysis.

3.12.2.4 Indirect Impacts

One potential indirect noise impact on this project would be traffic traveling to transit stations. The main roads that feed the stations would see an increase in traffic volume. Noise levels would increase 3 dB(A) for every doubling of traffic volume, provided there is no congestion.

A second potential indirect noise impact would be that related to induced growth. Additional growth in the area would result in more background noise, such as that from traffic on local streets, building construction, and people going about daily activities such as mowing the lawn. On a long-term average basis, noise levels would increase by 3 dB(A) for every doubling of the population. Higher, shorter term increases would result, such as those that would exist near a new home being constructed.

3.12.2.5 Construction Noise

Construction of the action alternatives would generate noise from diesel-powered earthmoving equipment such as dump trucks and bulldozers, backup alarms on certain equipment, compressors, or pile drivers. There would be the potential for impact because this equipment would need to operate in close proximity to residences and businesses. Also, given the magnitude and complexities of the proposed action alternatives, nighttime work would likely be required, and work would be ongoing for months to years. Construction noise at offsite receptor locations usually depends on the loudest one or two pieces of equipment operating nearby. Noise levels from diesel-powered equipment would range from 80 to 95 dB(A) at a distance of 50 feet. Impact equipment such as rock drills and pile drivers could generate louder noise levels.

Construction noise impacts could be mitigated by limiting work to certain hours of the day where possible, requiring the use of well-maintained equipment (particularly with respect to mufflers), modifying backup alarm systems within acceptable safety guidelines, locating haul roads, and providing public outreach.

Construction noise is addressed in both CDOT and FHWA noise policies, but on a qualitative basis only. Both policies suggest that a quantitative analysis of construction noise be considered for large, complex projects. This is the case here, and such an analysis should be conducted as part of any Tier 2 environmental studies that are conducted. Both CDOT and FHWA policies advocate the use of "common sense" mitigation measures.

Construction noise is subject to local ordinances. Most of the towns in the Corridor have only "nuisance" codes in place and do not specifically address construction noise. One exception is Vail, where construction noise is limited to 90 dB(A) between 7:00 AM and 7:00 PM.

Construction activities could produce considerable vibration levels, particularly pile driving, blasting, and drilling. FTA noise and vibration impact assessment procedures provide limits for both damage and annoyance from vibration. The damage criterion addresses historic structures, which is relevant to this project. A more detailed analysis should be conducted as part of any relevant Tier 2 environmental studies.

3.12.3 Mitigation Strategies to Reduce Highway Noise Levels

A number of noise mitigation strategies can be applied to reduce highway noise. A brief description of each is provided below, along with information as to its applicability to the Corridor. The following mitigation measures are considered general noise abatement techniques. Table 3.12-7 provides examples of site-specific treatments at community locations, their anticipated effectiveness, and possible concerns associated with their implementation. It should be noted that while these site-specific treatments show what the mitigation effectiveness could be, they are not recommended or proposed at this time. These measures will be considered where applicable in future Tier 2 studies. Noise mitigation measures will be evaluated for properties during these studies that meet the impact criteria under the appropriate regulations (FHWA/FTA) based on the future proposed alternatives.

3.12.3.1 Noise Walls

Strategy

Noise walls are the most commonly employed form of noise mitigation. They reduce noise by blocking the line of sight between a source and a receptor, therefore, forcing the sound waves to diffract over the top of the wall. Noise walls are typically placed along the shoulder of the roadway and can be placed on structures (such as bridges and elevated roadways), if necessary. They can, in certain circumstances, be placed outside the I-70 right-of-way. This would be appropriate for residences on a hill, where a wall along the roadway would not break line of sight. The cost-benefit of walls is taken into account by calculating the "cost per benefited receptor per dB(A) of reduction." In terms of benefit, a 5 dB(A) reduction is required. Otherwise, the wall would be only minimally effective.

The most cost-effective way to increase the performance of a noise wall is to increase its height. However, height can be limited in some situations due to aesthetics or weight (for walls on structure), or shading of icy roadways. Absorptive treatments to reduce noise barrier reflections back into unprotected areas could enhance their effectiveness, as could irregular wall top patterns or curved or branched elements on the wall top.

Noise Reduction

When residences are level with the highway, a 15-foot-tall wall would provide approximately 5 to 10 dB(A) of noise reduction. This would be a noticeable reduction, but the highway would still be audible. This would apply only to residences located within 100 to 200 feet of the wall. Residences further back, or those located on a hill overlooking the highway, would experience less reduction.

3.12.3.2 Noise Berms

Strategy

Noise berms are typically preferred over walls for aesthetic reasons, particularly in the mountain environment. The main issue with berms is space, as they require a footprint that is about six times their height (that is, a 15-foot-tall berm requires a footprint of 90 feet). This sort of land often does not exist in developed areas. CDOT has, over the past few years, been constructing earthen berms along parts of the Corridor.

Noise Reduction

Noise berms would provide equal or better reduction than a noise wall of the same height. Also, they would reflect very little noise to the other side of the road, which could be an issue with walls.

3.12.3.3 Small Concrete Barriers ("Jersey Barriers")

Strategy

The 3-foot-tall solid concrete barriers, which currently separate the eastbound and westbound lanes of I-70 in many locations, would form the guideway for the Bus in Guideway alternatives and would separate the Rail with IMC alternative from the highway, thus providing some noise reduction.

Noise Reduction

Three to 5 dB(A) of reduction could be achieved from tie noise for residences that are located (1) within 200 feet of the highway and (2) below the elevation of I-70 by at least 5 to 10 feet. Very little, if any, reduction would be provided by these barriers for residences located beyond 200 feet from the highway or those elevated above it.

3.12.3.4 Reducing Speed Limits

Strategy

On I-70, speeds range from approximately 55 mph in curvy and hilly areas east of Idaho Springs, to 65 mph in Vail, to 75 mph in central Eagle County. A reduction in speed would result in a reduction of noise levels. Speed reduction, of course, depends on enforcement.

Noise Reduction

Realistically, it would not be feasible to reduce speed limits by more than 10 mph. If this were accomplished, it would reduce noise levels by only 1 to 1.5 dB(A). This reduction would be perceptible to some and not others, as the ability to perceive small changes in noise levels is a complex and subjective phenomenon.

3.12.3.5 Acquisition of Property to Form Buffer Zone

Generally, this mitigation measure is a viable alternative only for undeveloped lands where noise impact prevention is the goal. This would be difficult to implement on this project because I-70 is generally located in narrow valleys that are already at least partially developed.

3.12.3.6 Alteration of Horizontal Alignment

To provide a perceptible noise reduction (at least 3 dB(A)) at a given receptor, the distance that currently exists between the receptor and the highway would need to be doubled. This would not be a viable mitigation option in the Corridor, given the land constraints. Also, in many cases this action would only shift impact on receptors on the opposite side of the highway, and it would be extremely costly.

3.12.3.7 Alteration of Vertical Alignment

Changing the vertical alignment of I-70, that is, lowering its elevation by depressing it into the ground, could provide a considerable noise reduction at roadside receptors. This option would not be feasible in many areas along the Corridor due to drainage and floodplain issues, which would prohibit construction. It would be feasible in other areas in terms of constructibility, but the costs would be substantial. The idea of depressing I-70 into the ground and covering it with a structure has been discussed in Vail, as the land it would create for development could help offset the cost.

3.12.3.8 "Jake Brakes"

The use of unmuffled "jake brakes" by large trucks is an annoyance issue in the Corridor. Noise walls are minimally effective in reducing this noise, as it is generated at the mouth of the exhaust stack, which is located as much as 10 feet off the surface of the road. "Jake brake" noise is effectively reduced if the truck is equipped with a working muffler. Enforcement of muffler use is the most direct noise mitigation measure. Existing state law imposes a $500 fine for commercial vehicles that have no muffler.

3.12.3.9 Noise Insulation of Buildings

The insulation or soundproofing of buildings typically involves the installation of double-pane windows that are specially designed to provide a high degree of noise attenuation. CDOT guidelines state that noise insulation be applied only to public or nonprofit buildings, such as schools and churches, unless there is a severe impact (absolute noise levels of 75 dB(A) or an increase of 30 dB(A) over existing levels) and other exterior noise mitigation measures are as cost-effective.

3.12.3.10 Pavement Type

Different pavements exhibit different levels of noise for a given traffic flow. Current research indicates that new asphalt is somewhat quieter than new concrete. However, how long, in terms of years, this benefit lasts is unclear. It is known that concrete is generally more cost-effective than asphalt in the long term. Therefore, at this time, asphalt is not viewed as a noise mitigation measure in and of itself.

3.12.3.11 Active Noise Control

Active noise control is a method where noise from the source of interest is measured with a microphone; speakers then broadcast the measured noise after it has been digitally processed to be 180 degrees out of phase with the incoming noise. The noise from the speakers then cancels out the undesired sound. This technology has been applied with some success to noise inside aircraft and to engines. However, the technology is nowhere near advanced enough to be applied to highways.

Table 3.12-7. Possible Mitigation Examples and Potential Effectiveness

Area	Alternative	Example Mitigation	Likely Effectiveness	Concerns With Mitigation
Dowd Canyon	Rail with IMC	Wall along rail line	10 dB(A) of reduction at ground level condos	Visual
	• 6-Lane Highway 55 mph • Reversible/HOV/HOT Lanes	Enhance existing landform	Additional 3 dB(A) of reduction	None identified
	6-Lane Highway 65 mph	Relocation of highway	5 to 15 dB(A) of reduction	Visual
Vail	Combination 6-Lane Highway with Rail and IMC	Wall along highway	10 dB(A) to south where houses are lower in elevation; 0 to 5 dB(A) at residences to the north	Effectiveness, reflection of noise to opposite side of highway, aesthetics, blocking of views, icing
Dillon Valley	All	Wall-berm combination	5 to 10 dB(A)	Wall-berm is in place
Silver Plume	Rail with IMC	• Use of rail bed as barrier • Wall	5 to 10 dB(A)	Visual
	• Bus in Guideway alternatives • Highway alternatives	Wall along highway	5 to 10 dB(A)	Reflection of noise to opposite side of highway, aesthetics
Georgetown ("flats" area)	All	Berm on south side of highway	3 to 5 dB(A)	Residents somewhat distant from highway
Lawson, Downieville, Dumont	Rail with IMC	• Lawson: Wall along south side of highway • Downieville: Wall along rail alignment in front of town • Dumont: Wall along north side of rail alignment	• Lawson: Very effective due to houses being close to highway and lower in elevation • Downieville: Ineffective, as highway would need to mitigated too • Dumont: Would effectively block both rail and highway noise, as I-70 is in a cut	• Lawson: Icing on I-70 • Downieville: Cost and complexity of walls near interchange versus benefit • Dumont: Reflection of noise to residences on south side of highway
Idaho Springs	Rail with IMC	Wall along north side of highway	5 to 10 dB(A) in east and west parts of town; 0 to 5 dB(A) in central part of town and residents to north that are higher in elevation	Effectiveness, aesthetics, icing, reflection of noise to opposite side of highway
	Bus in Guideway alternatives	Wall along north side of highway and elevated roadway	5 to 10 dB(A) in east and west parts of town; 0 to 5 dB(A) in central part of town and residents to north that are higher in elevation	Effectiveness, aesthetics, icing, reflection of noise to opposite side of highway
	Highway alternatives	Wall along north side of highway and elevated roadway	5 to 10 dB(A) in east and west parts of town; 0 to 5 dB(A) in central part of town and residents to north that are higher in elevation	Effectiveness, aesthetics, icing, reflection of noise to opposite side of highway

Notes:

At this time, mitigation was not discussed for the AGS alternative. If this alternative is advanced for future Tier 2 studies, it will be evaluated in greater detail.

The reductions provided for noise walls are approximate and apply only to residences located within 300 feet of the highway/rail line. Little to no reduction is provided at residences located 500 feet or more from the highway/rail line or for those located higher in elevation.

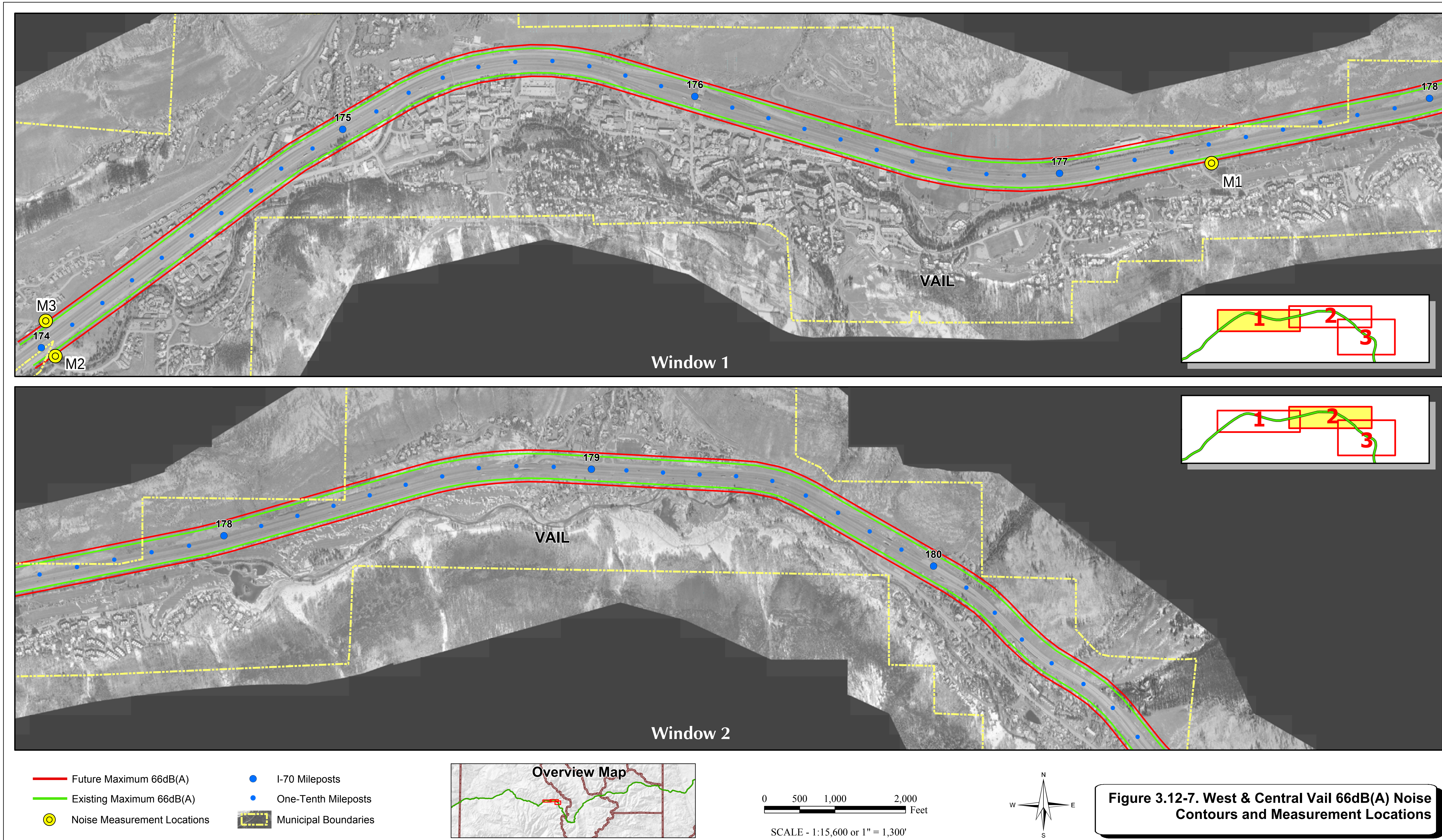


Figure 3.12-7. West & Central Vail 66dB(A) Noise Contours and Measurement Locations

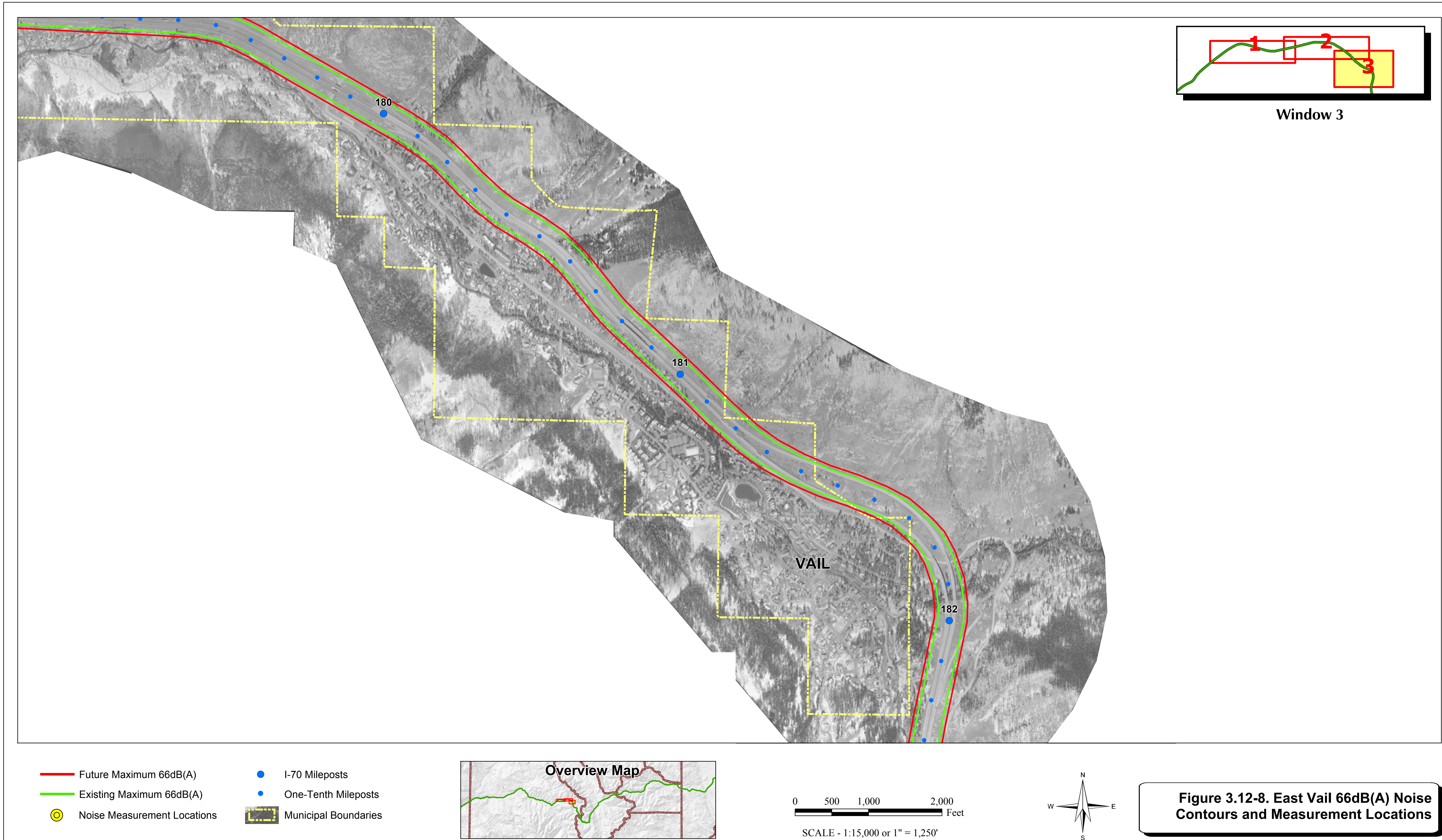


Figure 3.12-8. East Vail 66dB(A) Noise Contours and Measurement Locations

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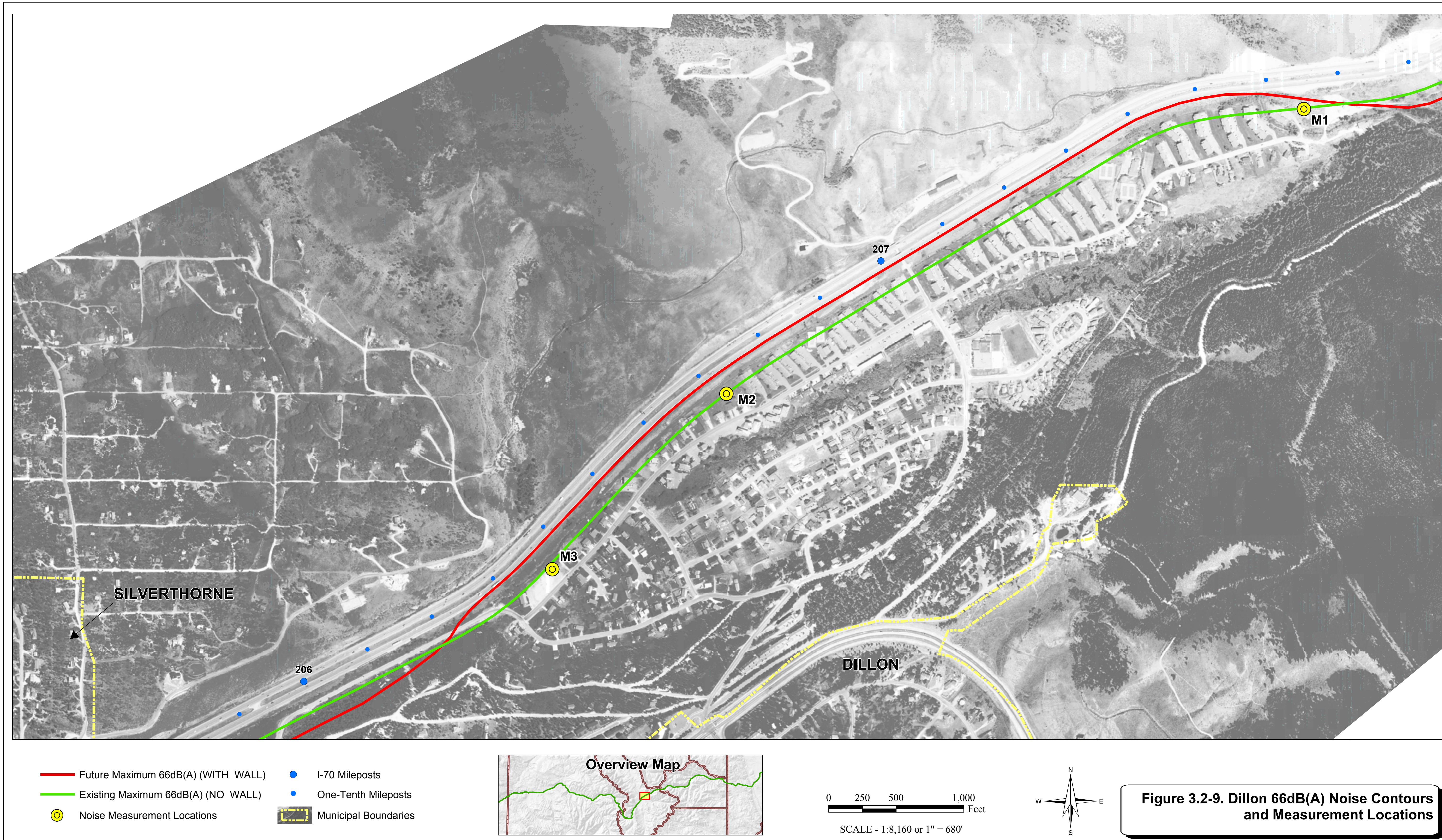

Figure 3.2-9. Dillon 66dB(A) Noise Contours and Measurement Locations

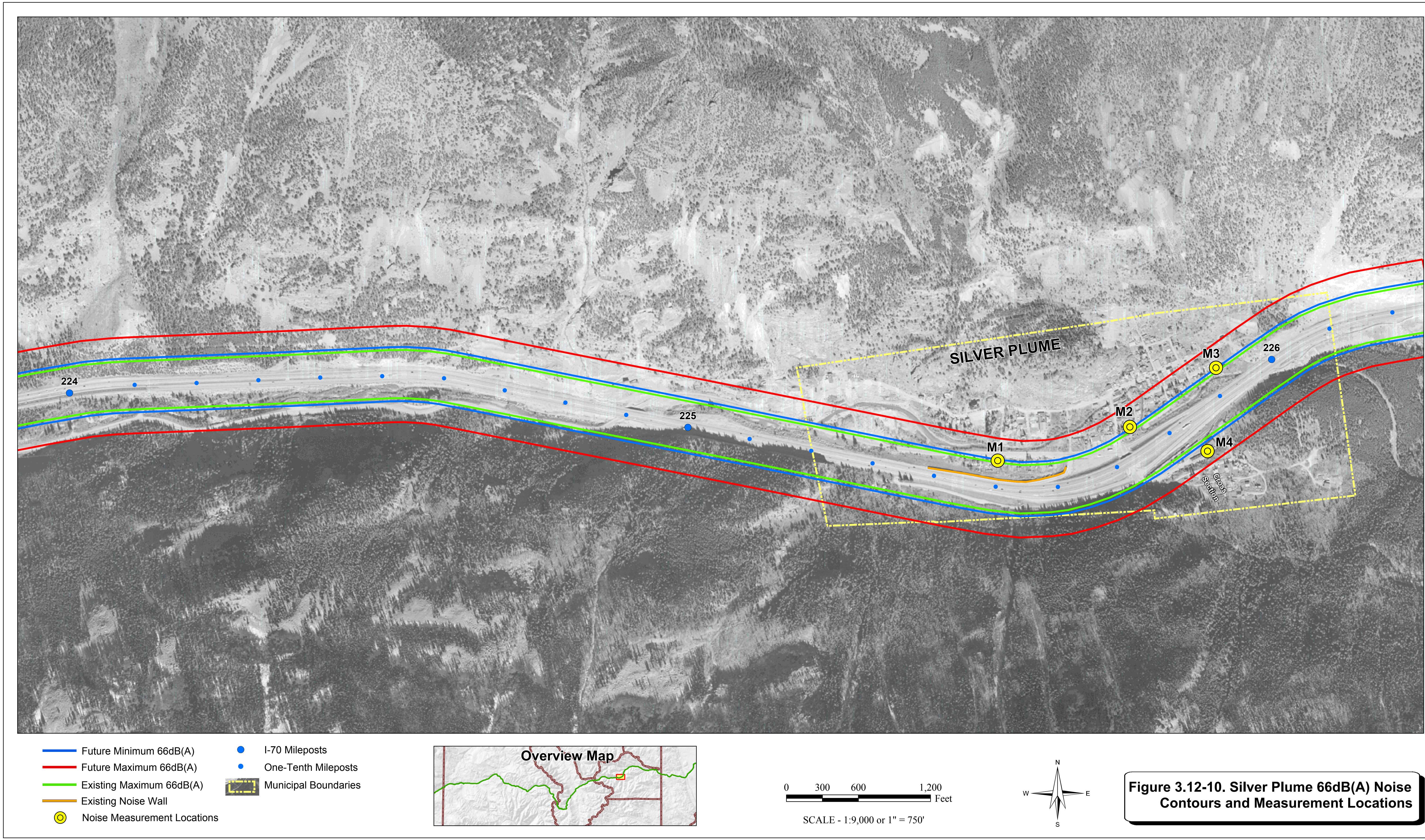

Figure 3.12-10. Silver Plume 66dB(A) Noise Contours and Measurement Locations

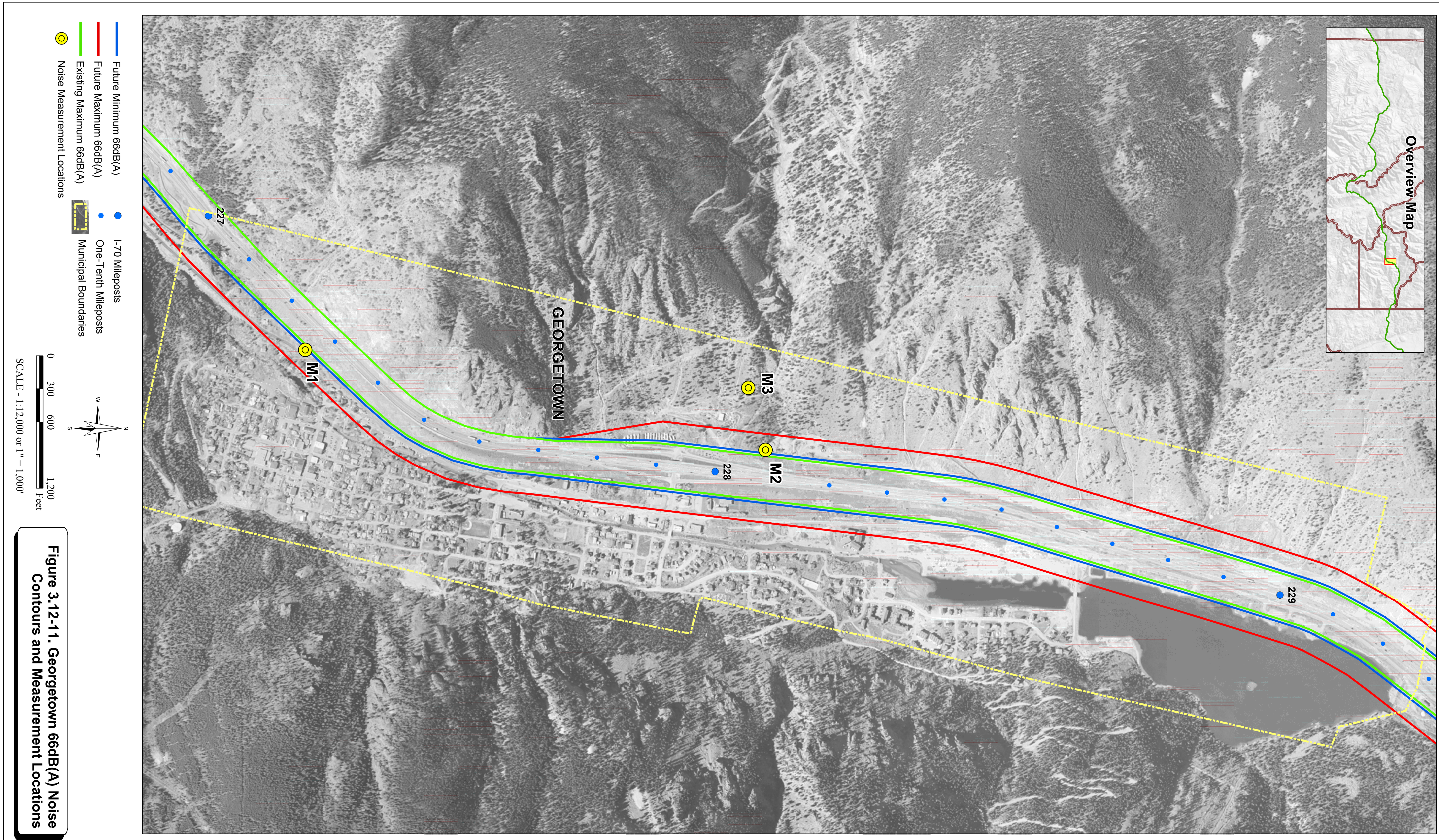

Figure 3.12-11. Georgetown 66dB(A) Noise Contours and Measurement Locations

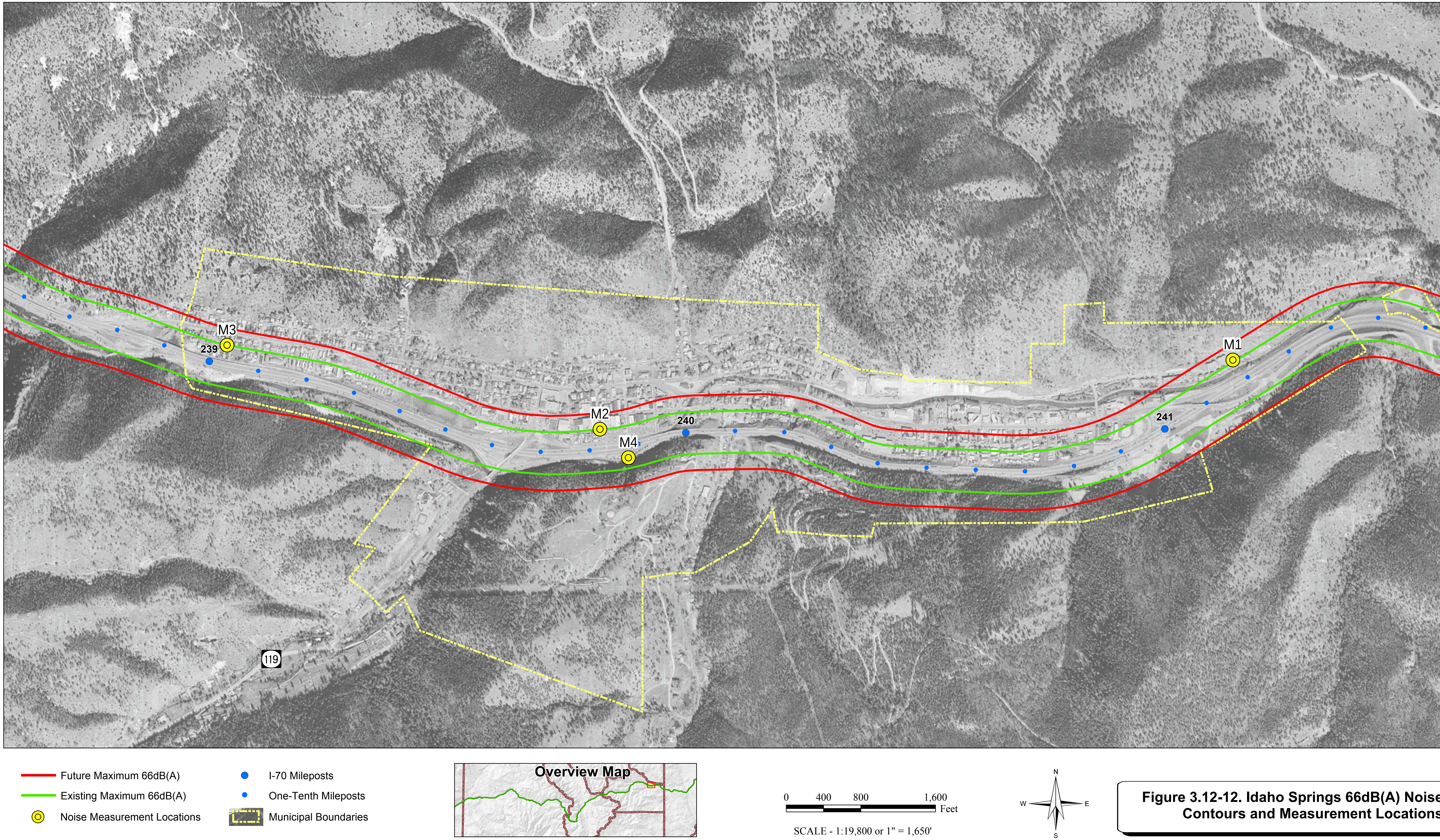

Figure 3.12-12. Idaho Springs 66dB(A) Noise Contours and Measurement Locations

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