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**Final Report**

# **SYNTHESIS OF PAVEMENT NOISE STUDIES CONDUCTED FOR THE COLORADO DEPARTMENT OF TRANSPORTATION**

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**December 2005**

**COLORADO DEPARTMENT OF TRANSPORTATION  
RESEARCH BRANCH**

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<b>16. Abstract</b> Highway traffic noise is a source of environmental pollution and noise control is an important consideration for the Colorado Department of Transportation (CDOT). Compliance with Federal noise regulations is required for all major Federally funded highway construction projects. CDOT personnel involved in traffic noise analysis should be familiar with previously completed noise impact studies. This compilation is intended to be a handy, concise reference source on road noise issues and mitigation practices in Colorado.  Implementation It is recommended that this report be used as a guide to the selection of acceptable pavement/tire noise abatement methods.			
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Report No. CDOT-DTD-R-2005-14

Prepared by  
Colorado Department of Transportation  
Research Branch

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## 1.0 INTRODUCTION

Pavement/tire noise has been studied for well over 30 years throughout the United States and in Europe. The engineers, designers, and administrators at the Colorado Department of Transportation (CDOT) often face questions regarding noise issues for which information already exists, either in documented form or as undocumented experience and practice. This information may be scattered throughout CDOT and collectively unevaluated. As a consequence, full knowledge of what has been learned about a noise issue may not be brought into the solution and costly research findings may not be used as efficiently as possible. Experiences from others within CDOT may have been overlooked and consideration may not have been given to others solving the same issue.

This study, “Synthesis of Pavement Noise Studies Conducted for the Colorado Department of Transportation,” provides a systematic means of assembling useful knowledge from all CDOT sources and prepares a concise summary on noise issues. This report, in compact format, does not include detailed directions which are found in handbooks or design manuals. A panel of experts on the Pavement Noise Subcommittee guided the work, evaluated the collected information, and reviewed the final synthesis report. This synthesis is a useful document that reports the practices that were acceptable within the limitations of the knowledge available at the time it was prepared. As progress in research and practice continues, new information will be added to that now at hand.

The development of this synthesis was accomplished by two discrete elements: an intensive CDOT Library search on noise and a collection of studies performed by the regions. The CDOT Library search, by Joan Pinamont, included Transportation Research Information Services. Pavement/tire noise information collected in the regions was provided by the Program Managers during the course of this study.

This synthesis is organized as follows:

- Section 2 summarizes research projects including the report title, number, and date published
- Section 3 summarizes project-specific noise studies in the State along with the title of the study, who prepared the study, and date published

## **2.0 RESEARCH PROJECTS CONDUCTED BY CDOT**

This section summarizes the research projects conducted by CDOT as of 2005 relevant to noise studies to provide a context for understanding in the focus of CDOT's efforts. This limited literature search describes the recent work on key topics related to noise including noise reduction, noise abatement, and surface texture. They provide insight to the direction CDOT research has taken over the last 30 years. Significant findings from future CDOT research projects will be added to the synthesis as they become available. For more information on noise research performed throughout the United States, a search using Transportation Research Information Service (TRIS) Online will provide a number of results.

**April 2004**

**Colorado DOT Tire/Pavement Noise Study**

**Report Number CDOT-DTD-R-2004-5**

**By: Doug Hanson and Robert James**

In October 2003 the National Center for Asphalt Technology tested 18 pavement surfaces, 12 Hot Mix Asphalt (HMA), and 6 Portland Cement Concrete Pavement (PCCP), located throughout Colorado. The Department selected all the sites to be tested. All testing was done at 60 mph using a Goodyear Aquatred and a Uniroyal TigerPaw. Three tests were conducted with each tire on each pavement surface.

The following conclusions regarding noise were drawn from the testing that was accomplished.

- Longitudinal tining possesses adequate frictional properties, has lower noise levels than transverse tining, is easy to install, and costs less. Due to these benefits, CDOT adopted longitudinal tining as the preferred method of texturing concrete pavements.
- The quietest HMA pavement tested was the surface of the open-graded friction course.
- The age of a HMA pavement can have a major effect on the noise level of the pavement.
- On the recently built PCCP pavements (2 to 3 years old) the type of texturing procedure used did not seem to make much difference in the noise level of the pavement.
- The noisiest pavement tested in the study was an 11-year old transversely tined PCCP pavement.

**June 2001**

**Noise and Skid Measurements on US 285 in the Turkey Creek Canyon Area Project  
Number NH 2854-068**

**Report Number CDOT-R1-R-2001-9**

**By: Robert LaForce and Jill Schlaefer**

Under Project NH 2854-068, Region 1 constructed several test sections to evaluate possible treatments to address noise problems on Phase I and II of US 285 between mileposts 243.4 and 246.2. The tire noise from transverse tining causes an objectionable whine, which has resulted in complaints from area residents. The report included noise and skid measurements from several surface types in relatively close proximity. A measurement was taken before and after the concrete pavement was ground ¼-inch in order to remove the transverse tining.

The following conclusions regarding noise were drawn from the testing that was accomplished.

- From noise measurements taken near the road, the ¼-inch longitudinal grinding test section resulted in a reduction in the noise level of 6 decibels from the original transverse tined concrete. Although a noise level reduction of 6 decibels was achieved by this change in surface texture, this does not constitute noise abatement under federal regulations.
- The majority of the annoying frequency components from tire/pavement noise lie between 700 and 2000 Hertz. The average reduction in sound pressure level between 800 to 2500 Hertz was 7 decibels for this test section.
- The current standard surface finish for concrete pavement (longitudinal tining) resulted in comparable noise level values to the ground surface and the 3/8-inch stone matrix asphalt surfacing.
- The reduction in noise level after grinding away the transverse tining is very similar to those reported in a recent Wisconsin report, "Noise and Texture on PCC Pavements" Report No. WI/SPR-08-99. The noise levels for the other surface treatments are also similar to those reported in the above-mentioned report.

**January 2000**

**PCCP Texturing Methods**

**Report Number CDOT-DTD-R-00-1**

**By: Ahmad Ardani and William (Skip) Outcalt**

This report presents a 5-year evaluation and construction details of nine test sections with varying textural properties. Included in the report is an overview of the methodologies used to texture concrete pavement surfaces and their impact on noise properties. To examine noise properties of the test sections, noise measurements were acquired inside the test vehicle, 3 feet away from the right driving lane and near the right rear tire in order to acoustically assess the impact of various surface textures. The sound pressure level (SPL) generated at the control section was normalized to represent a datum (zero SPL), and were compared with the SPL taken from other test sections. The preliminary

information used in this report can be found in CDOT Report Number CDOT-DTD-R-95-2 entitled "PCCP Texturing Methods."

The following conclusions regarding noise were drawn from the testing that was accomplished.

- The Portland Cement Concrete (PCC) surface texture has a profound effect on the traffic-induced noise characteristics generated at the interface of the tire and the pavement surface.
- Longitudinal macrotexture and microtexture were the quietest surfaces based on the SPL taken inside the vehicle, at the shoulder, and at the rear tire.
- The CDOT standard section (combination of burlap drag and uniform 1 inch spacing) exhibited the highest noise level among the test sections with the microphone at the rear tire position.
- SPL taken at the shoulder showed the A-weighted decibel of a semi-truck to be approximately 7 decibels higher than the A-weighted decibel of the test vehicle.
- Automobiles and heavy truck noise measurements show that the ¾" saw cut tined pavement provides a lower noise level at 300' and 600' than the pavement with no tining and the pavement with ¾" rake drag tining.
- At 300' the measurements show that the ¾" saw-cut tined pavement with longitudinal Astro Turf drag texture is 5 to 7 dB(A) quieter than the ¾" rake drag tined and the no-tined pavement. At 600' the improvement is only 1 to 3 dB(A).

## **February 1995**

### **Reference Energy Mean Emission Levels Used in STAMINA 2.0 for Highway Noise Prediction in the State of Colorado Report Number CDOT-R-TG-95-6**

**By: Louis Cohn**

**The Technology Group  
14300 Wakefield Place  
Louisville, Kentucky 40245**

This report documents the tests done on noise emission levels found on vehicles in Colorado. It justifies modifications of the STANDARD Method in Noise Analysis (STAMINA) 2.0 traffic noise prediction model for use in Colorado. Three sets of noise level measurements were made at two locations on Colorado 470 south of Denver. Two sets of measurements were taken at milepost 11.15 and one set at milepost 2.3. Traffic volumes and mix, as well as average vehicle speed, were recorded during each measurement period.

The following conclusions regarding noise were drawn from the study that was accomplished.

- The STAMINA 2.0 model tended to over-predict the emissions.
- CDOT was allowed by FHWA to change the emission rates in STAMINA 2.0.
- The change in the model has reduced the cost of noise mitigation by reducing height and extent of noise barriers.

**May 1973**  
**Noise Levels Associated with Plant Mix Seals**  
**Report Number CDOH-P&R-R&SS-73-3**  
**By: Lowell Steere**

This report investigates the relative level of noise produced by three types of tires on a moving motor vehicle when traveling on open-graded plant mix seals. Two types, known as Colorado Type "A" and Type "B" were compared with other pavement. Noise levels were measured inside the passenger compartment and outside, 25 feet from the vehicle, to provide noise levels experienced by both the passenger and the pedestrian.

The following conclusions regarding noise were drawn from the testing that was accomplished.

- The data collected indicates that the type of tire used in making noise measurements is not a critical factor for comparison studies.
- Variations in noise levels between different types of pavement, made by a common type of vehicle traveling at a moderate speed, are more significant when heard by a pedestrian than by a passenger.
- Colorado Type "A" open-graded plant mix seal coat produces significantly less traffic noise than other common Colorado pavements.

**December 1, 2002**  
**Noise Analysis and Abatement Guidelines**  
**By: CDOT Task Force**

The guidelines are intended to provide a consistent, equitable approach in addressing highway traffic noise and to foster a rational abatement decision-making process for highway projects within the State of Colorado. These guidelines are based on currently accepted practices and procedures used by CDOT and will be subject to review every three years. Interim amendments to the guidelines will be made on an as-needed basis.

### **3.0 CDOT PROJECT-SPECIFIC NOISE STUDIES AND ENVIRONMENTAL DOCUMENTS**

This section summarizes and inventories some of the significant project-specific noise studies conducted for CDOT as of 2005. This limited literature search describes work on key topics related to project-specific noise including noise reduction and noise abatement. They provide insight to the findings over the last 30 years. Significant findings from future CDOT projects will be added to the synthesis as they become available.

#### **May 2005**

##### **Wadsworth/Grandview Environmental Assessment**

**By: Parsons, Brinkerhoff, Quade, and Douglas**

Environmental Assessment to evaluate the environmental impacts of the construction of a grade separation at the intersection of Wadsworth Bypass (SH-121) and the Burlington Northern Santa Fe Railroad in Arvada.

The following conclusions regarding noise were drawn from the study that was performed:

- Noise impacts along the reconfigured Wadsworth Bypass (reconstructed under the BNSF) were identified for only one property, an open space area at the NE corner of Ralston Road and Wadsworth.
- Mitigation for this property was not found to be feasible or reasonable and was not recommended.
- Temporary noise impacts were identified due to the configuration of the temporary detour of Wadsworth Bypass to the west, which would be located much closer to a residential neighborhood. To alleviate these impacts, a temporary safety, noise, and visual barrier will be installed for the duration of the construction of the project.

#### **April 2005**

##### **Valley Highway Draft Environmental Impact Statement and Noise Technical Report**

**By: Fellsburg, Holt, and Ullevig**

Environmental Impact Statement to evaluate the environmental impacts of improvements to I-25 from Logan Street to US-6 (6<sup>th</sup> Avenue), US-6 from I-25 to Federal Blvd., and portions of Santa Fe Drive and Kalamath Street, to include crossings of the Consolidated Main Line Rail Corridor.

The following conclusions regarding noise were drawn from the study that was performed:

- Noise impacts were identified for several residential neighborhoods, parks, and commercial properties.

- Noise mitigation for one of these neighborhoods would be constructed as part of the T-REX project, while under this project noise mitigation was recommended for two residential areas adjacent to the project and one portion of the South Platte River bike trail that would be as little as 10 feet from the edge of the reconstructed I-25.

**October 2004**

**US-287, SH-1 to the Laporte Bypass Environmental Assessment**

**By: JF Sato and Associates**

Environmental Assessment to evaluate the environmental impacts of mobility and safety improvements to approximately 2 miles of US-287 from SH-1 to the Laporte Bypass intersection in Ft. Collins.

The following conclusions regarding noise were drawn from the study that was performed:

- Noise mitigation was found to be feasible and reasonable for three mobile home communities adjacent to SH-287 in Ft. Collins north of SH-1.
- 1,500 linear feet of noise barrier is recommended. Final configuration of the noise mitigation will be determined at the final design of the project.
- One portion of one of the communities lies outside of the immediate project construction area; however, for continuity an extension of that noise barrier will be evaluated.

**August 2004**

**Eagle County Airport Interchange and Connector Environmental Assessment**

**By: JF Sato and Associates**

Environmental Assessment to evaluate the environmental impacts of the construction of a new interchange on I-70 between Eagle and Gypsum in Eagle County and the construction of an intermodal connector road to the Eagle County Airport.

The following conclusions regarding noise were drawn from the study that was performed:

- Noise impacts were not identified for any existing residential properties.
- An examination of the future development plans in the area identified potential impacts to one future development, which is at this time listed as commercial.
- As in general commercial properties desire visibility, noise mitigation was not recommended for these properties.

**July 2004**

**US-285 Foxtan Road to Bailey Environmental Assessment**

**By: Carter-Burgess**

Environmental Assessment to evaluate the environmental impacts of proposed improvements to US-285 between Foxtan Road and Bailey in Jefferson and Park Counties. Improvements include roadway capacity increases, safety improvements, and construction of several grade-separated intersections at major intersections along the corridor.

The following conclusions regarding noise were drawn from the study that was performed:

- Impacts were identified to over 50 individual properties along the corridor, but most of these impacts could not be mitigated under CDOT feasibility and reasonableness criteria.
- One neighborhood was identified where noise barriers could be constructed that met the criteria, and a two-segment noise barrier approximately 1800 feet long was recommended for inclusion on the project.

**March 2004**

**SH-9 Final Environmental Impact Statement**

**By: Carter-Burgess**

Environmental Impact Statement to evaluate the environmental impacts of improvements to the SH-9 corridor between Frisco and Breckenridge.

The following conclusions regarding noise were drawn from the study that was performed:

- Noise mitigation was recommended for two neighborhoods in the corridor, one adjacent to Fairview Drive and one at the Farmer's Corner development.
- These noise barriers are currently under final design.

**March 2004**

**I-25 Improvements through Colorado Springs Urbanized Area Environmental Assessment**

**By: Wilson & Company**

Environmental Assessment to evaluate the environmental impacts of improvements to I-25 from Monument (SH-105) to Fountain (SH-16).

The following conclusions regarding noise were drawn from the study that was performed:

- This noise analysis evaluated over a dozen residential neighborhoods, several parks, and commercial districts, including hotels/motels, for noise-related impacts.
- 10 individual neighborhoods, three parks, and 12 hotel properties were evaluated for noise mitigation.
- Four neighborhoods were recommended for noise mitigation.
- Approximately 13,000 linear feet of noise barrier will be constructed in conjunction with the I-25 improvements.
- Of particular local interest along the project corridor were impacts to Monument Valley Park, a historic site. In response to a major coordination effort, various mitigation strategies, for both noise and visual effects, will be employed at the park. These recommendations include walls and berms for noise, and additional vegetation for visual and aesthetic improvements.

**April 2003**

**120<sup>th</sup> Avenue Extension, Quebec Street to US-85 Environmental Assessment**

**By: URS**

Environmental Assessment to evaluate the environmental impacts of the construction of a new roadway linking US-85 and Quebec Street in Adams County.

The following conclusions regarding noise were drawn from the study that was performed:

- This federally-funded local agency project will construct noise barriers for two residential neighborhoods along 120<sup>th</sup> Avenue in Adams County.

**August 2002**

**Nevada Avenue, Uintah – North**

**SMA Overlay Noise Study – Phase II**

**CDOT Project Number NH 0252-335**

**By: Hankard Environmental, Inc.**

This report documents the second phase of a study designed to measure the difference in roadside noise levels from traffic traveling on open-graded Stone Matrix Asphalt (SMA) versus Hot Mix Asphalt (i.e., HMA or Superpave). The study was conducted along Nevada Avenue, between approximately Uintah and Lilac Streets, in Colorado Springs, Colorado. CDOT needed to overlay Nevada Avenue, and decided to take this opportunity to gather some of its own data regarding the sound quality of SMA. The preliminary information used in this report can be found in the Phase I study dated August 2001.

The following conclusions regarding noise were drawn from the testing that was performed:

- After making adjustments for the differences in traffic volume and speed, the resulting noise levels for “new SMA” pavement were approximately 3 to 4 dB(A) less than the noise levels for “old HMA” pavement.
- The noise levels measured in front of “new HMA” were 0 to 2 dB(A) quieter. Therefore, it is possible that some of the benefit measured between “old HMA” and “new SMA” may be due to the “old” versus “new,” and not strictly due to “HMA” versus “SMA.”

**July 2002**

**I-70/SH-58 Interchange Environmental Assessment**

**By: CH2M Hill**

Environmental Assessment to evaluate the environmental impacts associated with improvements in the vicinity of the I-70/SH-58 interchange in Wheat Ridge, to include the construction of missing movements within the I-70/SH-58 interchange, traffic relief on local arterial streets, and relocation of existing I-70 ramps at 38<sup>th</sup> and 44<sup>th</sup> Avenues.

The following conclusions regarding noise were drawn from the study that was performed:

- Noise impacts were identified in several locations along I-70 from 35<sup>th</sup> Avenue to Kipling Street and along Youngfield Street in Wheat Ridge.
- In all cases, additional noise mitigation was not found to be feasible and reasonable.
- Existing noise mitigation in the area, particularly the noise barrier along the south side of I-70 from Tabor Street to Miller Street, continues to protect adjacent properties.

**June 2002**

**Interstate 25 Bijou to Fillmore Noise Wall Study**

**Region 2**

**By: Hankard Environmental, Inc.**

This report describes the results of a multifaceted acoustical study of two noise walls constructed along Interstate 25 in Colorado Springs, Colorado. The study had four objectives: measure the noise reduction of the noise walls, determine the accuracy of the noise model STandard Method In Noise Analysis (STAMINA) 2.0 in predicting noise reduction, determine if there is any negative effect of these walls running parallel, and determine how much noise is being reflected from the noise wall on the west side of Interstate 25 to the park and neighborhoods on the east side of Interstate 25. The wall on the west side of Interstate 25 extends for approximately two miles between Bijou Street and Fillmore Street. The wall on the east side of Interstate 25 extends for approximately 1,000 feet just south of Cache La Poudre Street.

The following conclusions regarding noise were drawn from the study that was performed:

- The average noise reduction, or average insertion loss (IL) at the residences closest to the wall was 6 dB (A). The average IL at points further from the wall, where less reduction is expected, was 5 dB(A).
- The STAMINA predicted values were within -2 to +3 dB(A) of the measured IL at the closer locations, with an average difference of 1 dB(A). At the further locations, the STAMINA predicted values were within -4 to +5 dB(A) of the measured IL, with an average difference of 0 dB(A).
- The effectiveness of the noise wall is predicted to be degraded by approximately 2 dB(A) at receptors behind the Monument Valley Park wall, and approximately 1 dB(A) at the receptors behind the Bijou to Fillmore noise wall.
- The predictions show that a 1 to 3 dB(A) increase could be expected from the reflections with an average increase of 2 dB(A).

### **May 2001**

#### **South I-25 Corridor and US-85 Corridor Final Environmental Impact Statement**

**By: PBS&J**

Environmental Impact Statement to evaluate the environmental impacts of improvements to the I-25 corridor from C-470 to south of Castle Rock, and to the US-85 corridor from C-470 to Castle Rock.

The following conclusions regarding noise were drawn from the study that was performed:

- Impacts were identified at seventeen different locations along the I-25 corridor and seven along the US-85 corridor.
- Noise barriers were analyzed for the impacted properties but only one barrier, an earthen berm, was recommended as it was the only one that met CDOT feasible/reasonable criteria.
- The primary reason for the majority of the negative recommendations was the fact that along these corridors the impacted properties are generally located on large lots, or are fairly isolated from each other. This is a major hindrance towards cost-effective noise mitigation.

### **February 2001**

#### **Noise Technical Report**

#### **US 24 – Pavement Noise Study**

**By: Hankard Environmental, Inc.**

This report documents a study that measured the difference in noise levels from traffic traveling on ultra-thin bonded wearing course (NovaChip), compared to traffic traveling on “standard asphalt” pavement. Measurements were conducted on U.S. 24 east of Colorado Springs, Colorado in September 2000. Measurements were conducted using

actual traffic, instead of a test vehicle, at distances of 25, 300, and 600 feet from the highway in order to determine the effects of the pavement where residences typically exist along highways.

The following conclusions regarding noise were drawn from the testing that was performed:

- For automobiles, the measurements show that NovaChip is 4 to 5 dB(A) quieter than standard asphalt within 300 feet of the roadway, but only 2 dB(A) quieter at 600 feet.
- For heavy trucks, the measurements show that NovaChip is 2 to 4 dB(A) quieter than standard asphalt within 300 feet of the roadway, but only 1 dB(A) quieter at 600 feet.

### **January 2000**

#### **North End Neighborhood Noise Study**

**By: Hankard Environmental, Inc. and Wilson & Company**

The study was designed to determine noise levels from July 1 through September 24, 1999 in the North End Neighborhood approximately bounded by Jackson Street on the north to Boulder Street on the south and Nevada Avenue on the east to I-25 on the west. The goals of the study were to determine the major source of noise, research the acoustical benefit of the range of noise mitigation measures available to reduce traffic noise, and determine which mitigation effort might help reduce noise levels in the North End Neighborhood.

The following conclusions regarding noise were drawn from the study that was performed:

- Noise levels from I-25 are greatest during the a.m. rush hour, and noise levels from local roads are greatest during the p.m. rush hour. Average daytime noise levels ranged from 54 to 64 dB(A) at residences adjacent to Nevada Avenue and at residences on the east edge of Monument Valley Park with an unobstructed view of I-25. Average nighttime levels ranged from 46 to 58 dB(A) with the quietest levels measured in the Wood Avenue area and the loudest levels measured at locations with unobstructed views of I-25.
- Analysis of the correlation between noise and traffic data indicates that I-25 is the predominate noise source within the North End Neighborhood from Monument Valley Park east to approximately Cascade Avenue. At Cascade, noise from local traffic, particularly Nevada Avenue, begins to be a factor.
- The most viable noise mitigation measure that can be applied to individual residences is the construction of structural barriers, particularly on the north and northwest sides of activity areas (i.e., decks and lawns).
- The increase in noise levels since the construction of the Bijou to Fillmore noise wall is approximately 1 dB(A). Therefore, the application of noise absorbent material to the east face of the noise wall would not provide any perceivable noise reduction in the North End Neighborhood.

**February 2000**

**SH-119 Ken Pratt Boulevard Extension Environmental Assessment**

**By: Carter-Burgess**

Environmental Assessment to evaluate the environmental impacts associated with the rerouting of SH-119 onto a new location through the extension of Ken Pratt Blvd. between Main Street and County Line Road in Longmont.

The following conclusions regarding noise were drawn from the study that was performed:

- Noise barriers for five areas were considered, with one mobile home community, located north of the new SH-119 alignment east of SH-287 (Main Street) being recommended for noise mitigation.

**December 1999**

**Southeast Corridor Final Environmental Impact Statement**

**By: Carter-Burgess**

Environmental Impact Statement to evaluate the environmental impacts of improvements to I-25 between Logan Street and Lincoln Avenue, I-225 between I-25 and Parker Road, and the construction of a light-rail line between Broadway and Lincoln Avenue and I-225 between I-25 and Parker Road.

The following conclusions regarding noise were drawn from the study that was performed:

- Noise barriers were recommended for all residential areas between Lincoln Street and south of Quincy Avenue for I-25, and from I-25 to Yosemite Street for I-225.
- In many cases, wooden noise barriers had been constructed adjacent to I-25 and I-225, which would need to be replaced with the project.
- Additionally, two masonry barriers along I-25, constructed in the late-1990s, would also have to be replaced.
- During the design-build stages of the T-REX project, the public approval process eliminated several noise barrier segments north of Downing Street, and reduced the size of the walls between Yale and Hampden Avenues.
- Overall, 8 to 10 miles of new noise barrier will be constructed, reducing noise levels from 5 to 10 decibels.

**December 1998**

**County Line Road, I-25 to Santa Fe Drive Environmental Assessment**

Environmental Assessment to evaluate the environmental impacts of improvements to County Line Road (between Arapahoe and Douglas Counties) from I-25 to Santa Fe Drive.

The following conclusions regarding noise were drawn from the study that was performed:

- The noise analysis evaluated several neighborhoods adjacent to County Line Road and recommended noise mitigation for the residential areas.
- The recommended noise mitigation will be constructed as separate phases of the project are completed.

**April 1998**

**US-287 Relocation Environmental Assessment**

Environmental Assessment to evaluate the environmental impacts of the upgrade of US-287 between SH-402 and the Little Thompson River and establish a bypass route for US-287 around the town of Berthoud.

The following conclusions regarding noise were drawn from the study that was performed:

- Mitigation was recommended for portions of the expanded US-287 adjacent to existing residential properties.
- The bypass alternative wound up impacting only 10 properties rather than over 200 with the existing alignment alternative.

**October 1997**

**I-25/SH-50/SH-47 Environmental Assessment**

Environmental Assessment to evaluate the environmental impacts of improvements to the north portion of I-25, SH-50, SH-47, and surrounding roads in the North Pueblo Commercial District.

The following conclusions regarding noise were drawn from the study that was performed:

- The noise analysis for this project recommended construction of a noise barrier along the south side of SH-47 east of I-25 in Pueblo.

**August 1997**

**State Highway 82 Entrance to Aspen Final Environmental Impact Statement**

Environmental Impact Statement to evaluate the environmental impacts of improvements to SH-82 between the Pitkin County Airport and Rubey Park in downtown Aspen.

The following conclusions regarding noise were drawn from the study that was performed:

- This study followed the results of a Supplemental Draft Environmental Impact Statement that evaluated four additional project alternatives and arrived at an overall modified alternative as the preferred.
- The noise analysis identified 13 noise impacts.
- In the Record of Decision, a noise analysis was committed to at final project design for the area between the Castle Creek Bridge and 7<sup>th</sup> & Main Street.

**December 1996**

**C-470 Extension Environmental Assessment**

**By: Carter-Burgess**

Environmental Assessment to evaluate the environmental impacts of the extension of C-470 from I-70 to US-6 and for completion of the C-470/I-70 interchange.

The following conclusions regarding noise were drawn from the study that was performed:

- Noise mitigation was recommended for the Golden Terrace Mobile Home Park, located at the SW corner of the C-470 extension segment and existing US-6 (6<sup>th</sup> Avenue).
- This EA also recommended further evaluation of the area at final design of subsequent project phases.

**August 1996**

**Parker Road (SH-83)/I-225 Interchange Final Environmental Impact Statement**

Environmental Impact Statement to evaluate the environmental impacts of improvements on Parker Road between Peoria Street and Hampden Avenue to include reconstruction of the interchange at I-225.

The following conclusions regarding noise were drawn from the study that was performed:

- This noise study examined noise impacts to the areas directly adjacent to the interchange and the areas along existing roadways that feed into the interchange.

- Noise mitigation was recommended and constructed for residential neighborhoods on both sides of I-225 from the Parker Road interchange to Yale Avenue.
- Mitigation was considered for impacted properties at the Parker Road/Hampden Avenue interchange, but this mitigation was not recommended.

**October 1993**

**State Highway 82 East of Basalt to Buttermilk Ski Area Final Environmental Impact Statement**

This study examined the environmental impacts associated with proposed improvements to SH-82 between Basalt and the Buttermilk Ski Area. This document did not consider the SH-82 entrance to Aspen, which was done under a separate study.

The following conclusions regarding noise were drawn from the study that was performed:

- The noise analysis identified noise impacts to numerous properties within the 11-mile corridor.
- Project design actually reduced noise levels to several properties.
- Mitigation was found to be feasible and reasonable for two locations along the corridor.

**November 1992**

**Corridor Improvement Feasibility Study**

**I-25 Colorado Springs**

**By: Felsburg Holt and Ullevig**

This study describes a range of safety and capacity improvements to I-25 through Colorado Springs, recommends a multi-year corridor improvement plan, and summarizes the environmental effects associated with the improvement plan. The focus of this synthesis will be on the study and findings regarding noise. The studies were prepared in accordance with the policies and procedures of the FHWA and were consistent with the requirements of the National Environmental Policy Act of 1969. The noise analysis was prepared to evaluate existing and future traffic noise levels along the entire I-25 corridor, including existing noise, year 2010 noise with no freeway improvements, and year 2010 noise levels with the long-range regional plan.

The following conclusions regarding noise were drawn from the study that was performed:

- The noisiest conditions occurred during off peak hours when traffic volume is lighter, truck traffic is heavier, and speeds are faster than during the more congested peak hours.
- There is no difference in worst case noise levels between the existing and no build conditions, although the time of day and duration may be somewhat different.

- In the areas where no additional right-of-way will be acquired, such as between South Academy Boulevard and Circle Drive, the plan averaged about 2 dB(A) higher than the existing or no freeway improvement levels.
- In the section between Bijou and Fillmore Streets west of I-25 where a row of houses will be removed, the reduced noise shielding and closer roadway proximity produce noise levels about 3 to 10 dB higher than the no freeway improvement levels.
- In the existing and no freeway improvement conditions, 474 residential units are exposed to noise levels that approach or exceed the 67 dB(A) guideline, while 10 commercial properties approach or exceed the 72 dB(A) criterion. In the plan, approximately 20 more residential units and 35 more commercial properties would approach or exceed the guideline.
- Noise barriers were found to be the most viable noise abatement alternative.
- Earth berms may be used in combination with walls where the terrain and right-of-way allow.

**April 1987**

**Social, Economic, and Environmental Results Report**

**North I-25 Corridor Study**

**By: Howard Needles Tammen and Bergendoff**

This report contains an assessment of the social, economic, and some environmental impacts of alternate modifications to the North I-25 corridor from 20<sup>th</sup> Street to 120<sup>th</sup> Street that will optimize the people-carrying capacity within the existing right-of-way. The noise analysis was prepared to evaluate existing and future traffic noise levels along the entire corridor for bus/HOV access locations.

The following conclusions regarding noise were drawn from the study that was performed:

- The 10 homes along the north side of 62<sup>nd</sup> Avenue are currently exposed to noise levels from 72 to 79 dB(A) which exceed the 67 dB(A) threshold. It is recommended that a noise barrier be constructed along the east right-of-way to shield these homes.
- At 88<sup>th</sup> Avenue east of I-25, four multi-story apartment buildings will be exposed to levels in excess of the threshold in the year 2000. To shield the ground floor apartments in these four buildings, a noise barrier will be built along the right-of-way line.
- Due to the high elevation of the proposed fly over ramp south of 120<sup>th</sup> Avenue in relation to the affected pre-school and homes, the only effective noise barrier would be along the south side of the ramp.

**November 1985**

**Reevaluation of the Final Environmental Impact Statement FHWA-COLO-EIS 75-02-F for Project FCU 024-3(9)**

**US 24 Bypass Colorado Springs, Colorado**

**By: De Leuw, Cather & Company**

This report was required since the original Environmental Impact Statement (EIS) was older than three years for this project on US 24 from I-25 to Platte Avenue. The 1977 noise study has been updated to the existing 1985 levels using the FHWA noise prediction model STAMINA 2.0. Since 1977, a significant amount of land development has taken place along the approved alignment. This unforeseen increase in development has resulted in significantly different traffic projections than those prepared in the original EIS. Thus, the results of the 1977 study in terms of the predicted noise levels, as well as the locations of important receptors, have changed.

The following conclusions regarding noise were drawn from the study that was performed:

- From Chelton Road to Academy Boulevard on Fountain Boulevard, noise reduction by noise barriers would be feasible.
- Nazarene Bible College is anticipated to be adversely impacted and the construction of noise barriers in the area would be feasible.
- The predicted noise levels near the residential areas on the northern portion of Powers Boulevard will be lower than the Noise Abatement Guidelines as established in FHPM 7-7-3.

**March 1980**

**Centennial Parkway Environmental Impact Statement**

Environmental Assessment to evaluate the environmental impacts of the right-of-way acquisition and construction of 25.6 miles of new roadway connecting I-25 and I-70 in the southwest metropolitan Denver area.

The following conclusions regarding noise were drawn from the study that was performed:

- 2400 linear feet of noise barrier was recommended to protect the two main residential neighborhoods in existence at the time of the study, the Columbine Hills neighborhood and the Wolhurst adult community west of Santa Fe Drive.
- Only the South Suburban Golf Course, McClellan Reservoir, and 10 isolated homes were in existence in the corridor from Santa Fe Drive and I-25.
- No additional noise mitigation was recommended between Santa Fe Drive and I-25.

**December 1976**  
**Environmental Impact Assessment**  
**Reconstruction of Washington Street and 38<sup>th</sup> Street**  
**By: Daniel, Mann, Johnson, & Mendenhall**

The objective of this report is to disclose the social, economic, and some environmental impacts of reconstructing Washington Street and 38<sup>th</sup> Street between I-70 on the north and Lawrence Street-Larimer Street one-way couplet on the south. This report also is intended to respond to the letter and intent of the NEPA of 1969, as well as the December 1974 FHWA guidelines and regulations for environmental assessments and the State of Colorado Action Plan. Existing noise levels within the study area were measured in June 1976.

The following conclusions regarding noise were drawn from the study that was performed:

- Much of the property around the project is industrial and will not be impacted by the proposed reconstruction.
- Some residential areas do exist and most of these areas currently experience noise levels above the desired 70 dB(A) and will persist after the project is completed.
- Noise levels will increase in year 2000 with or without the project, although the levels will be slightly higher if the roadway is reconstructed due to its greater carrying capacity.

**August 1974**  
**Foothills Parkway Final Environmental Impact Statement**

Environmental Impact Statement to evaluate the environmental impacts of the design and construction of SH-157 (Foothills Parkway) from SH-119 to US-36 in Boulder.

The following conclusions regarding noise were drawn from the study that was performed:

- The study recommended the construction of earth berms along the future SH-157 ROW to abate noise in the neighborhoods that existed in the area at the time of the study.