NOISE TECHNICAL REPORT
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Estes Park Downtown Loop Road Realignment

(CO FLAP 34(1) & 36(1) Riverside–Moraine)

Traffic Noise Impact and Abatement Assessment

Prepared for:
Federal Highway Administration
Central Federal Lands

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<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CDOT</td>
<td>Colorado Department of Transportation</td>
</tr>
<tr>
<td>CFLHD</td>
<td>Central Federal Lands Highway Division</td>
</tr>
<tr>
<td>dB</td>
<td>Decibels</td>
</tr>
<tr>
<td>dBA</td>
<td>A-weighted decibels</td>
</tr>
<tr>
<td>FHU</td>
<td>Felsburg Holt &amp; Ullevig</td>
</tr>
<tr>
<td>FHWA</td>
<td>Federal Highway Administration</td>
</tr>
<tr>
<td>Leq(h)</td>
<td>one-hour equivalent sound level</td>
</tr>
<tr>
<td>MPH</td>
<td>miles per hour</td>
</tr>
<tr>
<td>NAC</td>
<td>Noise Abatement Criteria</td>
</tr>
<tr>
<td>Town</td>
<td>Town of Estes Park</td>
</tr>
<tr>
<td>TNM</td>
<td>FHWA's Traffic Noise Model</td>
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1. Introduction

Felsburg Holt & Ullevig (FHU) conducted a traffic noise analysis for the Estes Park Downtown Loop project within the Town of Estes Park (Town) in Larimer County, Colorado (Figure 1). The noise analysis was in support of the environmental approval process for the proposed highway improvement project.

The purpose of the analyses presented in this report was to conclude whether noise levels at properties (i.e., receptors) near the prospective road improvements from the project alternatives may exceed applicable thresholds, according to Federal Highway Administration (FHWA) or Colorado Department of Transportation (CDOT) guidelines. This report presents the evaluation of existing and future traffic noise levels and impacts.

1.1 Project Description

The Central Federal Lands Highway Division (CFLHD), together with its partners the Town and CDOT, is initiating the project development process including public outreach, environmental analysis and preliminary engineering for the downtown road realignment project – “the Downtown Estes Loop.” The project includes evaluation of three primary roadways: Elkhorn Avenue, Moraine Avenue and Riverside Drive through downtown Estes Park. The project is in the Environmental Assessment phase.

The Proposed Action has several components and will consist of multiple phases. Phase I components will include:

- Conversion of Elkhorn Avenue, Moraine Avenue and Riverside Drive into the Downtown Estes Loop One-Way Couplet through pavement rehabilitation, restriping, and installation of new signage and signals on Elkhorn Avenue, Moraine Avenue, and Rockwell Street. It also includes all of Rockwell Street (Moraine Avenue east to East Riverside Drive).
- Realignment and full reconstruction of roadways (new curb, gutter, sidewalk, pavement, bike lane, drainage, signing, and striping). This would include all of West Riverside Drive, all of Ivy Street, a portion of East Riverside Drive (from Ivy Street to Elkhorn Avenue), and a new signal intersection at Moraine Avenue, West Riverside Drive, and Crags Road.
- Three bridge replacements along the Big Thompson River on Ivy Street, East Riverside Drive, and Rockwell Street.
- The project also includes bike lanes, sidewalks and trail connection improvements and park land improvements to address project effects.

The mill and overlay paving portion of Phase I includes grinding the existing pavement and repaving to repair the deteriorating wearing surfaces. The mill and overlay paving work would occur on Elkhorn from west of the US 34/US 36 intersection to the Elkhorn/Moraine intersection and along Moraine from the Elkhorn/Moraine intersection to the Moraine/Riverside/Crags intersection. Riverside would be completely reconstructed.
Figure 1  Overview of Project Area
The conversion to the Downtown Loop One-Way Couplet configuration would provide road capacity improvements with the following distinct elements:

- Conversion of three two-way streets, involving portions of East Elkhorn Avenue (US 36), Moraine Avenue (US 36) and West and East Riverside Drive, to form a counterclockwise one-way couplet crossing the Big Thompson River near the existing Ivy Street and East Riverside Drive crossings.
- Intersection reconstruction and reconfiguration at Moraine Avenue, Crags Drive and West Riverside Drive. Currently signalized intersection and roundabout options are both being considered.
- Minor realignments of portions of West Riverside and East Riverside and full reconstruction of the Riverside Drive segments.

The Phase I elements currently are funded; however, additional elements of the Proposed Action are not currently funded and would occur under later project phases. The later elements include streambed alterations to the Big Thompson River from approximately Riverside Drive to N. St. Vrain Avenue (which are not traffic related) and reconstruction of additional bridges.

### 1.2 Basics of Sound

Sound is created when an object vibrates and radiates part of that energy as acoustic pressure or waves through a medium, such as air. Noise is commonly defined as unwanted sound. Sound and noise have many characteristics that are important to consider for impacts, including loudness (energy intensity), frequency and fluctuations over time.

Sound pressure levels are measured in units of decibels (dB). The dB scale is logarithmic. To illustrate this, consider that two identical sound sources, each producing 60 dB, would produce 63 dB when added together. Some examples of common sound levels are shown in Figure 2.

The human ear can sense a wide range of sound energy levels, with the maximum levels having more than a million times the sound energy of the minimum levels. The human ear is not equally receptive to all frequencies of sound-producing vibrations. Mathematical adjustments to sound levels through the sound frequency bands using the “A” weighting network are often used to approximate how the human ear perceives sounds. In simple terms, the weighting consists of reducing the contributions from low and extremely high sound frequencies by specified amounts. Sound levels that have been weighted this way are reported in dBA.

Research has shown that most people do not notice a difference in loudness between sound levels of less than 3 dBA, which corresponds to a two-fold change in the sound energy. Most people relate a 10-dBA increase in sound levels to a doubling of sound loudness, though it represents a 10-fold increase in sound energy.

Noise often is not constant and fluctuates over time because of the characteristics of the source. For example, traffic noise will fluctuate from changes in traffic volumes, vehicle types and vehicle speeds. The fluctuations make it challenging to quantify the many aspects of noise through a single value, but CDOT and FHWA use the one-hour equivalent sound level (Leq(h)) as the metric for assessing traffic noise impacts (CDOT, 2015). In simple terms, the Leq(h) is the “average” of the fluctuating noise levels over one hour; more precisely, it is the constant sound...
level that would produce the same amount of overall sound energy as the naturally fluctuating noise levels over the hour.

Sound levels decrease with distance from the source because of spreading, atmospheric absorption, interference from objects and ground effects. "Hard" ground (such as asphalt) and "soft" ground (such as grass) affect sound transmission differently. "Hard" ground is more reflective and will lead to louder sound levels farther from the source. Using traffic noise passing over “hard” ground as an example, either doubling the traffic volume or cutting the distance from the listener to the roadway in half could cause a 3-dBA increase in noise levels, which would be barely noticeable to most people.

Existing and future noise levels and impacts are based on worst traffic noise hour Leq(h). The loudest traffic noise generally occurs when the largest traffic volume can travel at the highest speed, which may not be during rush hour if the traffic volumes become so high that roads become congested and speeds slow.

**Figure 2  Examples of Sound Levels**

![Examples of Sound Levels](image)

1.3 **Noise Analysis Approach**

The overall purpose of the noise analysis was to conclude whether noise levels at any sensitive receptors near proposed project improvements may exceed applicable impact thresholds. The analysis process for this project followed the CDOT *Noise Analysis and Abatement Guidelines* (CDOT, 2015). A distance of 500 feet from project roads was selected as the traffic noise study area (Figure 3); this choice was supported by the results shown in **Section 4.6**. When noise impacts are identified, abatement actions for the impacted receptors are considered for the project.

The analysis examined roads that would be changed or newly built by the project, would have substantially different traffic volumes because of an alternative, or would be important local traffic noise sources. The overall analysis was based on measurements of 2015 conditions and on modeling of 2014 (existing) traffic conditions and future design year (2040) traffic conditions for two alternative conditions—No Action and Proposed Action (**Section 2.2**). Note that the Proposed Action has two intersection options at Moraine Avenue and Riverside Drive that were evaluated—a traditional intersection and a roundabout.

Several measurements of current noise were performed in the noise study area in 2015 (**Section 3**). Computer modeling was used to examine 2014 and expected 2040 noise conditions for numerous locations in the noise study area, focusing on potential impacts to the most sensitive receptors (**Sections 3 and 4**). The resulting noise levels were compared to applicable criteria to assess for and identify impacted areas (**Sections 3 and 4**). The efficacy of various abatement measures for the impacted areas was evaluated and abatement measures were recommended, if appropriate according to CDOT feasibility and reasonableness guidelines (**Section 5**).
Figure 3  Land Uses and Noise Measurement Locations
2. Analysis Methods

Noise impacts from vehicle traffic were evaluated through a combination of measurements and computer modeling. The specific methods used for each part of the analysis are described below.

The state and federal transportation departments have developed traffic noise evaluation criteria specifically for their environmental impact analyses. United States Code of Federal Regulations Title 23 Part 772 establishes federal standards for the abatement of highway traffic noise (FHWA, 2012). CDOT has developed traffic noise analysis guidance based on the federal standard (CDOT, 2015). All highway projects that involve federal facilities or funds must follow these federal regulations and state highway guidelines.

The proposed project is expected to use federal funds, so the project must comply with the federal and state highway guidelines. The Proposed Action would realign some existing roads closer to adjacent noise-sensitive receptors; therefore, the Proposed Action is a Type I project for noise and the requisite traffic noise analysis was completed following the CDOT guidelines (CDOT, 2015). Table 1 shows the CDOT Noise Abatement Criteria (NAC) that set the traffic noise impact threshold levels.

Table 1  CDOT Noise Abatement Criteria

<table>
<thead>
<tr>
<th>Land Activity Category</th>
<th>CDOT NAC (Leq(h))</th>
<th>Description of Land Activity Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>56 dBA (Exterior)</td>
<td>Tracts of land in 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.</td>
</tr>
<tr>
<td>B</td>
<td>66 dBA (Exterior)</td>
<td>Residential.</td>
</tr>
<tr>
<td>C</td>
<td>66 dBA (Exterior)</td>
<td>Active sport areas, amphitheaters, auditoriums, campgrounds, cemeteries, day care centers, hospitals, libraries, medical facilities, places of worship, public meeting rooms, public or non-profit institutional structures, radio studios, recording studios, schools, Section 4(f) sites, trails, trail crossings, and television studios.</td>
</tr>
<tr>
<td>D</td>
<td>51 dBA (Interior)</td>
<td>Auditoriums, day care centers, hospitals, libraries, medical facilities, places of worship, public meeting rooms, public or non-profit institutional structures, radio studios, recording studios, schools and television studios.</td>
</tr>
<tr>
<td>E</td>
<td>71 dBA (Exterior)</td>
<td>Hotels, motels, offices, restaurants, bars and other developed lands, properties or activities not included in A-D or F.</td>
</tr>
<tr>
<td>F</td>
<td>NA</td>
<td>Agriculture, airports, bus yards, emergency services, industrial, logging, maintenance facilities, manufacturing, mining, rail yards, retail facilities, ship yards, utilities (water resources, water treatment, electrical), and warehousing.</td>
</tr>
<tr>
<td>G</td>
<td>NA</td>
<td>Undeveloped lands that are not permitted for development.</td>
</tr>
</tbody>
</table>

To summarize the traffic noise analysis process, noise impacts occur when properties/receptors near the project roads will have traffic noise levels at or above the relevant CDOT NAC (Table 1)
or future noise levels that increase by 10 dBA or more over existing conditions. Typically, the most crucial NAC on road projects is for homes (Activity Category B), which is an Leq(h) of 66 dBA.

When determining impacts, primary consideration is to be given to exterior areas of frequent human use on properties (Table 1). These areas include uses such as yards/decks for Category B, park activity areas for Category C or exterior dining areas at restaurants for Category E. For a noise impact to occur, an applicable area of frequent human use must be present on the property and the noise level must be at or above the relevant CDOT NAC (Table 1) or future noise levels must increase by 10 dBA or more over existing conditions. The traffic noise levels are evaluated through computer modeling. Any receptors found to be impacted by noise for the proposed improvements are then considered for abatement actions. Noise abatement actions that are found to be both feasible and reasonable according to CDOT guidelines are recommended for construction under the proposed improvements. Noise impacts are based on the worst hour Leq(h), which may or may not correspond to the hour of largest traffic volume.

2.1 Traffic Noise Measurements

Traffic noise measurements were taken with an NTI XL2 Type 1 sound level meter calibrated at the site with a Norsonic 1251 calibrator. This equipment conforms to American National Standards Institute Standard S1.4 for Type 1 sound level meters. Calibrations traceable to the US National Institute of Standards and Technology were performed in the field before and after each set of measurements using the acoustical calibrator. The meters undergo annual laboratory calibration and meters with current calibrations were used. The measurement microphone was protected by a windscreen and located on a tripod approximately 5 feet above the ground. The microphone was positioned at each site to characterize the exposure to the dominant noise sources in the area.

The measurements were made on January 15, 2015. Measurements were made during calm weather conditions that were acceptable according to FHWA guidance (FHWA, 1996). Weather conditions, including wind speed, were monitored during the measurements. The traffic noise measurements were spread across the noise study area (Figure 3). Short-term (15-minute) traffic noise measurements were performed at each location to document existing ambient conditions in the noise study area (Section 3).

Traffic counts, including the number of large trucks, were collected during the noise measurement periods for model verification. Vehicles were concluded to be traveling at the posted speed limits during the measurements—traffic was not congested. The measurement results were used to document ambient conditions and to evaluate the performance of the computer models.

2.2 Traffic Noise Modeling Methods

Computer modeling was performed for both existing conditions (2014) and the project alternatives for Year 2040. The traffic noise modeling software was FHWA’s Traffic Noise Model (TNM) Version 2.5. The ultimate purpose of the models was to examine whether traffic noise levels would be high enough to impact neighboring properties, and subsequently whether noise abatement should be recommended for any such impacts within the noise study area.
Modeling is used because day-to-day variations in traffic or weather conditions that affect noise levels cannot be captured or quantified by brief noise measurements alone. Modeling of noise levels is used to simulate future noise levels using projected traffic volumes and compositions. In addition, the modeling can evaluate many more locations than can reasonably be measured.

Typically, the noise modeling will represent predicted average daily traffic conditions during peak noise periods. Estes Park is a tourist destination and traffic conditions are very seasonal—volumes can be inconsistent week to week. The project traffic analysis report describes the decisions made to evaluate traffic volumes and operations (FHU, 2016). In accordance with those decisions and the CDOT guidance (CDOT, 2015), the existing traffic conditions noise model included the 2014 road configurations and volumes for the 30th busiest traffic hour of a year. Corresponding 2040 traffic volumes were evaluated for the future alternatives in this analysis—No Action and the Proposed Action. The percentage of heavy trucks used in the TNM modeling was derived from CDOT’s published traffic counts obtained from the CDOT website in July 2015.

TNM was used to calculate noise levels at 128 points (Appendix A) up to 500 feet from a modeled roadway, as illustrated in Figure 4 based on CDOT guidance. In some cases, a single model point represented several nearby receptors/properties where traffic and geography were similar (e.g., one point for multiple cottages), so the number of modeled TNM “points” was not always the same as the number of individual “receptors” (Appendix A). The same modeled points were used in each model for consistency, unless the point would be removed by the alternative.

The modeled roadways were Elkhorn Avenue, Moraine Avenue, Riverside Drive, W. Riverside Drive, Virginia Drive, Bighorn Drive, Park Lane, Rockwell Street, Ivy Street. Some of these roads are also highways. US 36 (Elkhorn and Moraine Avenues) was a substantial traffic noise source observed in the noise study area.
The TNM models require a considerable amount of input data regarding the geometry of the roadways as well as traffic volumes, vehicle mix and vehicle speeds. The current positions of roads and streets were mapped and used in both the existing and No Action Alternative models, though individual road parameters differed between the two models. The Proposed Action (Figure 4) was modeled to assess the possible noise impacts from the proposed roadway changes. Appendix A contains more information on the modeling inputs. In general, the following data were used in the TNM models:

- Units - feet and MPH
- Roadway alignments - XY coordinates from CAD files and aerial photographs
- Vehicle speeds - posted speed limits: 20-25 MPH
- Traffic Volumes - from project traffic study (FHU, 2016); Appendix A
- Vehicle Mix - from project traffic study (FHU, 2016)
- Elevations - from ground surface contours of the noise study area and preliminary road designs; model receptors were 5 feet above ground
- Structural and terrain barriers were used as needed to simulate the existing area; abatement barriers were added to models where appropriate for noise abatement evaluations
- TNM ground type was set to “hard soil” based on measured noise results (Section 3.1)
The features modeled in TNM are illustrated in Figure 5. In addition to the receiver locations, the modeled roads are shown and labeled. Road traffic data are provided in Appendix A. There are substantive elevation changes in places in the study area, particularly the southern portion and at the rivers, so several terrain lines were used. The project includes downtown Estes Park and there are numerous buildings present that act as noise barriers, so several structural barriers and building rows were included to represent them. There are relatively few private yard areas and they tend to be small; much of the study area surface is paved or bare ground. There are few grassy areas in the study area—the only ground zone modeled was for lawn at Bond Park. The numerous TNM input data for the model objects can be found in the TNM model files, which were submitted with this report.

Figure 5  TNM Model Objects for Proposed Action with Intersection
3. Affected Environment

The current traffic noise conditions in the noise study area were assessed through a combination of measurements and modeling. There are residential, park and commercial areas within the noise study area (Figure 3). No undeveloped properties in the study area with active building permits that would affect the noise analysis approach were identified. Existing conditions for traffic noise are presented below.

3.1 Traffic Noise Measurement Results

Short-term traffic noise measurements were performed at six locations on January 15, 2015 to document ambient conditions for noise model verification (Figure 3). Table 2 presents the measurement results. None of the measurement results reached or exceeded the CDOT NAC for Category B (Table 2), recognizing that this was not peak tourism season.

Table 2 Existing Traffic Noise Measurement Results

<table>
<thead>
<tr>
<th>Location Number</th>
<th>Location Description</th>
<th>Activity Category*</th>
<th>CDOT NAC (dBA)*</th>
<th>Measured Leq(h) (dBA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Confluence Park North</td>
<td>C</td>
<td>66</td>
<td>57.1</td>
</tr>
<tr>
<td>2</td>
<td>Bond Park</td>
<td>C</td>
<td>66</td>
<td>55.7</td>
</tr>
<tr>
<td>3</td>
<td>145 Elkhorn Ave.</td>
<td>E</td>
<td>71</td>
<td>65.2</td>
</tr>
<tr>
<td>4</td>
<td>E. Riverside Dr. near Cyteworth Rd.</td>
<td>G</td>
<td>None</td>
<td>56.9</td>
</tr>
<tr>
<td>5</td>
<td>Riverside Park</td>
<td>C</td>
<td>66</td>
<td>52.2</td>
</tr>
<tr>
<td>6</td>
<td>201 Moraine Ave.</td>
<td>E</td>
<td>71</td>
<td>60.3</td>
</tr>
</tbody>
</table>

* See Table 1 for descriptions of land activity categories.

3.2 Traffic Noise Verification Model

As a check on noise model parameters, the traffic conditions observed during the noise measurements were used to construct a verification model in TNM. The intent was to check the accuracy of the noise levels calculated through a model that reflected the road alignments and traffic conditions at the time of field measurement. A close match between model results and field measurements ensured that the TNM models provided accurate noise results (CDOT, 2015).

The verification models covered the areas where noise level measurements were made (Figure 3). The model was constructed in TNM using the same approach as the alternatives models (Section 2). Through evaluation of the verification model, it was determined that the “hard soil” ground type in TNM provided better agreement of results than the standard “lawn” setting; therefore, “hard soil” was the default ground type used in the TNM models for this project. A “lawn” ground zone was modeled for Bond Park.

The verification results were in close agreement with the measurements, as shown in Table 3. The results were acceptable according to the CDOT guidelines (CDOT, 2015), which require the difference in results to be no more than 3 dBA.
Table 3  Verification Noise Model Results

<table>
<thead>
<tr>
<th>Location Number</th>
<th>Location</th>
<th>Measurement Leq(h) (dBA)</th>
<th>Verification Model Result (dBA)</th>
<th>Difference (dBA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Confluence Park North</td>
<td>57.1</td>
<td>56.9</td>
<td>-0.2</td>
</tr>
<tr>
<td>2</td>
<td>Bond Park</td>
<td>55.7</td>
<td>57.4</td>
<td>+1.7</td>
</tr>
<tr>
<td>3</td>
<td>145 Elkhorn Ave.</td>
<td>65.2</td>
<td>64.1</td>
<td>-1.1</td>
</tr>
<tr>
<td>4</td>
<td>257 E. Riverside Dr.</td>
<td>56.9</td>
<td>54.9</td>
<td>-2.0</td>
</tr>
<tr>
<td>5</td>
<td>Riverside Park</td>
<td>52.2</td>
<td>51.8</td>
<td>-0.4</td>
</tr>
<tr>
<td>6</td>
<td>201 Moraine Ave.</td>
<td>60.3</td>
<td>57.3</td>
<td>-3.0</td>
</tr>
</tbody>
</table>

3.3 Existing Conditions Traffic Noise Model Results

A noise model was developed (Section 2) to evaluate existing (2014) conditions. The existing conditions model included the major existing roads that may be affected by the project, with existing traffic volumes and road layouts.

A total of 128 points were modeled for traffic noise and the noise impacts are shown in Figure 4. Appendix A presents the calculated result for each model point. Overall, the calculated noise level range for the model points was 43-72 dBA. These results showed 13 modeled points representing 13 receptors (seven residences, four park areas and two dining areas or downtown public seating areas) were calculated to be impacted through existing traffic noise levels being above the NAC during the peak noise hour (Figure 6).
Figure 6  Noise Impacts from Existing Conditions Model

Legend
- Noise Impact
- No Noise Impact
- Noise Study Area
4. Environmental Consequences

The future conditions being examined for the project were No Action and the Proposed Action. Future roadway traffic scenarios were modeled to predict 2040 noise levels for noise study area receptors if the proposed improvements are built as designed (Proposed Action) or not built (No Action). The traffic noise modeling effort was conducted as described in Section 2 to assess whether 2040 noise levels near the project alternatives would exceed relevant CDOT thresholds. If so, abatement measures to alleviate the predicted impacts were considered and evaluated for the Proposed Action following CDOT guidelines (Section 5).

The models included the major project roads using predicted future traffic volumes and road layouts. The model noise results are tabulated in Appendix A.

4.1 No Action Alternative 2040 Results

The 2040 noise impact results for No Action are shown in Figure 7. Appendix A presents the calculated result for each model point. Overall, the calculated noise level range for the model points was 45-73 dBA. These results showed 27 modeled points representing 27 receptors (13 residences, five park areas and nine dining areas or downtown public seating areas) were calculated to be impacted through 2040 traffic noise levels being above the NAC during the peak noise hour (Table 4). No receptors are expected to experience a 10-dBA increase; the largest increase is predicted to be 2 dBA.

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<thead>
<tr>
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<tbody>
<tr>
<td>Category B</td>
<td>7</td>
<td>13</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Category C</td>
<td>4</td>
<td>5</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Category E</td>
<td>2</td>
<td>9</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>Total</td>
<td>13</td>
<td>27</td>
<td>32</td>
<td>32</td>
</tr>
</tbody>
</table>

4.2 Proposed Action with Intersection—2040 Results

The noise impact results for the Proposed Action with an intersection at Moraine/Riverside are shown in Figure 8. Appendix A presents the calculated result for each model point. Note that 11 model points representing 12 receptors would be removed if the Proposed Action is constructed—these points are not included in the results below (Appendix A). Three of the removed receptors were impacted under the No Action Alternative. Overall, the calculated noise level range for the model points was 46-73 dBA. These results showed 30 modeled points, representing 32 remaining receptors (10 residences, nine park areas, a seating area at the Post Office and 12 dining areas or downtown public seating areas) were calculated to be impacted through 2040 traffic noise levels being above the NAC during the peak noise hour (Table 4). No receptors are expected to experience a 10-dBA increase; the largest increase is predicted to be 7 dBA.
4.3  Proposed Action with Roundabout—2040 Results

The noise impact results for the Proposed Action with a roundabout at Moraine/Riverside are shown in Figure 9 and are the same as the intersection alternative. Appendix A presents the calculated result for each model point. Note that 11 model points representing 12 receptors would be removed if the Proposed Action is constructed—these points are not included in the results below (Appendix A). Three of the removed receptors were impacted under the No Action Alternative. Overall, the calculated noise level range for the model points was 46-73 dBA. These results showed 30 modeled points, representing 32 remaining receptors (10 residences, nine park areas, a seating area at the Post Office and 12 dining areas or downtown public seating areas along Elkhorn Avenue) were calculated to be impacted through 2040 traffic noise levels being above the NAC during the peak noise hour (Table 4). No receptors are expected to experience a 10-dBA increase; the largest increase is predicted to be 7 dBA.

Figure 7  Noise Impacts for No Action Alternative—Year 2040
4.4 Summary of Traffic Noise Impacts

Traffic noise impacts were predicted for each of the alternatives for 2040. The predicted impacts (without abatement) are summarized in Table 4. The modeled 2040 conditions would be similar in terms of noise impacts, but the Proposed Action with either a traditional or roundabout intersection was calculated to have five more impacts than No Action.
4.5 Construction Noise

Adjoining properties in the noise study area could be exposed to noise from construction activities from the Proposed Action. The construction activities would be common road construction equipment and methods, such as milling/paving equipment, dump trucks, loaders, backhoes, jackhammering, excavating and the like. Construction noise differs from traffic noise in several ways:

- Construction noise lasts only for the duration of the construction event, with most construction activities in noise-sensitive areas being conducted during hours that are least disturbing to adjacent and nearby residents.
- Construction activities generally are short term and, depending on the nature of the construction operations, could last from seconds (e.g., a truck passing a receptor) to months (e.g., constructing a bridge).
- Construction noise is intermittent and depends on the type of operation, location, and function of the equipment, and the equipment usage cycle.
Construction noise is not assessed like operational traffic noise; there are no FHWA or CDOT NACs for construction noise. Construction noise would be subject to relevant local regulations and ordinances, and any construction activities would be expected to comply with them.

The prospective road improvements abut residential areas. To address the temporary elevated noise levels that may be experienced during construction, standard abatement measures should be incorporated into construction contracts, where it is feasible to do so. These would include:

- Notify neighbors in advance when construction noise may occur and its expected duration so that they may plan appropriately.
- Manage construction activities to keep noisy activities as far from sensitive receptors as possible.
- Exhaust systems on equipment would be in good working order. Equipment would be maintained on a regular basis, and equipment may be subject to inspection by the construction project manager to ensure maintenance.
- Properly designed engine enclosures and intake silencers would be used where appropriate.
- Use temporary noise barriers where appropriate and possible.
- New equipment would be subject to new product noise emission standards.
- Stationary equipment would be located as far from sensitive receptors as possible.
- Perform construction activities during hours that are least disturbing to adjacent and nearby residents.

The Proposed Action will also make streambed alterations to the Big Thompson River from approximately Riverside Drive to N. St. Vrain Avenue, which are not traffic related. This construction is expected during a later phase of the project. It is currently expected this construction may involve blasting. Blasting is beyond the scope of the traffic noise analysis. Blasting would be an exceptional event that should be handled on a case by case basis with local authorities. Appropriate actions should be taken to prevent damage and disruption to neighbors, which will be coordinated with the Town prior to the blasting events. Actions may include: consulting with blasting experts; acquire any necessary variances; minimize amounts of explosives used; employ appropriate protection methods; notify neighbors in advance; and, time blasting activities for the least disruption.

4.6 Information for Local Officials

There is little undeveloped property in the noise study area available for development, but to support local land use planning decisions and future development, the 2040 distances to the CDOT Category B/C (66 dBA) and E (71 dBA) NACs were evaluated. The distances will vary somewhat through the noise study area due to topography and changing traffic volumes, but in general, sensitive receptors within approximately 65 feet from the proposed new edge of pavement may be at or above 66 dBA during peak traffic noise hours. These areas may not be compatible with residential uses without noise mitigation actions. The distance to 71 dBA for sensitive commercial properties will be approximately 25 feet from the proposed new edge of pavement.
5. **Noise Abatement Evaluation**

The results from the traffic noise analysis indicated that receptors would be impacted by noise with each of the 2040 alternatives. Therefore, potential abatement actions for the impacted receptors under the Proposed Action were investigated in accordance with relevant guidelines (CDOT, 2015; FHWA, 2011). Impacted areas are not guaranteed abatement measures under these guidelines, but abatement measures for the areas must be evaluated for feasibility and reasonableness. Reasonableness includes the amount of noise reduction, cost/benefit of the abatement and the preferences about abatement from the benefitting receptors.

Noise impacts with the Proposed Action were previously described (Section 4) and the impact results are the same with an intersection or roundabout; therefore, the Proposed Action with an intersection is the basis for the abatement evaluations presented below. Several types of noise abatement for the impacts were considered. Barriers are a common abatement action and were evaluated, but other kinds of abatement were also considered. The overall feasibility and reasonableness of noise abatement actions that provide a substantive benefit for the impacted receptors were evaluated. Those actions found to be feasible and reasonable were then recommended for inclusion in the project.

5.1 **Evaluation of Abatement Other than Barriers**

The CDOT guidelines present several non-barrier noise abatement options. For various reasons that are described below, none of these options appeared to be viable for the Proposed Action.

Traffic management measures such as lane closures or reduced speeds could reduce noise but application of these concepts is neither reasonable for the roads of primary interest to the project nor compatible with the purpose of the project. A primary reason for the proposed improvements noise study area is to improve local traffic access and flow—closing lanes would not meet the purpose of the project and may prevent local access. The local speed limit is already very low—20 to 25 MPH. Traffic speeds would need to be reduced approximately 25 mph to achieve a 7-dBA noise reduction (Section 5.2), which clearly is not feasible for this project.

Changes in horizontal alignments of the roads near impacted receptors may reduce noise but are not practical as a noise abatement action for this project. Central Estes Park is already developed and extremely constrained, so there is not vacant land present to shift the roads. The flood channels for Big Thompson River and Fall River have to be considered by the project, which further constrains opportunities to shift the roads. In summary, horizontal shifts were considered, but such changes just to reduce traffic noise are not practical.

Changes in vertical alignments (cuts or fills) could reduce noise. However, changes in road elevations in the noise study area would present challenges to the numerous local connections that must be maintained for property access. There are numerous street, alley and private driveway connections directly adjacent to the project roads that would be negatively affected by depressing or elevating the roads. There are other constraints related to protection of the nearby streams—Big Thompson River and Fall River—that must be accommodated by the project and preclude large shifts in project road elevations. In summary, vertical elevation changes were considered, but vertical realignments just to reduce traffic noise are not practical.
Noise buffer zones could reduce noise levels, but there are no opportunities in the noise study area due to prior development within central Estes Park. Sufficient space for buffers is not available at the noise impact areas. Noise insulation actions may be considered for Category D (indoor) impacts, but there are none for this project.

Pavement types and surfaces can affect traffic noise. Research efforts to learn more about the long-term noise benefits of different pavement types and surface treatments are ongoing. Quieter pavement types can be preferred for the project when minimum requirements for safety, durability and other materials requirements are also met. However, this cannot be counted as an abatement action under the noise reduction evaluation because it is not a “permanent” solution.

### 5.2 Traffic Noise Barrier Evaluations

Noise barriers are a common and often effective noise abatement measure and were considered for the Proposed Action. Noise barriers and other abatement actions must be both feasible and reasonable to be included in the Proposed Action. All of the criteria below must be met or a barrier will not be recommended.

For a noise barrier to be feasible it must:

- Provide at least 5 dBA of noise reduction at one impacted receptor
- Not have any “fatal flaw” issues (safety, maintenance, drainage, access, etc.)
- Be constructible using reliable and common practices
- Not exceed 20 feet in height

For a noise barrier to be reasonable it must:

- Meet the minimum design goal of at least 7 dBA of noise reduction at one location
- Meet the cost/benefit index of not more than $6,800/receptor/dBA of benefit
- Have support from more than 50 percent of the potentially benefitting receptors

It is important to note that noise barriers can be earth berms or constructed walls and that many materials can be effective noise walls. Berms can be very effective but occupy considerably more space than walls. There are also more property access and drainage considerations for berms. The impacted receptors in the noise study area tend to be close to project roads. This made earth berms impractical choices for noise barriers in the noise study area, so the barriers would need to be walls.

The noise study area, with the identified noise impacts from the Proposed Action, was reviewed for the potential placement of noise abatement barriers. Figure 10 illustrates prospective barrier locations needed to address the identified 2040 Proposed Action noise impacts. Note that due to a lack of space between the roads and impacted receptors, the nearness of adjacent infrastructure and general physical conditions in the noise study area, the only available space for barriers would be at the curb/sidewalk connection. That is, at the outside edge of local sidewalks. The CDOT guidance states that multiple barrier locations should be evaluated (CDOT, 2015), but there were no other locations available for barriers in the noise study area—particularly within the road right-of-way. For these reasons and others described below, it has been concluded that suitable locations for noise abatement barriers were not available in the noise study area and that noise barriers are infeasible.
Estes Park is a small town and the noise study area is in the core of the downtown area. Barriers that would be effective in reducing traffic noise in this area were concluded to cause unacceptable safety, pedestrian movement and property access issues. Barriers would substantively change the character of the downtown area. The challenges faced in placing noise barriers in these locations, due to the lack of space, numerous access points and pedestrian-oriented setting, are illustrated in Figures 11 through 15.

Emergency access by police or fire departments would be inhibited as few impacted properties have alternative access points such as alleys. Several areas will provide on-street parking; installation of noise barriers would block the sidewalk from parked cars which would negatively affect the safety of and access by vehicle occupants. Some impacted locations are at street corners, which would prevent normal pedestrian movement (Figure 10).

Some of the roads of interest are national highways (US 36); however, these are also low-speed local streets with numerous access points in the noise study area (Figures 11 and 12). A primary reason there are noise impacts associated with such low-speed traffic (20-25 MPH) is the closeness of some receptors to the streets. Because of this, there is not sufficient space available to construct noise barriers without placing barriers unacceptably close to buildings or inhibiting normal access. Barriers would essentially cut the receptors off from their local neighborhood.
Figure 10  Locations of Prospective Noise Barriers—Proposed Action*

* This figure depicts the standard intersection option.
Figure 11  View of Elkhorn Avenue Looking West

(From Google Maps; accessed July 2015)

Figure 12  View of Moraine Avenue at Fall River Looking South

(From Google Maps; accessed July 2015)
Figure 13  View of Riverside Drive at Big Thompson River Looking South

(From Google Maps; accessed July 2015)

Figure 14  View of Riverside Drive at Rockwell Street Looking South

(From Google Maps; accessed July 2015)
Because most of the impacted properties have direct access only from the project streets, which must be maintained by the Proposed Action, gaps in the prospective barriers would be required that would compromise the noise abatement effectiveness. Preserving safe driver sight lines in such tight quarters, with numerous pedestrians expected, would require even larger gaps. In some locations, such as along West Riverside Drive, this would effectively preclude any barriers.

The footprint of disturbances by the Proposed Action was intended to be as small as possible because of the numerous social and environmental considerations in the noise study area. Inserting a noise barrier into the proposed cross-sections of the new roads would require space that is not readily available and would have negative consequences for other resources. The amount of right-of-way needed would increase and could lead to park land or private property acquisitions not otherwise anticipated. It could also lead to design issues to avoid impingement on the two local streams.

From this review, it was concluded that noise barriers in the noise study area would be infeasible. Therefore, an assessment of reasonableness is not required. No noise abatement barriers are recommended for the Proposed Action.
5.3 Impacted Receptors After Recommended Abatement

The No Action Alternative will not include any noise abatement actions, so there would be no change in the traffic noise impacts (Table 4). Traffic noise would still have an impact on the same 27 receptors, as shown in Figure 7.

For a noise abatement action to be recommended, it must be both feasible and reasonable according to the evaluation guidelines (CDOT, 2015). Noise abatement was determined to be not feasible for the Proposed Action, so no abatement actions would be included in the Proposed Action (Section 5.2). There would be no change in the traffic noise impacts (Table 4). Traffic noise would still impact the same receptors: 32 for the Proposed Action with an intersection (Figure 8) or with a roundabout (Figure 9). That would be five more impacts than No Action.

5.4 Statement of Likelihood

The analysis described above concluded that noise abatement barriers in the noise study area would not be both feasible and reasonable. Therefore, noise abatement barriers are not recommended for the Proposed Action, regardless of which intersection type is chosen for Moraine/Riverside. Final recommendations on the construction (or lack of construction) of abatement measures will be determined during the completion of the project's final design and the public involvement processes.
6. References


Appendix A
Traffic Volumes, Model Points and Noise Results
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Figure A-1  TNM Modeling Points and Labels
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^a Letter in the name indicates the Activity Category for the receptor.
^b This is an indoor Category D receptor; 25 dBA was subtracted from TNM results to account for building walls.
NA = not applicable; receptor would be removed by Proposed Action
Appendix B

Noise Abatement Evaluation Worksheets
COLORADO DEPARTMENT OF TRANSPORTATION
NOISE ABATEMENT DETERMINATION WORKSHEET
Instructions: To complete this form refer to CDOT Noise Analysis Guidelines

STIP # ___________________________ Date of Analysis: 4/29/16

Project Name & Location: Estes Park Moraine Avenue

A. FEASIBILITY:
1. Can a 5dBA noise reduction be achieved by constructing a noise barrier or berm?
   □ YES □ NO
2. Are there any fatal flaw drainage, terrain, safety, or maintenance issues involving the proposed noise barrier or berm?
   □ YES □ NO
3. Can a noise barrier or berm less than 20 feet tall be constructed?
   □ YES □ NO

B. REASONABLENESS: NA
1. Has the Design goal of 7 dBA noise reduction for abatement measure been met for at least one impacted receptor?
   □ YES □ NO
2. Is the Cost Benefit Index below $6800 per receptor per dBA?
   □ YES □ NO
3. Are more than 50% of responding benefited resident/owners in favor of the recommended noise abatement measure?
   □ YES □ NO

C. INSULATION CONSIDERATION: NA
1. Are normal noise abatement measures physically infeasible or economically unreasonable?
   □ YES □ NO
   If the answer to 1 is YES, then:
   2a. Does this project have noise impacts to NAC Activity Category D?
       □ YES □ NO
   2b. If yes, is it reasonable and feasible to provide insulation for these buildings?
       □ YES □ NO

D. ADDITIONAL CONSIDERATIONS:
   Noise barriers in this area would block parking, loading, pedestrian and bicyclist access. Visibility would be compromised. Walls would create difficult barricades in the small downtown area.

E. STATEMENT OF LIKELIHOOD:
1. Are noise mitigation measures feasible?
   □ YES □ NO
2. Are noise mitigation measures reasonable?
   □ YES □ NO
3. Is insulation of buildings both feasible and reasonable?
   □ YES □ NO
4. Shall noise abatement measures be provided?
   □ YES □ NO

F. ABATEMENT DECISION DESCRIPTION AND JUSTIFICATION:
For reasons described above, barriers were determined to be infeasible. Therefore, barriers are not recommended.

Completed by: Dale Tischner Date: 4/29/16

CDOT Form #1209 Revised 02/15

Appendix B
Appendix B
Appendix B

COLORADO DEPARTMENT OF TRANSPORTATION
NOISE ABATEMENT DETERMINATION WORKSHEET

Instructions: To complete this form refer to CDOT Noise Analysis Guidelines

STIP # ___________ Date of Analysis: ___________
Project Name & Location: ____________________________

A. FEASIBILITY:
1. Can a 5dBA noise reduction be achieved by constructing a noise barrier or berm?
   □ YES □ NO
2. Are there any fatal flaw drainage, terrain, safety, or maintenance issues involving the proposed noise barrier or berm?
   □ YES □ NO
3. Can a noise barrier or berm less than 20 feet tall be constructed?
   □ YES □ NO

B. REASONABLENESS: N/A
1. Has the Design goal of 7 dBA noise reduction for abatement measure been met for at least one impacted receptor?
   □ YES □ NO
2. Is the Cost Benefit Index below $6000 per receptor per dBA?
   □ YES □ NO
3. Are more than 50% of responding benefited resident/owners in favor of the recommended noise abatement measure?
   □ YES □ NO

C. INSULATION CONSIDERATION: N/A
1. Are normal noise abatement measures physically infeasible or economically unreasonable?
   □ YES □ NO
   If the answer to 1 is YES, then:
2. a. Does this project have noise impacts to NAC Activity Category D?
      □ YES □ NO
   b. If yes, is it reasonable and feasible to provide insulation for these buildings?
      □ YES □ NO

D. ADDITIONAL CONSIDERATIONS:
Continuous walls in this area are not possible due to the numerous curb cuts that would be required for property access. Walls would block parking, loading, pedestrian and bicyclist access. Additional right of way would be required.

E. STATEMENT OF LIKELIHOOD:
1. Are noise mitigation measures feasible?
   □ YES □ NO
2. Are noise mitigation measures reasonable?
   □ YES □ NO
3. Is insulation of buildings both feasible and reasonable?
   □ YES □ NO
4. Shall noise abatement measures be provided?
   □ YES □ NO

F. ABATEMENT DECISION DESCRIPTION AND JUSTIFICATION:
For reasons described above, barriers were determined to be infeasible. Therefore, barriers are not recommended.

Completed by: ___________________________ Date: ___________

CDOT Form #1209 Revised 02/15
Appendix C
Traffic Data from Noise Measurements
Presented below are the traffic data gathered during the on-site traffic noise measurements from January 15, 2015. These were the data used for the TNM verification model. Traffic was concluded to be travelling at the posted speed limits (20 to 25 MPH), except Measurement 6 where speeds were estimated to be 30 MPH.

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TNM Model Files Provided Separately