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February 4, 2020

Derek T. Webb, PE
City of Arvada - Civil Engineer IV
8101 Ralston Road, Arvada, CO 80002
(720) 898-7660

Re: W. 72nd Avenue – Kipling Street to Simms Street: Noise Technical Report Review

Dear Mr. Webb,

As requested, Ulteig has reviewed the Noise Technical Report for the W. 72nd Avenue Project from Kipling Street to Simms Street and have included a summary of our review in the attached as a technical memo.

Overall, the noise analysis process was followed correctly. However, in reviewing the Noise Technical Report, we have identified three items that would enhance the model and report but will not significantly change the results shown in the report. These include the following:

1. The CDOT Noise Abatement and Analysis Guidelines does not require but recommends taking two field measurements at each receptor site. The Noise Technical Report indicates that only one field measurement was taken at each site in the field. An additional field measurement can be taken at each receptor site to further validate the model.
2. The three properties being acquired by the project appear to be included in the future conditions TNM. As these three properties will be demolished as part of the project, they should be removed in the modeled future conditions TNM to represent the removal of the acquired properties.
3. TNM input and output files were not included with the Noise Technical Report and therefore were not checked by Ulteig. If the TNM input and output files need further review, they can be submitted to Ulteig to be checked.

Implementing the recommendations of these three items can be easily remedied and may further validate the results of the model. It is highly unlikely that these updates will significantly change the results shown in the report. The noise analysis process was followed correctly, and these changes would only enhance the current model and findings of the report.

We would be happy to meet to discuss our review further. In the meantime, please let me know if you have any questions.

Sincerely,

A handwritten signature in blue ink that reads "Andria Schmid".

Andria Schmid, PE
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W. 72nd Avenue Kipling Street to Simms Street Noise Technical Report Review - Technical Memo

Purpose of Memo:

This memo is intended to review and comment upon the original Noise Technical Report submitted by HDR for the City of Arvada, CO, in reference to the W. 72nd Avenue - Kipling Street to Simms Street project (Project). The intent of the Noise Technical Report was to determine potential noise impacts and abatement analysis for the 72nd Avenue project. The project was analyzed as a Type I project due to the addition of through travel lanes by new construction, as well as the alteration of the horizontal and vertical alignment of existing lanes. The outcome of the Noise Technical Report shows that three receptors would be impacted by the future (2040) modeled noise levels for the Proposed Action. As a result, three noise barriers were evaluated and determined to be either not feasible or reasonable. This technical memo will evaluate and validate or disprove the findings analyzed and summarized in the original Noise Technical Report.

Project Purpose and Description:

The purpose of the Project is to improve traffic operations and accommodate current and future general vehicular traffic, heavy trucks, bicycles, and pedestrians on 72nd Avenue between just west of Simms Street and Kipling Street.

The project will consist of improvements on W. 72nd Avenue between Kipling Street and Simms Street, including a new grade-separated crossing (underpass) of the Union Pacific Railroad Project (UPRR). The roadway template consists of a four-lane arterial parkway roadway and is consistent with the existing roadway template to the east of Kipling Street. The project limits are from approximately Swadley Court to Kipling Street, a distance of about 1.16 miles. Full-width improvements are anticipated between Simms Street and Kipling Street.

Noise Technical Report Background:

A traffic noise analysis was completed for this Project because it was classified as a Type I project as described and defined in 23 CFR Part 772 - Procedures For Abatement Of Highway Traffic Noise And Construction Noise. All projects that constitute as Type I projects must have a noise analysis completed to determine if noise levels will be impacted. This proposed Project constitutes a Type I classification because of the addition of through-travel lane(s) by new construction.

Field measurements were taken, the model was validated, existing condition noise levels were determined, future noise levels were predicted, and noise abatement was evaluated as part of the noise analysis completed for the project. The analysis resulted in impacts to the three receivers and the acquisition of three receivers. Three noise barriers were evaluated because of the impacts to the receivers. The three barriers evaluated were determined to be not feasible or reasonable. Noise abatement is not recommended to be built with the project per the Noise Technical Report.



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Regulations, Guidelines, and Tools:

To complete the noise analysis discussed in the Noise Technical Report, the following regulation, guidelines, and tools were used. These regulations, guidelines, and tools are sufficient to complete a highway traffic noise analysis:

- 23 CFR Part 772 (Procedures for Abatement of Highway Traffic Noise and Construction Noise)
- Colorado Department of Transportation (CDOT) Noise Analysis and Abatement Guidelines (NAAG)
- Federal Highway Administration's (FHWA) Highway Traffic Noise: Analysis and Abatement Guidance
- Measurement of Highway-Related Noise
- FHWA Traffic Noise Model (TNM) Version 2.5

Noise Study Zone and Land Use Identification:

A noise study zone was developed for the project area to help identify and quantify land use categories and noise receivers and receptors for the noise analysis. The Noise Technical Report uses a noise study zone that extends 500 feet in all directions from the proposed edge of travel lanes throughout the project extent. The noise study zone distance used is consistent with the guidance listed in the CDOT's NAAG and Traffic Noise Technical Report Template.

Noise sensitive receptors are identified throughout the noise study zone to determine where there may be potential impacts and where highway traffic noise may be detrimental to the enjoyment and function use of the property, as defined by the Federal Highway Administration (FHWA) Noise Abatement Criteria (NAC). All noise sensitive locations were included in the analysis. Some locations were represented by several receptors, this is typically done to represent several areas with similar noise environments. Receivers are modeled points that have been selected to represent receptors within the noise study zone and are placed in the model at the receptor locations to determine potential traffic noise impacts.

Figure 2 in the Noise Technical Report shows the noise study zone, NAC activity categories within the noise study zone, and the field measurement locations. Figures 3a – 3e and Figures 6a – 6e show the noise receptor/receiver locations throughout the noise study zone. In reviewing the figures, the receivers were placed at all potential noise sensitive locations within the noise study zone.

Noise Measurements:

Once noise receiver and receptor locations were determined, traffic noise measurements were performed at several receiver locations to acquire data for TNM model validation. Field measurements were collected at locations that were representative of the noise environment for each nearby area. A minimum of two existing field measurements are required within the noise study zone, per the NAAG. For this Project, five field measurements were taken in the noise study zone, one for each land use type within the noise study zone. The NAAG recommends taking two measurements at each site. Each measurement was 30 minutes in duration, which corresponds to the NAAG. According to NAAG, "For high-volume roads, a 10-minute sample is usually statistically accurate enough to obtain a good measurement, but sample time of 30 minutes but not more than 1 hour may be needed for measurements along lower volume roads." Traffic was counted and classified by vehicle



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type to be used as input in the traffic noise model. Noise measurements were taken during acceptable weather conditions, according to the FHWA guidance. The weather conditions, including wind speed and direction, were monitored during the measurements. Field measurement sheets with data from each measurement can be found in Appendix A (Noise Measurement Data) of the Noise Technical Report.

Model Validation:

To validate the noise model, field measurements are taken within representative locations in the noise study zone and later compared to predicted values from the model. The traffic noise model is built with the same traffic and speed data, weather conditions, receiver locations, and roadway parameters that are collected in the field. To validate the model, the difference between the measured and predicted levels must be within 3 A-weighted decibels (dBA). If the measured and predicted levels are not within 3 dBA, the measured and modeled data must be examined to determine the reason for the difference, and it must be explained in the noise report. If the model is within 3 dBA, then the model is considered validated and can be used to predict noise levels across the noise study zone and used to determine the worst-hour existing noise levels and to predict the future noise levels.

For this Project, the Noise Technical Report describes and presents the field measurements collected and the results of the modeled noise levels. The measured and predicted levels described in the report are all within the allowable 3 dBA tolerance; therefore, the traffic noise model is considered validated. The model can be used to determine existing noise levels and predict future noise levels. The TNM files were sent directly to CDOT and not available for review.

TNM Inputs:

To model existing (existing year; 2019) and future (design year; 2040) conditions, model inputs are developed from estimated receiver and receptor locations and noise sensitive data across the noise study zone. The following input data are collected by the analyst for the model:

- Current and future design year roadway alignment for roadways in the immediate area, which may contribute to the noise environment. Only throughways carrying substantial traffic volumes are modeled;
- Traffic volumes, including the breakdown of automobiles, medium trucks, heavy trucks, buses and motorcycles for all roadways;
- Posted speed limit for all roadways;
- Receptor and receiver locations;
- Terrain features;
- Any existing noise barriers;
- Modeled pavement type;
- Default ground type; and
- Other features which may result in a shield effect (e.g., buildings).

The current and future design year roadway alignments were modeled, and only roads that would be changed or newly built by the Project, have substantially different traffic volumes or are important local traffic noise sources were included in the model. The Noise Technical Report indicated average pavement type was used in the model, as per FHWA requirements.



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Traffic volumes were included in the input values and were broken down into percentages of automobiles, medium trucks, heavy trucks, buses, and motorcycles. The traffic volumes and vehicle mix (percentages) were supplied by Muller Engineering for the Noise Technical Report; however, no supporting documentation is attached to the report. A breakdown of traffic volumes and vehicle mix are provided in Appendix B (TNM Noise Modeling Input Data) of the Noise Technical Report.

The current posted speed limit for each road was used for the existing and future conditions.

The receiver locations are shown in Figures 3a – 3e and their activity category, and the predicted noise levels are shown in Table C-1 in Appendix C (TNM Noise Modeling Input Data). TNM files were submitted directly to CDOT and were not available for review; however, the noise level outputs are shown in Table C-1.

Building rows and barriers were included in the model, and the locations are presented in Figures 4 and 5. The ground type was set to “Lawn” for the analysis in the model.

Existing Conditions:

Existing noise levels (2019) were determined from the validated TNM model and from traffic data provided by Muller Engineering. According to the Noise Technical Report, noise levels were modeled at 348 receivers and the noise levels ranged from 43.5 to 66.8 dBA. The noise levels are listed in Table B2 in Appendix B of the Noise Technical Report.

No – Action Alternative:

The future design-year no-action alternative noise levels were calculated using the TNM model once the existing noise levels had been determined. The no-action alternative conditions were modeled for 2040 at the 348 receivers in the noise study zone. The noise levels ranged from 44.1 to 67.2 dBA. The noise levels are listed in Table B2 in Appendix B of the Noise Technical Report.

Proposed Action:

The future design-year noise levels were calculated using the TNM model once the existing noise levels were determined. The proposed action conditions were modeled for 2040 for the 348 receivers in the noise study zone, and the resulting noise levels ranged from 44.1 to 67.4 dBA. The noise levels are listed in Table B2 in Appendix B of the Noise Technical Report.

Noise Levels and Impact:

A traffic noise impact occurs if one of the following conditions are met:

- Predicted design year traffic noise level approaches (i.e., equals) or exceeds CDOT’s NAC at a minimum of one receptor.
- Predicted design year traffic noise level substantially exceeds the existing highway traffic noise level at a minimum of one receptor, where “Substantial” is defined as a noise increase of 10 dBA or more between the existing and design years.



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The Noise Technical Report describes the existing conditions as having no noise impacts; however three receivers do approach or exceed the NAC and have not been marked as impacted on Figures 3d and 3e in the Noise Technical Report. The noise levels for these receivers range from 66.2 - 66.8 dBA (Table C-1 in Appendix C of the Noise Technical Report). These receivers will be acquired as part of the Project and are marked in yellow on Figures 6d and 6e in the Noise Technical Report. If the receivers are acquired as part of the Project, there would be no future traffic noise impacts. According to NAAG, noise abatement evaluation of barriers is to be conducted in TNM using the future conditions data. Since there would not be impacts in future conditions, abatement evaluation is not needed at these locations. The Noise Technical Report does not go into any further detail about the property acquisitions. More information is needed on property acquisition if the properties are to be completely removed. This information should be added to the model. If the properties are removed, the shielding from those houses would no longer be there and the model would need to reflect that for future conditions. Figures 4 and 5 in the Noise Technical Report do not show the three receivers removed from the future model.

If the project were not to be built (No-Action Alternative), the city would not be responsible for mitigating highway traffic noise.

The Noise Technical Report describes the future condition to have noise impacts at three receivers. The future condition impacts exceed the NAC at three locations (Figures 6b and 6c in the Noise Technical Report).

TNM files were submitted directly to CDOT and not reviewed. A table with the results from TNM was shown in Appendix B.

Noise Abatement:

All receptors that were determined to be impacted by noise must be evaluated for traffic noise abatement. The Noise Technical Report shows three receptors as being impacted. Abatement for impacted receptors must be evaluated in accordance with guidelines from CDOT's NAAG and FHWA. After evaluation, abatement measures would only be recommended to build if they are determined to be both feasible and reasonable. The feasible and reasonable criteria can be found in CDOT's NAAG and FHWA Guidelines.

Three noise barriers were evaluated in the Noise Technical Report as abatement to the potential noise impacts shown in the model. The Noise Technical Report indicates that:

- Noise Barrier A was determined to be feasible but not reasonable because cost exceeded the Cost Benefit Index;
- Noise Barrier B was determined to be feasible but not reasonable because the Noise Reduction Design Goal of 7 dBA at a minimum of one benefited receptor was unable to be met; and,
- Noise Barrier C was determined to be feasible but not reasonable because cost exceeded the Cost Benefit Index.

The noise barriers were considered in multiple locations, and the best option for each impacted receiver was optimized. Each noise barrier was able to provide a reduction of 5 dBA at the impacted receivers and do not



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exceed the maximum barrier height of 20 feet. The TNM input files were submitted directly to CDOT and were not included in the report; thus, optimization could not be checked.

Noise barriers A and C meet the noise reduction design goal of 7 dBA at a minimum of one benefited receptor. Noise barrier B does not meet the noise reduction design goal. None of the noise barriers meet the cost benefit index value of \$6,800 per receptor per decibel of reduction. The math was verified, and all barrier costs were greater than allowed.

CDOT's NAAG requires CDOT Form 1209 (Noise Abatement Determination Worksheet) to be completed for each barrier segment that was evaluated in the abatement analysis and included in the Noise Technical Report. Form 1209 was completed and included in Appendix D for Noise Barrier A, B, and C.

Construction Noise:

Type I projects will result in land uses or activities that may be affected by construction noise caused by the project. A noise analysis of construction noise is not required, but CDOT recommends the use of the FHWA construction noise model and suggested mitigations. Typical best management practices to be incorporated into construction were included in the Noise Technical Report.

Information for Local Officials:

The noise study zone for the project contains land that is unpermitted and undeveloped. As a result, noise-related information shall be submitted to local officials to support local land use planning decisions and future development. The CDOT's NAAG states "Noise contour maps of the project area clearly delineating the future 66 dBA and 71 dBA contours on the most current available base mapping or aerial photography of the CDOT project including the surrounding community shall be supplied to the local agency planning department, the zoning department, and the building permit department." The noise contours represent the distances from the edge of the nearest travel lane of the highway to where the design year noise levels occur for Activity Category B, C, and E.

The Noise Technical Report includes the approximate distance from the proposed new edge of the nearest travel lane to where noise levels are predicted to exceed the Activity Category B, C, and E noise abatement criteria levels (66 dBA and 71 dBA, respectively). Only approximate distances are included in the report, although not required, noise contours should be included in the report.

Conclusions:

Residents in the area have expressed concern about the predicted noise levels and believed the noise levels were not accurate. As such, the Noise Technical Report has been reviewed to determine the accuracy of the content.

The overall noise analysis process followed the applicable guidance (NAGG and FHWA's guidance) in determining traffic noise impacts and evaluating abatement. The following steps were taken in completing the noise analysis described in the Noise Technical Report:



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- Noise sensitive receptors and land use types were determined with the noise study zone.
- Field measurements were taken at land-use types within the noise study zone to validate the model.
- The model was validated using field measurements and environmental conditions (temperature, wind speed, humidity, etc.).
- Noise conditions were modeled for existing roadways using the validated model.
- Future proposed action and no-action alternative noise conditions were modeled.
- Noise level impacts were determined from the existing and future models.
- Noise abatement was evaluated for noise impacts.

Items of concern listed in the memo above:

- The TNM files were not checked against the values in the Noise Technical Report, as they were sent directly to CDOT. The files include TNM input and output files for all models.
- CDOT NAAG recommends taking two field measurements at each site. The Noise Technical Report indicates that only one field measurement was taken at each site.
- No supporting documentation for the existing and future traffic volumes and percentage breakdown was included in the report.
- Three receivers approach the NAC in the existing condition and are not shown on the existing condition figures in the Noise Technical Report (Figures 3a -3e). These receivers are the properties that will be acquired as a result of the project, so they will not have impacts in the future condition. Abatement was not evaluated for these locations since there are no impacts on future conditions.
- More information is needed on property acquisition. If the properties are to be completely removed from the project area, the model would need to reflect this. If the properties are removed, the shielding from those houses would no longer be present, and the model would need to reflect that for future conditions.
- CDOT NAAG states "Noise contour maps of the project area clearly delineating the future 66 dBA and 71 dBA contours on the most current available base mapping, or aerial photography of the CDOT project including the surrounding community shall be supplied to the local agency planning department, the zoning department, and the building permit department." Only approximate distances from the proposed new edge of the nearest travel lane to where noise levels are predicted to exceed the Activity Category B, C, and E noise abatement criteria levels are included in the Noise Technical Report. Although not required, noise contours should be included in the report.

All tables included in the report were checked, and the values were accurate.

Based on the information provided above, it has been determined that the noise impacts are correct. The noise abatement barrier walls evaluated at the three impact locations were determined not to be feasible and/or reasonable and are not recommended to build as part of this project.