Technical Memo

To	Utah Department of Transportation and Utah Transit Authority
From	Lance Meister, Cross-Spectrum Acoustics, Inc.
Date	January 2026
Re	North of Provo Double Track Project Noise and Vibration Mitigation Assessment

Summary

The purpose of this memorandum is to summarize the noise and vibration mitigation assessment for the North of Provo Double Track Project. The project consists of double tracking approximately 0.7 miles of the FrontRunner Commuter Rail system from just north of the Provo Central Station until it merges with the existing double track just north of 900 West and 500 South in Provo.

A noise and vibration assessment was completed for this project in 2025[1] to determine impacts from infrastructure changes (adding the double track and associated trackwork). In addition, corridor-level noise and vibration assessments were completed in 2023 and 2025[2] for the entire FrontRunner corridor to determine impacts from service increase (15-min at peak, 30-min off-peak). Noise and vibration impacts were identified, and mitigations were recommended. This mitigation assessment is a detailed review of reasonable and feasible mitigation measures that would be implemented as part of the project.

The results of the mitigation assessment indicate that spring-rail frogs would need to be installed on the double or universal crossovers near Station 302+35 through Station 309+80, on the FrontRunner tracks, between 500 West and 200 West for both noise and vibration mitigation. In addition, a 670-foot long ballast mat would need to be installed under the new FrontRunner track from Station 310+90 to 317+60 on top of an HMA concrete slab for vibration mitigation. A 840-foot long, 12-foot tall noise barrier (above top of rail) would need to be installed on the south side of the tracks west of 500 West from approximately Station 312+12 to 320+50 and a 540-foot long 13-foot tall noise barrier (above top of rail) would need to be installed on the south side of the tracks east of 500 West and west of 400 West, from approximately Station 306+39 to 311+35. With the recommended mitigation measures, all identified noise and vibration impacts would be mitigated.

[1] Utah Transit Authority, Noise and Vibration Analysis for the North of Provo Double Track Project, July 21, 2025.
[2] Utah Transit Authority, FrontRunner Forward Corridor Level Noise and Vibration Analysis, May 18, 2023; and Utah Transit Authority, FrontRunner Forward Corridor Level Noise and Vibration Analysis Addendum, May 20, 2025.

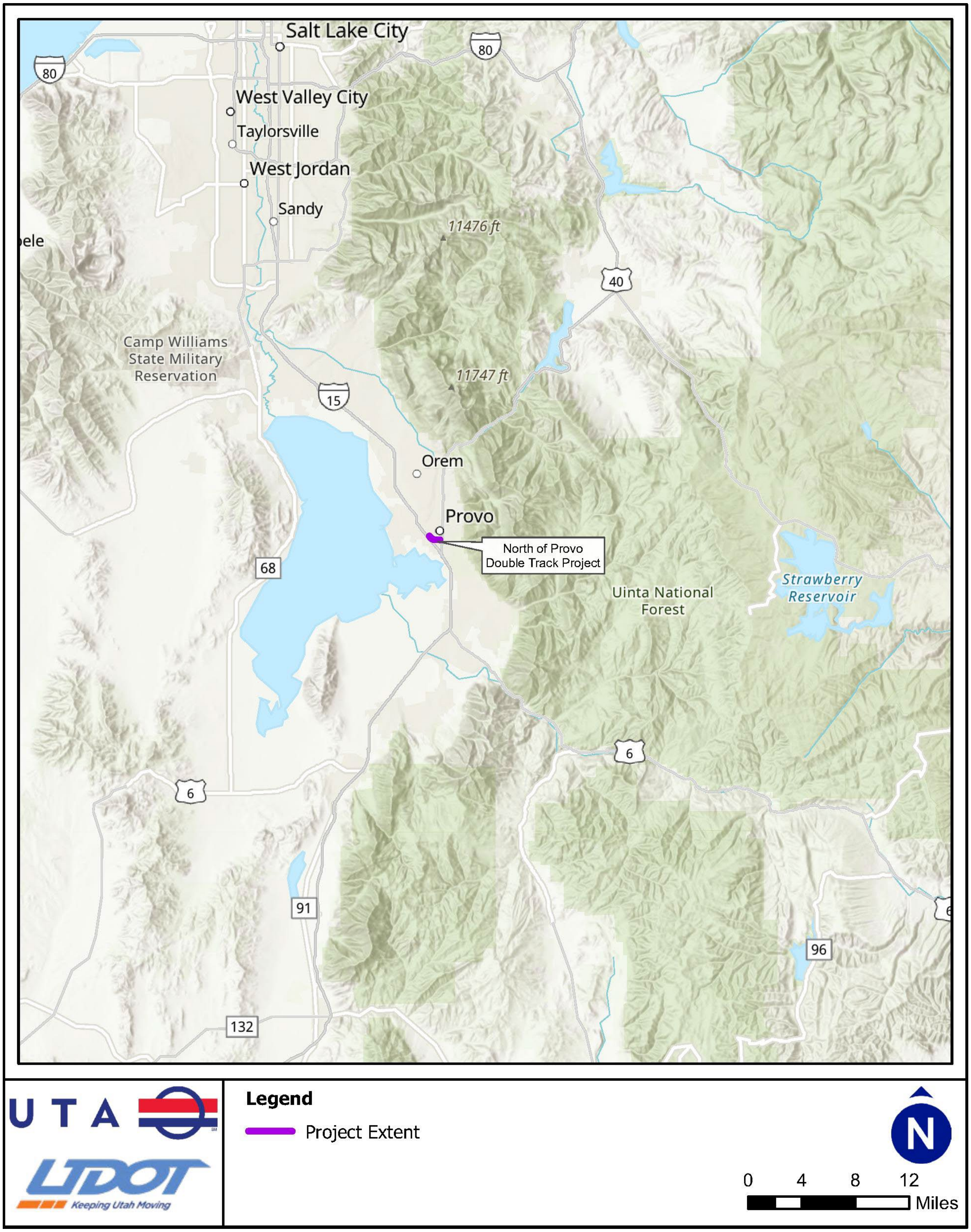

Figure 1. North of Provo Double Track Project Overview

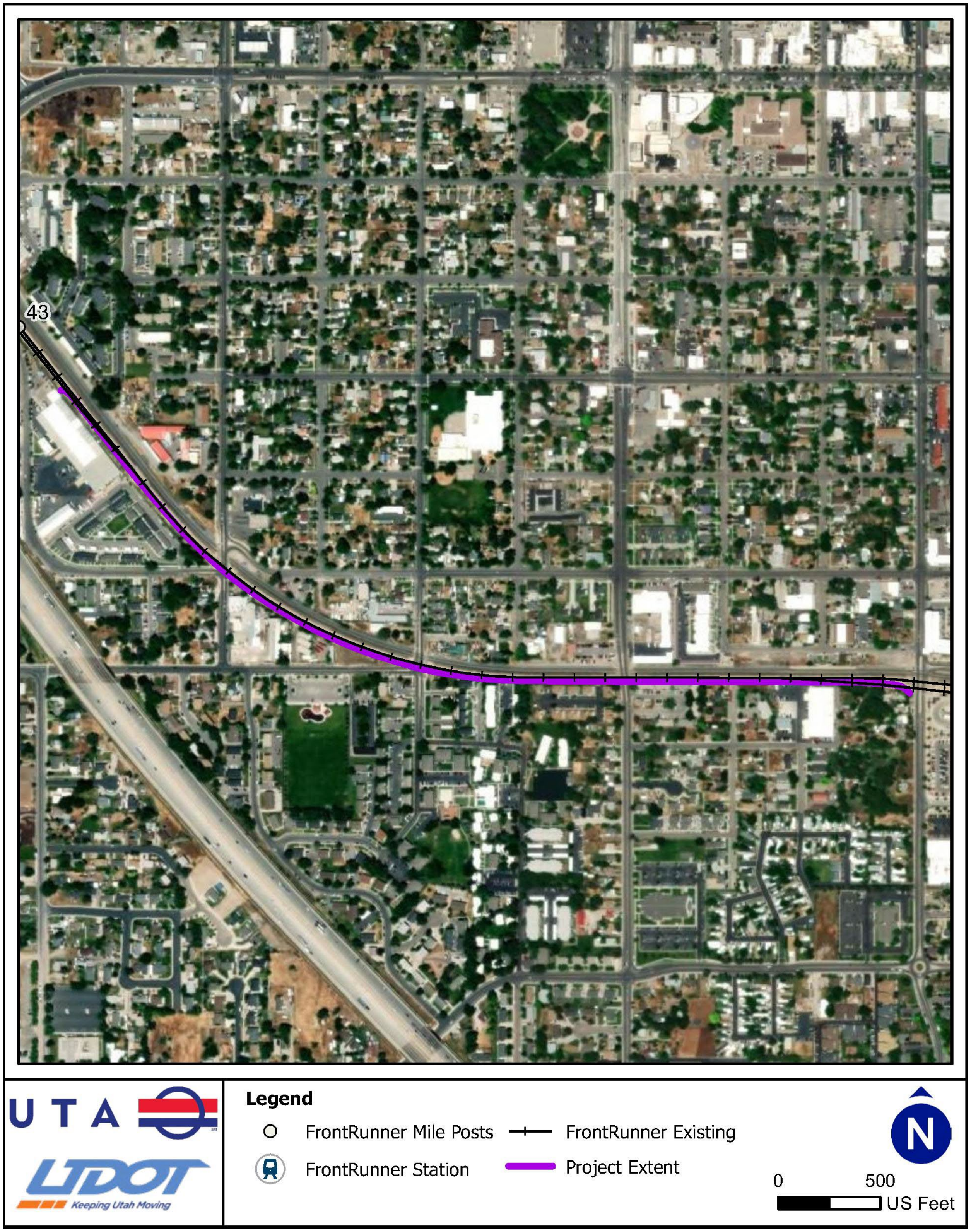

Figure 2. North of Provo Double Track Project Area

Noise

The Federal Transit Administration (FTA) noise and vibration guidance manual[3] was used in the assessment of impacts and the design of the noise mitigation. There were 13 buildings with 36 residences facing the track identified as moderate noise impacts in the North of Provo Double Track Project at 2 single-family homes, 10 4-unit buildings and one apartment complex. The impacts are due to the combined effects of the double track project and the service increase, including noise impacts due to the increase in noise for second row buildings from the removal of front-row buildings for the project. The locations of the noise impacts are shown in Figure 3 and Figure 4.

The moderate noise impacts are due to the presence of special trackwork, i.e. crossovers, at the eastern end of the project area for the FrontRunner trains and the proximity of the new track to receivers on the south side of the tracks on either side of 500 West. Crossovers and turnouts have a gap in the rail for the wheel, and this gap creates additional noise as the wheel impacts the gap. Because of the close proximity, the combined effects of the new double track closer to the homes and the additional service would cause moderate impacts at 11 multi-family buildings and 2 single-family homes (36 residences total) in the neighborhood.

The moderate noise impacts meet the mitigation threshold established in the UTA noise policy[4] because the existing noise levels are above 65 dBA Ldn. The mitigation for noise from the special trackwork is to install spring-rail frogs on the universal crossover near Station 302+35 to Station 309+80 on the FrontRunner tracks to eliminate the gap in the main direction of travel and the associated increase in noise. Installation of spring-rail frogs at the crossovers would reduce the FrontRunner noise levels by approximately 5 dB at some of the receivers near the crossovers but would not fully mitigate the impacts. Additional noise mitigation, in the form of noise barriers, would need to be considered at this location. Where feasible and cost effective, noise barriers can be considered for noise mitigation. If noise barriers are not effective, feasible or cost effective, sound insulation would be considered. Two noise barriers were assessed for the Project.

The noise barrier calculation is based on the equations in Table 4-28 of the FTA guidance manual. A noise barrier works by blocking the line of sight from the source of the noise to the receiver. The barrier calculations determine how effective a barrier is by calculating the path length difference and the protrusion of the barrier above the line of sight. The process for calculating the effectiveness of a noise barrier involves the following steps:

- Determining the appropriate barrier type and equation (see Table 4-28 in the FTA guidance manual).
- Determining the ground elevations of the track, barrier and receivers.
- Calculating the distance from each source of noise to the barrier and the distance from the barrier to each receiver.
- Determining the heights of the sources of noise and the height of the receivers.
- Estimating a barrier height for the calculations.
- Calculating the path length difference for each source/barrier/receiver set and then determining the insertion loss (reduction in noise level) of the barrier.
- Refining the barrier height until the desired insertion loss is achieved.

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[3] Federal Transit Administration, Transit Noise and Vibration Impact Assessment Manual, FTA Report No. 0123, September 2018.

[4] Utah Transit Authority Office of Capital Services SOP, No. OCS.01.01, Noise assessment and Mitigation, May 1, 2024.

- Calculating the cost effectiveness of the barrier. The UTA noise policy sets the maximum cost of a barrier at $30,000 per benefited receiver. The UDOT noise barrier unit cost is estimated at $20/square foot.[5]

For the barrier calculations, four sources of FrontRunner noise were used. For locomotives, the main source of noise is the engine and exhaust. For cars, the main source of noise is the wheel on the rail. All heights are referenced to height above top of rail:

- Northbound locomotives – 12-foot source height
- Southbound locomotives – 12-foot source height
- Northbound cars – 2-foot source height
- Southbound cars – 2-foot source height

All of the receivers were assumed to be two stories with a receiver heigh of 14 feet for the second story, with the exception of one single-family one-story home on the east side of 500 West, with a receiver height of five feet (these are the heights above ground level of the windows on the second floor or first floor for the single-family home). The ground elevation of the residences and barriers was approximately three feet below the top of rail elevation.

Barrier West of 500 West

The results of the barrier assessment for the FrontRunner trains are shown in Table 1 for the noise barrier proposed on the west side of 500 West. The barrier would have a height of 12 feet above the top of rail and be 831 feet long (as shown in Figure 3). At this height, all of the noise impacts would be mitigated. Additionally, the UTA noise assessment and mitigation policy requires that at least 50% of the receivers have at least a 5 dB reduction in noise for the barrier to be considered reasonable. All of the residences would have a noise reduction greater than 5 dB, so this would be considered a reasonable barrier.

For the cost effectiveness calculation, the barrier height is from ground level to required height above top of rail minus any retaining wall that was already planned prior to mitigation. For this barrier, 408 feet of the noise barrier would be on a 3-foot-tall retaining wall, for a barrier height of 12 feet, and the remaining 423 feet would not have a retaining wall under it resulting in a barrier height of 15 feet. The barrier would be located from Station 312+19 to Station 320+50. The total surface area of the noise barrier would be approximately 11,241 square feet (408 feet * 12 feet + 423 feet * 15 feet). At $20/square foot (per UDOT barrier cost data), the noise barrier would have a cost of $224,820. The noise barrier would benefit 22 residences in this impacted neighborhood, for a cost effectiveness calculation of $10,219 per benefited receiver. This is below the $30,000 cost per benefited receptor, so the noise barrier would be cost effective.

[5] Utah Department of Transportation Noise Abatement Report, 08A2-01, May 28, 2020.

Table 1. Noise Barrier Insertion Loss for FrontRunner Trains – West of S 500 West

Receiver	Story	Dwelling Units Facing the Tracks	Insertion Loss* Northbound Locomotive Noise, dB	Insertion Loss Southbound Locomotive Noise, dB	Insertion Loss Northbound Wheel-Rail Noise, dB	Insertion Loss Southbound Wheel-Rail Noise, dB	Total Insertion Loss, dB
607	First	1	9.2	10.9	10.9	11.1	10.7
607	Second	1	6.3	9.5	10.8	11.0	9.5
R11	First	1	14.0	14.4	14.0	14.4	14.2
R11	Second	1	7.9	11.9	14.0	14.4	12.3
608**	First	1	11.4	12.8	12.7	12.9	12.6
608**	Second	1	7.7	11.4	12.6	12.8	11.3
R22	First	1	14.6	15.2	14.6	15.2	15.0
R22	Second	1	7.6	11.7	14.6	15.2	12.6
R23	First	2	14.2	14.7	14.2	14.6	14.5
R23	Second	2	4.0	8.2	13.5	14.7	9.8
R24	First	2	14.0	14.4	14.0	14.4	14.2
R24	Second	2	3.6	6.9	12.9	14.4	9.1
R25	First	2	13.8	14.3	13.8	14.3	14.1
R25	Second	2	2.8	5.5	11.4	14.3	8.1
R26	First	1	13.3	13.8	13.3	13.8	13.6
R26	Second	1	5.5	7.6	11.8	13.8	9.9

* Insertion loss is the reduction in noise level provided by the barrier. Generally, first story receivers have a greater reduction than second story receivers.
**This building was not identified as an impact but would benefit from the barrier.

Noise Impact Location – West of 500 West

Figure 3. North of Provo Double Track Project

Barrier East of 500 West

The results of the barrier assessment for the FrontRunner trains are shown in Table 2 for the noise barrier proposed on the east side of 500 West. The barrier would have a height of 13 feet above the top of rail and 425 feet long (as shown in Figure 4). The barrier at this location is slightly higher than the other barrier due to the greater distance from the barrier to the receivers. At this height, all of the noise impacts would be mitigated. Additionally, the UTA noise assessment and mitigation policy requires that at least 50% of the receivers have at least a 5 dB reduction in noise for the barrier to be considered reasonable. Eleven of the 16 residences would have a noise reduction greater than 5 dB, so this would be considered a reasonable barrier.

For the cost effectiveness calculation of this barrier, 135 feet of the noise barrier would be on a 3-foot-tall retaining wall, for a barrier height of 13 feet, and the remaining 290 feet would not have a retaining wall under it resulting in a height of 16 feet. The barrier would be located from Station 306+50 to Station 210+75. The total area of the barrier would be 6,395 square feet (135 feet * 13 feet + 290 feet * 16 feet). At $20/square foot (per UDOT barrier cost data), the barrier would have a cost of $127,900. The barrier would benefit 11 residences in this impacted neighborhood (residences with a noise reduction greater than 5 dB), for a cost effectiveness calculation of $11,627. This is below the $30,000 cost per benefited receptor, so the barrier would be cost effective.

Table 2. Noise Barrier Insertion Loss for FrontRunner Trains – East of 500 West

Receiver	Story	Dwelling Units Facing the Tracks	Insertion Loss** Northbound Locomotive Noise, dB	Insertion Loss Southbound Locomotive Noise, dB	Insertion Loss Northbound Wheel-Rail Noise, dB	Insertion Loss Southbound Wheel-Rail Noise, dB	Total Insertion Loss, dB
615	--*	1	1.2	2.3	6.2	6.8	4.2
616	First	2	3.1	3.7	5.8	5.9	4.8
616	Second	2	1.6	2.7	5.7	5.8	4.0
617	First	2	5.0	5.9	8.2	8.3	7.0
617	Second	2	3.1	4.6	8.1	8.2	6.0
618	First	2	5.8	8.8	9.1	9.2	8.3
618	Second	2	3.8	8.2	9.0	9.1	7.4
R36***	First	1	9.9	10.8	11.8	12.0	11.3
R36	Second	1	5.9	7.9	11.7	11.9	9.4
R44	--*	1	11.7	13.0	13.3	13.6	13.1

*Receivers 615 and R44 are single family homes. The barrier performance was calculated based on the height of the highest story.
** Insertion loss is the reduction in noise level provided by the barrier. Generally, first story receivers have a greater reduction than second story receivers.
*** This building was not identified as an impact but would benefit from the barrier.

Noise Impact Location – East of 500 West

Figure 4. North of Provo Double Track Project

Noise Mitigation

The noise mitigation recommendation is to install spring-rail frogs at four locations along the universal crossovers, near Station 302+35 to Station 309+80, on the new FrontRunner tracks to eliminate the gap in the main direction of travel and the associated increase in noise, to construct a 12-foot tall noise barrier (above top of rail) to the west of 500 West from approximately Station 312+19 to 320+50 for a length of 831 feet and a 13-foot tall noise barrier (above top of rail) to the east of 500 West from approximately Station 306+50 to 310+75 for a length of 425 feet. The spring-rail frogs would reduce noise levels by approximately 5 dB but would not fully mitigate the impacts. However, with the inclusion of the spring-rail frogs and the noise barriers, all the noise impacts would be mitigated.

Vibration

The FTA noise and vibration guidance manual was used in the assessment of impacts and the design of the vibration mitigation. At most locations, the change in vibration levels due to the proposed track would not be above the impact threshold for an increase of 3 VdB, due to the small change in distance to sensitive receivers. However, there are two locations on the North of Provo Double Track Section where there would be increases of 3 VdB or more.

Crossovers and turnouts have a gap in the rail for the wheel, and this gap creates additional vibration as the wheel impacts the gap. There are five residential buildings at the eastern end of the segment east of 500 West and west of 400 West with vibration impacts near a set of proposed universal crossover on the FrontRunner tracks, as shown in Figure 5. With the installation of spring-rail frogs at this location, the vibration levels for these five residential buildings would be below the impact threshold of a 3 VdB increase.

To the west of 500 West, there are three residential buildings with vibration impacts due to the change in vibration levels from the new track being greater than 3 VdB, as shown in Figure 6. At this location, the existing track is 50 feet from the residences and the new track is 30 feet from the residences, resulting in an increase in vibration of 3.9 VdB. At this location, a ballast mat on top of an HMA concrete slab would be recommended to mitigate the vibration impacts.

In order to determine the existing vibration levels and the potential effectiveness of a ballast mat for this Project, a set of vibration measurements of FrontRunner trains were conducted on July 28, 2025, at the end of 400 West, south of the FrontRunner tracks in Provo, as shown in Figure 7. The vibration measurements followed the procedures outlined in Section 6.5 of the FTA guidance manual. Accelerometers were mounted on paving bricks set on the ground 35 feet from the FrontRunner tracks and a series of passbys of FrontRunner trains were measured, in both the northbound and southbound directions. The measurements included:

- 5 trains in the northbound direction
- 4 trains in the southbound direction

The data was analyzed to determine the maximum overall vibration levels and the vibration levels at each frequency band between 6.3 Hz and 250 Hz (the frequency data is summed to get the overall vibration level). The result of the measurements is shown by the orange line in Figure 9 and the first row in Table 3. The vibration consists of generally middle frequency vibration (between 31.5 Hz and 80 Hz).

To document the field performance of existing Frontrunner ballast mats, vibration measurements of existing FrontRunner trains were conducted in July 2025 in Lehi in the North of American Fork Project area. The ballast mat in this area was installed as a part of the FrontRunner South project (2008-2012) to mitigate vibration impacts for that project. Measurements collected in Lehi included those from an area near the track where ballast mat is present and a nearby area without ballast. The vibration measurements followed the procedures outlined in Section 6.5 of the FTA guidance manual. Details regarding the measurements can be found in the North of American Fork Double Track Project Noise and Vibration Mitigation Assessment[6], and the results are shown in Figure 8 and in second row of Table 3.

[6] Utah Department of Transportation and Utah Transit Authority, North of American Fork Double Track Project Noise and Vibration Mitigation Assessment, January 2026.

The data shown in Figure 9 and Table 3 represent the average of the FrontRunner passbys, including the overall level and each frequency. The ballast mat performance measured in Lehi was applied to this measurement by frequency to calculate the effect a ballast mat would have on the overall vibration levels. The third row in Table 3 and the blue line in Figure 9 represent the vibration levels with the ballast mat. Due to the vibration in the middle frequencies (between 31.5 Hz and 80 Hz), installing a ballast mat at this location would reduce the overall vibration from the FrontRunner trains by 2.5 VdB, which would reduce the vibration levels from the new track to below the impact threshold of an increase of 3 VdB.

With the application of spring-rail frogs at the two double crossovers near Station 304+00 and Station 309+00 and a 670-foot long ballast mat installed under the new track from Station 310+90 to 317+60, all of the vibration impacts would be mitigated.

Table 3. Vibration Measurement Results by Frequency

Vibration Level (VdB)																			
Vibration Results	**Train Speed (mph)**	**Overall Vibration Level**	**6.3 Hz**	**8 Hz**	**10 Hz**	**12.5 Hz**	**16 Hz**	**20 Hz**	**25 Hz**	**31.5 Hz**	**40 Hz**	**50 Hz**	**63 Hz**	**80 Hz**	**100 Hz**	**125 Hz**	**160 Hz**	**200 Hz**	**250 Hz**
Measured Vibration Level***	25	77.1	43.0	42.9	48.0	53.2	55.0	59.5	58.2	69.2	71.0	67.2	69.9	70.0	63.8	58.7	55.1	49.5	39.1
Ballast Mat Performance****	--	--	0.0*	0.0*	0.0*	1.6	2.6	0.7	1.6	-0.5	2.6	1.2	2.5	9.8	12.5	9.5	15.0**	15.0**	13.5
Mitigated Vibration Level	25	74.6	43.0	42.9	48.0	51.6	52.4	58.8	56.6	69.7	68.5	66.0	67.4	60.2	51.2	49.2	40.1	34.5	25.6

*The data at 6.3 Hz, 8 Hz and 10 Hz was excluded from the ballast mat performance calculation and set at 0. At very low frequencies, the data at close distances can have unusual results which are not valid. In this case, the on ballast mat measurements in American Fork at 75 mph are showing a significant reduction in the vibration levels at these frequencies, which is not possible with a ballast mat. The data was excluded at these frequencies, and the performance was set to zero. Because the vibration levels are much lower at these frequencies, there is no effect on the overall vibration level.
**For the purposes of ballast mat performance for other locations, a maximum reduction of 15 VdB was applied at each frequency. Reductions greater than 15 VdB at any frequency are not typical for ballast mats.
*** Data gathered in Provo for the North of Provo Double Track Project, July 2025.
**** Data gathered in Lehi for the North of American Fork Double Track Project, July 2025.

Vibration Impact Location – East of 500 West

Figure 5. North of Provo Double Track Project

Vibration Impact Location – West of 500 West

Figure 6. North of Provo Double Track Project

Figure 7. Provo Vibration Measurement Location

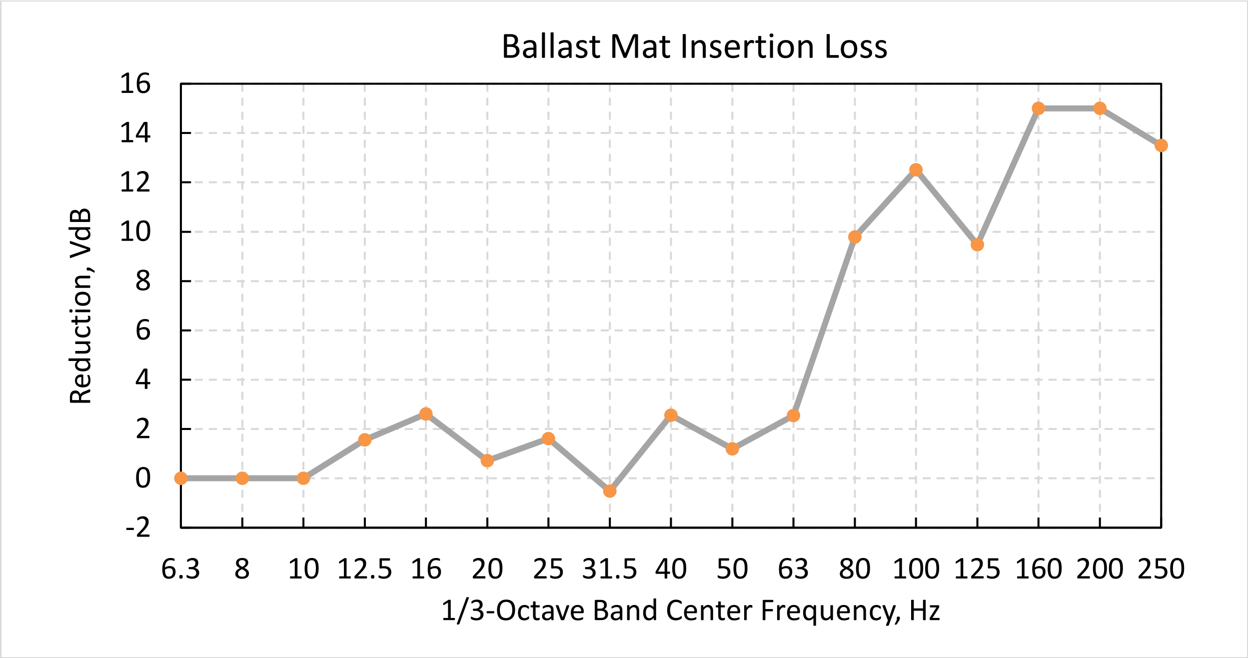

Figure 8. Existing Ballast Mat Performance
(From field data collected in Lehi, July 2025)

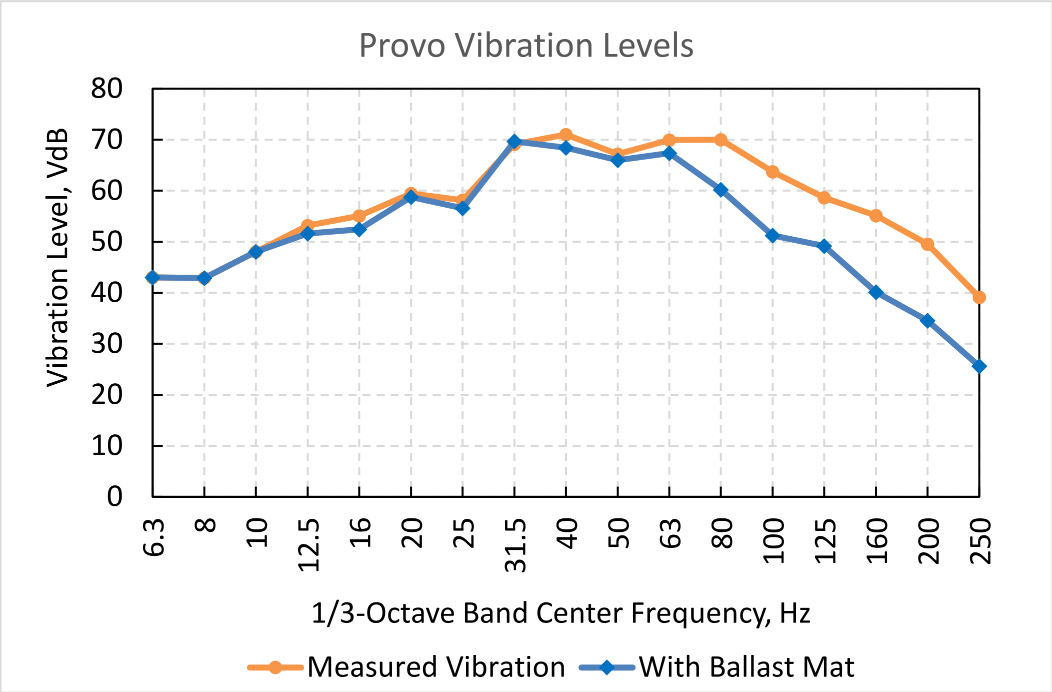

Figure 9. Projected Ballast Mat Vibration Reduction – Provo
(From field data collected in Provo and Lehi, July 2025)