



METRO Blue Line Light Rail Extension Project Noise and Vibration Technical Report

To: Kelcie Young Environmental Project Manager and Neha Damle Environmental Project Manager

From: Lance Meister, Cross-Spectrum Acoustics, Inc.
Joelle Suits, Cross-Spectrum Acoustics, Inc.

Date: February 22, 2024

Subject: Draft Noise and Vibration Technical Report for Metro Blue Line Light Rail Extension Project Supplemental Draft EIS

Contents

- 1 Introduction..... 5
- 2 Summary of Assessment Results 5
 - 2.1 Noise..... 5
 - 2.2 Vibration 6
- 3 Regulatory Context 6
 - 3.1 Noise..... 6
 - 3.1.1 Noise Basics..... 6
 - 3.1.2 Noise Impact Criteria 7
 - 3.2 Vibration 11
 - 3.2.1 Vibration Impact Criteria..... 13
- 4 Impact Assessment Methodology 18
 - 4.1 Noise..... 18
 - 4.2 Vibration 19
 - 4.3 Construction Noise Assessment Methodology 21
 - 4.4 Construction Vibration Assessment Methodology 22
- 5 Affected Environment..... 23
 - 5.1 Noise..... 23
 - 5.1.1 Noise Sensitive Land Use 23
 - 5.1.2 Existing Noise Measurements 24
 - 5.2 Vibration 30
 - 5.2.1 Vibration Sensitive Land Use..... 30
 - 5.2.2 Existing Vibration Measurements 30



- 6 Environmental Consequences 34
 - 6.1 Project Noise 35
 - 6.1.1 Capri Theater 49
 - 6.1.2 Stations 50
 - 6.1.3 Operations and Maintenance Facility 50
 - 6.1.4 Construction Noise 50
 - 6.2 Project Vibration 52
 - 6.2.1 Project Vibration 52
 - 6.2.2 Stations 59
 - 6.2.3 Operations and Maintenance Facility 59
 - 6.2.4 Construction Vibration 59
- 7 Mitigation Measures 60
 - 7.1 Noise 60
 - 7.1.1 Metro Transit Noise Mitigation Approach 60
 - 7.1.2 Noise Mitigation Methods 61
 - 7.1.3 Project Noise Mitigation 62
 - 7.1.4 Construction Noise Mitigation 63
 - 7.2 Vibration 63
 - 7.2.1 Vibration Mitigation Methods 63
 - 7.2.2 Project Vibration Mitigation 64
 - 7.2.3 Construction Vibration Mitigation 64
- 8 References 65
- Appendix A Existing Outdoor Noise Measurement Location Photographs 66
- Appendix B Noise Measurement Data 76
- Appendix C Vibration Measurement Location Photographs 84
- Appendix D Vibration Measurement Data 87
- Appendix E Project Noise Analysis from Project Alignment and Design Options Evaluated 94
- Appendix F Project Vibration Analysis from Other Project Alignment and Design Options Evaluated 123

List of Figures

Figure 3-1 Cumulative Noise Levels from Transit Sources	7
Figure 3-2 FTA Noise Impact Criteria	9
Figure 3-3 Vibration Levels from Typical Sources.....	12
Figure 3-4 Detailed Vibration Criteria.....	16
Figure 4-1 Force Density Levels at 40 mph	20
Figure 5-1 Existing Noise Measurement Locations	28
Figure 5-2 Vibration Propagation Measurement Schematic.....	31
Figure 5-3 Vibration Propagation Measurement Locations.....	33
Figure 5-4 Line Source Transfer Mobility Results at 50 feet	34
Figure 6-1 Project Noise Impacts in the City of Brooklyn Park.....	38
Figure 6-2 Project Noise Impacts in the City of Crystal.....	41
Figure 6-3 Project Noise Impacts in the City of Robbinsdale	44
Figure 6-4 Project Noise Impacts in the City of Minneapolis	48
Figure 6-5 Project Vibration Impacts in the City of Minneapolis along the 21st Ave N and Washington Ave Option	58

List of Tables

Table 3-1 Land Use Categories and Metrics for Transit Noise Impact Criteria	8
Table 3-2 Land Use Categories and Metrics for Transit Noise Impact Criteria	10
Table 3-3 FTA Construction Noise Criteria	11
Table 3-4 Ground-Borne Vibration and Ground-Borne Noise Impact Criteria for General Assessment.....	14
Table 3-5 Ground-Borne Vibration and Ground-Borne Noise Impact Criteria for Special Buildings.....	15
Table 3-6 FTA Construction Vibration Criteria	17
Table 3-7 FTA Vibration Damage Criteria from Construction	18
Table 4-1 Blue Line Reference Noise Levels.....	19
Table 4-2 Construction Equipment Noise Emission Levels	21
Table 4-3 Construction Equipment Vibration Source Levels.....	23
Table 5-1 Summary of Existing Noise Level Measurements	25
Table 5-2 Summary of Existing L10 and L50 Noise Levels at Long-Term Noise Measurement Locations	29
Table 6-1 Summary of Noise Impacts for Residential Land Use in the City of Brooklyn Park.....	36
Table 6-2 Summary of Noise Impacts for Institutional Land Use in the City of Brooklyn Park	37
Table 6-3 Summary of Noise Impacts for Residential Land Use in the City of Crystal.....	39
Table 6-4 Summary of Noise Impacts for Institutional Land Use in the City of Crystal	40
Table 6-5 Summary of Noise Impacts for Residential Land Use in the City of Robbinsdale	42
Table 6-6 Summary of Noise Impacts for Institutional Land Use in the City of Robbinsdale	43
Table 6-7 Summary of Noise Impacts for Residential Land Use in the City of Minneapolis	45
Table 6-8 Summary of Noise Impacts for Institutional Land Use in the City of Minneapolis	47
Table 6-9 FTA Noise and Vibration Criteria for the Capri Theater.....	49
Table 6-10 Summary of Project Noise and Vibration Levels for the Capri Theater.....	50
Table 6-11 Typical Construction Noise Levels	51
Table 6-12 Summary of Historic and Cultural Resources Noise Assessment.....	52
Table 6-13 Summary of Vibration Impacts for Residential Land Use in the City of Brooklyn Park	53



Table 6-14 Summary of Vibration Impacts for Institutional Land Use in the City of Brooklyn Park 54

Table 6-15 Summary of Vibration Impacts for Residential Land Use in the City of Crystal 54

Table 6-16 Summary of Vibration Impacts for Institutional Land Use in the City of Crystal 55

Table 6-17 Summary of Vibration Impacts for Residential Land Use in the City of Robbinsdale 55

Table 6-18 Summary of Vibration Impacts for Institutional Land Use in the City of Robbinsdale..... 55

Table 6-19 Summary of Vibration Impacts for Residential Land Use in the City of Minneapolis for the Build
Alternative 56

Table 6-20 Summary of Vibration Impacts for Institutional Land Use in the City of Minneapolis (21st Ave N to
Washington Ave)..... 57

Table 6-21 Summary of Potential Construction Vibration Impacts 59

Table E-1 Summary of Residential Noise Impacts by Project Cities and Option 94

Table E-2 Summary of Noise Impacts for Residential Land Use in the City of Minneapolis (21st Ave to East of I-
94) 96

Table E-3 Summary of Noise Impacts for Institutional Land Use in the City of Minneapolis (21st Ave to East of
I-94) 99

Table E-4 Summary of Noise Impacts for Residential Land Use in the City of Minneapolis (21st Ave N to
Lyndale Ave) 103

Table E-5 Summary of Noise Impacts for Institutional Land Use in the City of Minneapolis (21st Ave N to Lyndale
Ave) 106

Table E-6 Summary of Noise Impacts for Residential Land Use in the City of Minneapolis (W Broadway Ave to
East of I-94)..... 110

Table E-7 Summary of Noise Impacts for Institutional Land Use in the City of Minneapolis (W Broadway Ave to
East of I-94)..... 112

Table E-8 Summary of Noise Impacts for Residential Land Use in the City of Minneapolis (W Broadway Ave to
Lyndale Ave) 116

Table E-9 Summary of Noise Impacts for Institutional Land Use in the City of Minneapolis (W Broadway Ave to
Lyndale Ave) 118

Table F-1 Summary of Vibration Impacts by Project Cities and Option..... 123

Table F-2 Summary of Vibration Impacts for Residential Land Use in the City of Minneapolis (21st Ave N to
East of I-94)..... 124

Table F-3 Summary of Vibration Impacts for Institutional Land Use in the City of Minneapolis (21st Ave N to
East of I-94)..... 126

Table F-4 Summary of Vibration Impacts for Residential Land Use in the City of Minneapolis (21st Ave N to
Lyndale Ave) 130

Table F-5 Summary of Vibration Impacts for Institutional Land Use in the City of Minneapolis (21st Ave N to
Lyndale Ave) 131

Table F-6 Summary of Vibration Impacts for Residential Land Use in the City of Minneapolis (W Broadway Ave
to East of I-94) 135

Table F-7 Summary of Vibration Impacts for Institutional Land Use in the City of Minneapolis (W Broadway
Ave to East of I-94)..... 136

Table F-8 Summary of Vibration Impacts for Residential Land Use in the City of Minneapolis (21st Ave N to
East of I-94)..... 138

Table F-9 Summary of Vibration Impacts for Institutional Land Use in the City of Minneapolis (21st Ave N to
East of I-94)..... 139

1 Introduction

Cross-Spectrum Acoustics Inc. (CSA) conducted a noise and vibration impact assessment for the proposed METRO Blue Line Light Rail Extension Project (Project) Supplemental Draft Environmental Impact Statement (EIS). Noise and vibration have been assessed in accordance with guidelines specified in the Federal Transit Administration’s (FTA’s) Transit Noise and Vibration Impact Assessment guidance manual (FTA, 2018). The objective of the assessment was to document the noise and vibration impacts at sensitive locations and identify mitigation measures as a part of the Project.

The noise and vibration analysis for the Build Alternative is presented in the main body of this technical report, the analysis for Project alignment and design options is presented in Appendix E and F. A summary of the assessment results is described below in Section 2. Section 3 provides a discussion of the regulatory context, including noise and vibration basics and details regarding the noise and vibration criteria used to assess impact. Section 4 describes the methodology used to assess noise and vibration impact. Section 5 discusses the existing conditions, including a description of the noise and vibration sensitive land uses and the measurements conducted to determine the existing noise and vibration conditions. Section 6 includes the results of the noise and vibration impact assessment. Mitigation measures are discussed in Section 7. Appendices A and B contain detailed information on the noise measurements conducted for the Project. Appendices C and D contain detailed information on the vibration measurements conducted for the Project.

Based on the screening distances provided in Chapters 4 and 9 of the FTA guidance manual, the noise and vibration study area included the area 350 feet from the center line of the Project Alignment.

2 Summary of Assessment Results

2.1 Noise

This section contains a summary of the noise impacts by city and sensitive land use type. Most of the impacts are due to the proximity of the tracks (wheel/rail interaction) to the sensitive land use, grade crossing bells, and the location of the crossover.

Table 2-1 Summary of Noise Impacts by Municipality

Building Type	# of Properties Affected (# of Dwelling Units [DU])		Cause of Impact
	Moderate Impact	Severe Impact	
City of Brooklyn Park			
Single-family	1	0	Expansion of County Road (CR) 103 and LRV bells.
Multi-family	3 (12 DUs)*	0	
Institutional	1	0	
City of Crystal			
Single-family	4	0	Wheel/rail interaction and speed of train.
Multi-family	1 (14 DUs)*	0	
Institutional	0	0	
City of Robbinsdale			
Single-family	2	0	Wheel/rail interaction and speed of train.
Multi-family	0	0	



Building Type	# of Properties Affected (# of Dwelling Units [DU])		Cause of Impact
	Moderate Impact	Severe Impact	
Institutional	0	0	
City of Minneapolis			
Single-family	11	10	Wheel/rail interaction, LRV bells.
Multi-family	5 (200 DUs)*	5 (163 DUs)*	
Institutional	1	0	

Source: *Noise and Vibration Technical Report*. Cross-Spectrum Acoustics, Inc. 2023.

*Includes total number of DUs at the affected properties. Additional noise measurements and analysis will be performed to determine potential impacts at each dwelling unit and the reasonable and feasible mitigation measures that would be implemented.

2.2 Vibration

The detailed vibration analysis identified 28 vibration impacts in the City of Minneapolis. These impacts are due to proximity of sensitive receptors to the Project Alignment.

3 Regulatory Context

3.1 Noise

3.1.1 Noise Basics

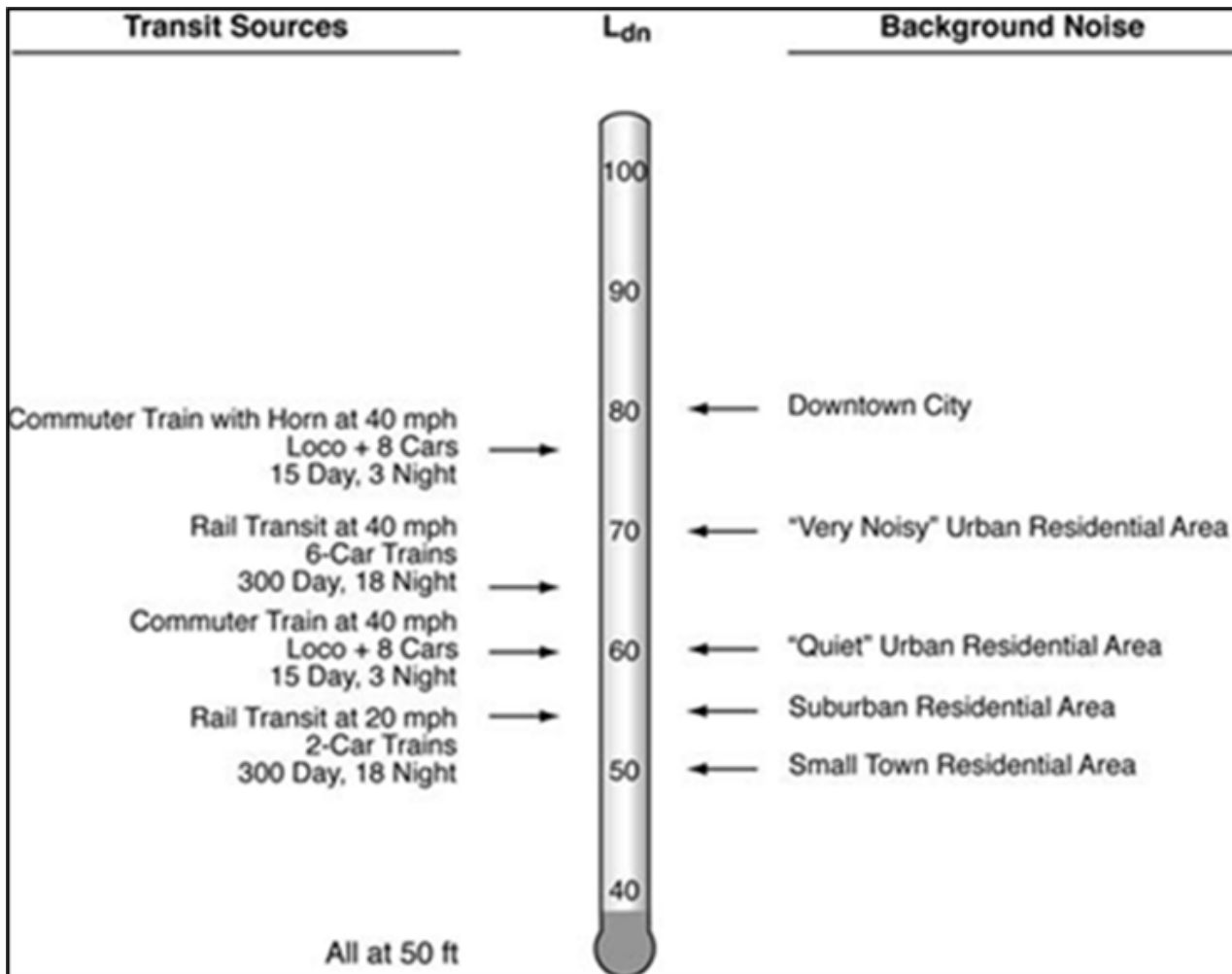
Sound is defined as small changes in air pressure above and below the standard atmospheric pressure and noise is usually considered to be unwanted sounds. The three parameters that define noise include:

- **Level:** The level of sound is the magnitude of air pressure change above and below atmospheric pressure and is expressed in decibels (dB). Typical sounds fall within a range between 0 dB (the lower limits of human hearing) and 120 dB (the highest sound levels experienced in the environment). A 3 dB change in sound level is perceived as a barely noticeable change outdoors and a 10-dB change in sound level is perceived as a doubling (or halving) of the sound level.
- **Frequency:** The frequency (pitch or tone) of sound is the rate of air pressure changes and is expressed in cycles per second, or Hertz (Hz). Human ears can detect a wide range of frequencies from around 20 Hz to 20,000 Hz; however, human hearing is not effective at high and low frequencies, and the A-weighting system (dBA) is used to correlate with human response to noise. The A-weighted sound level has been widely adopted by acousticians as the most appropriate descriptor for environmental noise.
- **Time Pattern:** Because environmental noise is constantly changing, it is common to condense all this information into a single number, called the equivalent sound level (Leq). The Leq represents the changing sound level over a period of time, typically 1 hour or 24-hours in transit noise assessments. For light rail transit (LRT) and freight rail projects, the day-night sound level (Ldn) is the common noise descriptor used, and it has been adopted by most agencies as the best way to describe how people respond to noise in their environment. Ldn is a 24-hour cumulative A-weighted noise level that includes all noises that happen within a day, with a 10 dB penalty for nighttime noise (10 p.m. to 7 a.m.). This nighttime penalty means that any noise events at night are equivalent to 10 similar events during the day.

Typical Ldn values for various transit operations are shown on Figure 3-1.

The operations shown in the figure represent typical operations for transit systems. For example, the second entry in the left column of the figure represents a light rail system with six car trains, traveling at 40 miles per hour (mph), with 300 operations during the daytime and 18 operations during the nighttime, at 50 feet from the tracks. The actual noise level would depend on the specific project factors and the distance from the receiver to the tracks.

Figure 3-1 Cumulative Noise Levels from Transit Sources



Source: CSA, 2023.

3.1.2 Noise Impact Criteria

3.1.2.1 Federal Transit Administration Transit Noise Criteria

The noise impact criteria used for the Project are based on the information contained in Section 4 of the FTA noise and vibration guidance manual.¹ The FTA noise impact criteria are based on well-documented research on

¹ FTA, "Transit Noise and Vibration Impact Assessment Manual." FTA Report No. 0123, September 2018.

community response to noise and are based on both the existing level of noise and the change in noise exposure due to a project. The FTA noise criteria compare the project noise with the existing noise (not the noise associated with the No-Build Alternative).

The FTA noise criteria are based on the land use category of the sensitive receptor and use Ldn for locations where people sleep (Category 2) and Leq for locations with daytime and/or evening use (Category 1 or 3), as shown in Table 3-1.

The noise impact criteria are defined by the two curves shown in Figure 3-2, which allow increasing Project noise as existing noise levels increase, up to a point at which impact is determined based on Project noise alone. The FTA noise impact criteria include three levels of impact, as shown on Figure 3-2. The three levels of impact include:

- **No Impact:** Project-generated noise is not likely to cause community annoyance. Noise projections in this range are considered acceptable by FTA and mitigation is not required.
- **Moderate Impact:** Project-generated noise in this range is considered to cause impact at the threshold of measurable annoyance. Moderate impacts serve as an alert to Project planners for potential adverse impacts and complaints from the community. Mitigation should be considered at this level of impact based on project specifics and details concerning the affected properties.
- **Severe Impact:** Project-generated noise in this range is likely to cause a high level of community annoyance. The Project sponsor should first evaluate alternative locations/alignments to determine whether it is feasible to avoid severe impacts altogether. In densely populated urban areas, evaluation of alternative locations may reveal a trade-off of affected groups, particularly for surface rail alignments. Projects that are characterized as point sources rather than line sources often present greater opportunity for selecting alternative sites. This guidance manual and FTA’s environmental impact regulations both encourage Project sites which are compatible with surrounding development when possible. If it is not practical to avoid severe impacts by changing the location of the Project, mitigation measures must be considered.

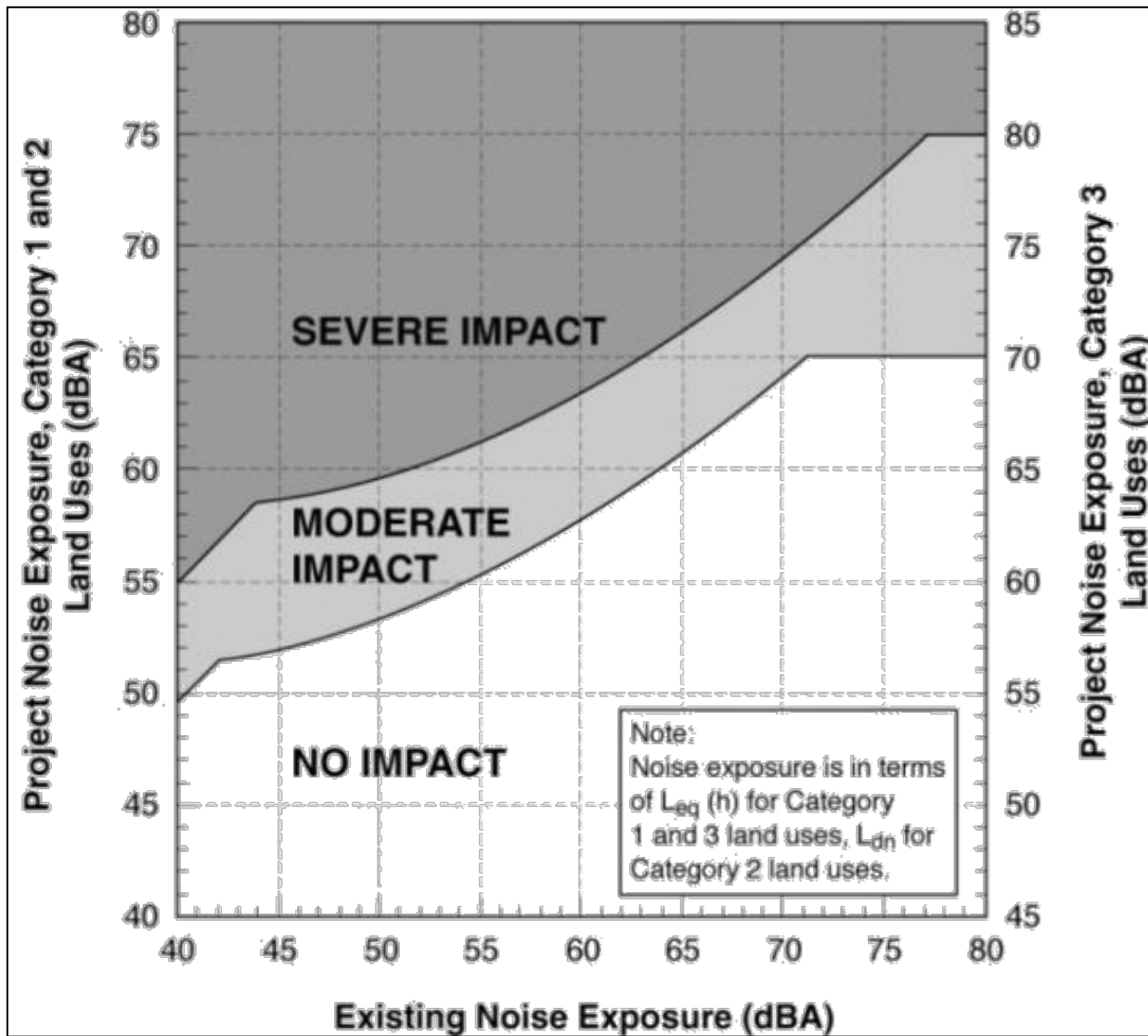
Table 3-1 Land Use Categories and Metrics for Transit Noise Impact Criteria

Land Use Category	Noise Metric (dBA)	Description of Land Use Category
1	Outdoor Leq(h) ^a	Land where quiet is an essential element of its intended purpose. Example land uses include preserved land for serenity and quiet, outdoor amphitheaters and concert pavilions, and national historic landmarks with considerable outdoor use. Recording studios and concert halls are also included in this category.
2	Outdoor Ldn	This category is applicable all residential land use and buildings where people normally sleep, such as hotels and hospitals.
3	Outdoor Leq(h) ^a	This category is applicable to institutional land uses with primarily daytime and evening use. Example land uses include schools, libraries, theaters, and churches where it is important to avoid interference with such activities as speech, meditation, and concentration on reading material. Places for meditation or study associated with cemeteries, monuments, museums, campgrounds, and recreational facilities are also included in this category.

Source: FTA, 2018.

^a Leq for the noisiest hour of transit-related activity during hours of noise sensitivity.

Figure 3-2 FTA Noise Impact Criteria



Source: FTA, 2018.

3.1.2.2 Cultural Resources

Under FTA guidance, historic sites are designated as noise sensitive depending on the land use of the site, not their designation as historic. Sites of national significance with considerable outdoor use required for site interpretation would be in Category 1. Historic sites that are currently used as residences would be in Category 2. Historic buildings with indoor use of an interpretive nature involving meditation and study would be in Category 3. These include museums, significant birthplaces, and buildings in which significant historical events occurred.

Most downtown areas have buildings which are historically significant because they represent a particular architectural style or are prime examples of the work of a historically significant designer. If the buildings or structures are used for commercial or industrial purposes and are located in busy commercial areas, they are not considered noise sensitive, and the impact criteria do not apply.

Similarly, historical transportation structures, such as terminals and railroad depots, are not considered noise sensitive land uses. These buildings or structures may however be afforded special protection under Section 4(f) of the United States Department of Transportation (USDOT) Act and Section 106 of the National Historic Preservation Act.

In the Section 106 process protecting historic and cultural properties, noise may or may not be considered an “adverse effect” depending on the individual circumstances and whether the use is noise sensitive, because, as previously noted, historic and cultural properties are only noise sensitive based on how they are used. The regulatory processes stemming from these statutes require coordination and consultation with agencies and organizations having jurisdiction over these resources. Their views on the Project’s impact on protected resources are given careful consideration by FTA and the project sponsor, and their recommendations may influence the decision to adopt noise reduction measures.²

3.1.2.3 Minnesota Pollution Control Agency Noise Standards

The Minnesota Pollution Control Agency (MPCA) has an established set of Noise Standards (Minnesota Rules ch. 7030), which provide limits on environmental noise using the L10 and L50 descriptors, which represent the noise level exceeded 10 percent (6 minutes) and 50 percent (30 minutes) of the time during an hour, respectively. The standards include both daytime and nighttime limits for three different categories of land use or noise area classification, with residential lands included in noise area classification 1. Classifications 2 and 3 are generally for commercial and industrial land uses, respectively. The standards are shown in Table 3-2.

Table 3-2 Land Use Categories and Metrics for Transit Noise Impact Criteria

Noise Area Classification	Daytime L10 (dBA)	Daytime L50 (dBA)	Nighttime L10 (dBA)	Nighttime L50 (dBA)
1	65	60	55	50
2	70	65	70	65
3	80	75	80	75

Source: MPCA

Because of the time limit component of the MPCA noise standards, the Project will not exceed the standards under the proposed operating conditions. Light-rail vehicles (LRVs) will pass by a location for approximately 10 seconds 12 times an hour (based on the operating assumptions of 10-minute headways in each direction) for a total of 120 seconds, or 2 minutes. Because the duration of exposure to LRT noise does not exceed the L10 (6 minutes) and L50 (30 minutes) time components, there is no potential for the Project to exceed MPCA thresholds. Because the

² For historic or cultural resources, the following two circumstances are considered in assessing impacts and mitigation measures: 1) The noise sensitivity of the property. While Table 1 gives a comprehensive list of noise sensitive land uses, there can be differences in noise sensitivity depending on individual circumstances. For example, a historic park or recreational area could vary in its sensitivity to noise depending on the type of use of the park (active versus passive recreation) and the settings in which it is located. 2) Special protection provided by law. Section 106 of the National Historic Preservation Act and Section 4(f) of the USDOT Act (which protects historic sites, as well as publicly owned parks, recreation areas, wildlife, and waterfowl refuges) come into play frequently during the environmental review of transit projects. See pages 3-12 and 3-13 of the FTA Transit Noise and Vibration Impact Assessment for additional information on considerations given to resources that have special protection provided by law.

Project does not exceed the MPCA thresholds, the FTA noise impact criteria described previously are more protective than the MPCA standards and have been used to assess and mitigate noise impacts identified within this Supplemental Draft EIS.

Information regarding existing L10 and L50 noise levels is described in Section 5.1.2.3.

3.1.2.4 FTA Construction Noise Criteria

The FTA’s construction noise criteria, summarized in Table 3-3, were used for the short-term noise impact analysis. The FTA construction noise criteria provide adequate protection for short-term noise impacts and allow for reasonable mitigation measures to be applied to the Project. Additionally, MPCA noise criteria were evaluated for the Project, and the Metropolitan Council (Council) will work with local jurisdictions to ensure that reasonable measures are taken to limit construction noise.

Table 3-3 FTA Construction Noise Criteria

Land Use Category	8-hour Leq, dBA Day	8-hour Leq, dBA Night	Noise Exposure, dBA 30-day Average
1	80	70	75
2	85	85	80
3	90	90	85

Source: FTA, 2018

3.2 Vibration

Ground-borne vibration is the motion of the ground transmitted into a building that can be described in terms of displacement, velocity, or acceleration. Vibration velocity is used in transit and freight rail and is defined by the following:

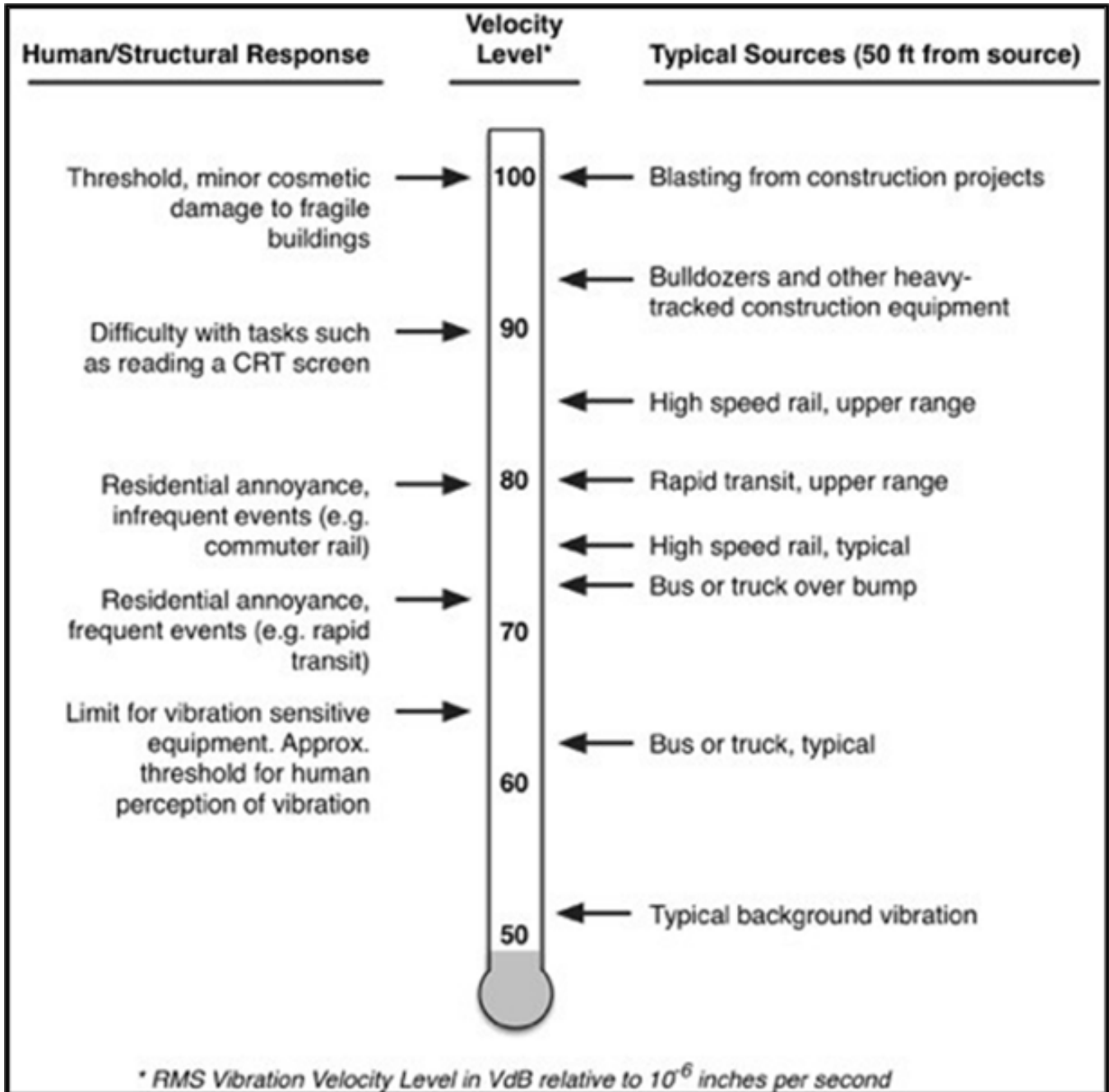
- **Level:** Vibration is expressed in terms of vibration velocity level, using vibration decibels (VdB), with a reference of one micro-inch per second. The level of vibration represents how much the ground is moving. The threshold of human perception to transit and freight rail vibration is approximately 65 VdB and annoyance begins to occur for frequent events at vibration levels over 70 VdB.
- **Frequency:** Vibration frequency is expressed in Hertz. Human response to vibration is typically from about 6 to 200 Hz.
- **Time Pattern:** Environmental vibration changes all the time and human response is roughly correlated to the number of vibration events during the day. The more events that occur, the more sensitive humans are to the vibration.

Figure 3-3 shows typical ground-borne vibration levels for typical sources as well as the corresponding human and structural responses to vibration.

Ground-borne vibration can lead to ground-borne noise, which is a low-volume, low-frequency rumble inside buildings that occurs when ground vibration causes the flexible walls of the buildings to resonate and generate noise. Ground-borne noise is normally not a consideration when trains are elevated or at grade. In these situations, the airborne noise usually overwhelms ground-borne noise, so that the airborne noise level is the major consideration. However, ground-borne noise becomes an important consideration where sensitive interior spaces are well-isolated from the airborne noise. In these situations, the airborne noise path is impeded, and ground-borne noise dominates inside buildings. In rare situations, ground-borne noise may also need to be considered where the airborne noise from a Project is substantially mitigated by a sound wall.



Figure 3-3 Vibration Levels from Typical Sources



Source: CSA, 2023.



3.2.1 Vibration Impact Criteria

3.2.1.1 FTA Transit Vibration Criteria

The vibration impact criteria used for the Project are based on the information contained in Section 6 of the FTA noise and vibration guidance manual. The criteria for a general vibration assessment are based on land use and LRV frequency, as shown in Table 3-4. Some buildings, such as concert halls, recording studios, and theaters, can have a higher sensitivity to vibration (or ground-borne noise) but do not fit into the three categories listed in Table 3-4. Because of the sensitivity of these buildings, special attention is paid to these buildings during the environmental assessment of a project. Table 3-5 shows the FTA criteria for acceptable levels of vibration for several types of special buildings.

Table 3-4 and Table 3-5 include additional criteria for ground-borne noise, which is a low-frequency noise that is radiated from the motion of room surfaces, such as walls and ceilings in buildings due to ground-borne vibration. Ground-borne noise is defined in terms of dBA, which emphasizes middle and high frequencies, which are more audible to human ears. The criteria for ground-borne noise are much lower than for airborne noise to account for the low-frequency character of ground-borne noise; however, because airborne noise typically masks ground-borne noise for above ground (at-grade or elevated) transit systems, ground-borne noise is only assessed for operations in tunnels, where airborne noise is not a factor, or at locations such as recording studios, which are well insulated from airborne noise.



Table 3-4 Ground-Borne Vibration and Ground-Borne Noise Impact Criteria for General Assessment

Land Use Category	Ground-Borne Vibration Impact Levels for Frequent Events (VdB re 1 micro-inch/sec) ^a	Ground-Borne Vibration Impact Levels for Occasional Events (VdB re 1 micro-inch/sec) ^b	Ground-Borne Vibration Impact Levels for Infrequent Events (VdB re 1 micro-inch/sec) ^c	Ground-Borne Noise Impact Levels for Frequent Events (dBA re 20 micro Pascals) ^a	Ground-Borne Noise Impact Levels for Occasional Events (dBA re 20 micro Pascals) ^b	Ground-Borne Noise Impact Levels for Infrequent Events (dBA re 20 micro Pascals) ^c
Category 1: Buildings where vibration would interfere with interior operations.	65 ^d	65 ^d	65 ^d	N/A ^e	N/A ^e	N/A ^e
Category 2: Residences and buildings where people normally sleep.	72	75	80	65	38	43
Category 3: Institutional land uses with primarily daytime use.	75	78	83	40	43	48

Source: FTA, 2018

- ^a "Frequent Events" is defined as more than 70 vibration events of the same source per day. Most rapid transit projects fall into this category.
- ^b "Occasional Events" is defined as between 30 and 70 vibration events of the same source per day. Most commuter trunk lines have this many operations.
- ^c "Infrequent Events" is defined as fewer than 30 vibration events of the same kind per day. This category includes most commuter rail branch lines.
- ^d This criterion limit is based on levels that are acceptable for most moderately sensitive equipment such as optical microscopes. Vibration-sensitive manufacturing or research will require detailed evaluation to define the acceptable vibration levels. Ensuring lower vibration levels in a building often requires special design of the HVAC systems and stiffened floors.
- ^e Vibration-sensitive equipment is generally not sensitive to ground-borne noise.



Table 3-5 Ground-Borne Vibration and Ground-Borne Noise Impact Criteria for Special Buildings

Type of Building or Room	Ground-Borne Vibration Impact Levels for Frequent Events (VdB re 1 micro-inch/sec) ^a	Ground-Borne Vibration Impact Levels for Occasional or Infrequent Events (VdB re 1 micro-inch/sec) ^b	Ground-Borne Noise Impact Levels for Frequent Events (dBA re 20 micro Pascals) ^a	Ground-Borne Noise Impact Levels for Occasional Events (dBA re 20 micro Pascals) ^b
Concert Halls	65	65	25	25
TV Studios	65	65	25	25
Recording Studios	65	65	25	25
Auditoriums	72	80	30	38
Theaters	72	80	35	43

Source: FTA, 2018

Note: If the building will rarely be occupied when the trains are operating, there is no need to consider impact. As an example, consider locating a commuter rail line next to a concert hall. If no commuter trains will operate after 7 p.m., it should be rare that the trains interfere with the use of the hall.

^a "Frequent Events" is defined as more than 70 vibration events of the same source per day. Most rapid transit projects fall into this category.

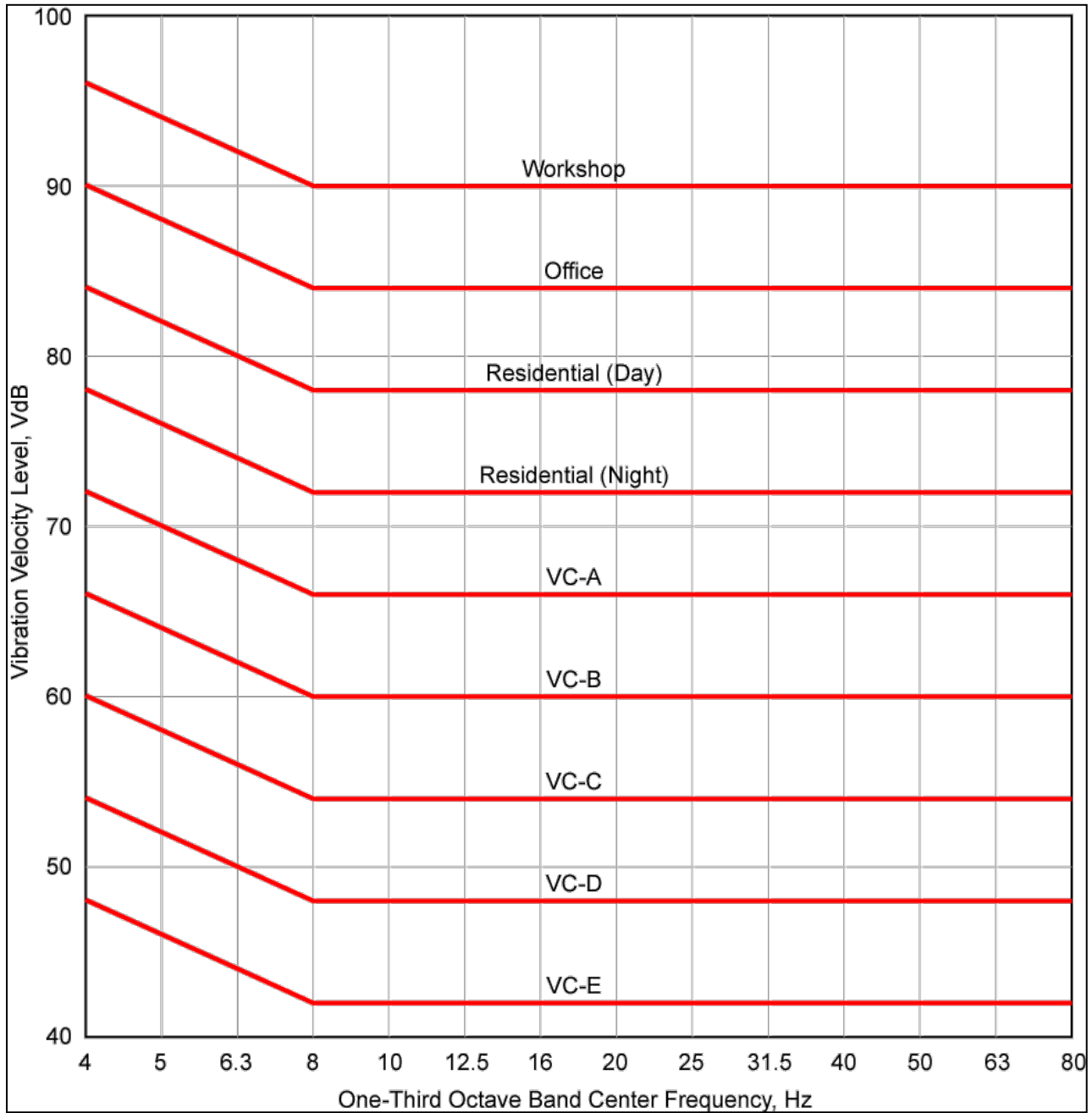
^b "Occasional or Infrequent Events" is defined as fewer than 70 vibration events per day. This category includes most commuter rail systems.

The criteria for a detailed vibration assessment are shown in Figure 3-4 and descriptions of the curves are shown in Table 3-6. The curves in Figure 3-4 are applied to the projected vibration spectrum for the Project. If the vibration level at any one frequency exceeds the criteria, there is impact. Conversely, if the entire proposed vibration spectrum of the Project is below the curve, there will be no impact.

For the Project, the general vibration assessment criteria will be used at special buildings. The detailed vibration assessment criteria will be used to assess LRT ground-borne vibration.



Figure 3-4 Detailed Vibration Criteria



Source: FTA, 2018.



Table 3-6 FTA Construction Vibration Criteria

Criterion Curve (See Figure 2-4)	Max Level (VdB) ^a	Description of Use
Workshop	90	Distinctly feelable vibration. Appropriate to workshops and non-sensitive areas.
Office	84	Feelable vibration. Appropriate to offices and non-sensitive areas.
Residential Day	78	Barely feelable vibration. Adequate for computer equipment and low-power optical microscopes (up to 20X).
Residential Night, Operating Rooms	72	Vibration not feelable, but ground-borne noise may be audible inside quiet rooms. Suitable for medium-power optical microscopes (100X) and other equipment of low sensitivity.
VC-A	66	Adequate for medium- to high-power optical microscopes (400X), microbalances, optical balances, and similar specialized equipment.
VC-B	60	Adequate for high-power optical microscopes (1000X), inspection and lithography equipment to 3 micron line widths.
VC-C	54	Appropriate for most lithography and inspection equipment to 1 micron detail size.
VC-D	48	Suitable in most instances for the most demanding equipment, including electron microscopes operating to the limits of their capability.
VC-E	42	The most demanding criterion for extremely vibration-sensitive equipment.

Source: FTA, 2018

^a As measured in 1/3-octave bands of frequency over the frequency range 8 to 80 Hz.

3.2.1.2 Cultural Resources

Under FTA guidance, historic sites are designated as vibration sensitive depending on the land use of the site, not their designation as historic. Historical sites that are currently used as residences will be in Category 2. Historic buildings with indoor use of an interpretive nature involving meditation and study will be in Category 3. These include museums, significant birthplaces, and buildings in which significant historical events occurred. One difference between noise and vibration is that outdoor land uses are not considered vibration sensitive. Only indoor land uses are considered vibration sensitive.

Most downtown areas have buildings which are historically significant because they represent a particular architectural style or are prime examples of the work of a historically significant designer. If the buildings or structures are used for commercial or industrial purposes and are located in busy commercial areas, they are not considered vibration sensitive, and the impact criteria do not apply.

Similarly, historical transportation structures, such as terminals and railroad depots, are not considered vibration-sensitive land uses. These buildings or structures may however be afforded special protection under Section 4(f) of the USDOT Act and Section 106 of the National Historic Preservation Act.

In the Section 106 process protecting historic and cultural properties, vibration may or may not be considered an “adverse effect” depending on the individual circumstances and whether the use is vibration sensitive, because, as previously noted, historic and cultural properties are only vibration sensitive based on how they are used. The regulatory processes stemming from these statutes require coordination and consultation with agencies and organizations having jurisdiction over these resources. Their views on the Project's impact on protected resources are

given careful consideration by FTA and the project sponsor, and their recommendations may influence the decision to adopt vibration reduction measures.

3.2.1.3 FTA Construction Vibration Criteria

In addition to the vibration criteria for human annoyance and interference with equipment and spaces described above, there are also vibration criteria for damage from construction activities. Typical transit operations do not have the potential for damage, so only certain construction activities are assessed for damage.

The thresholds for damage to structures are typically several orders of magnitude above the thresholds for human response to vibration. Table 3-7 shows the FTA criteria for vibration damage to structures. This is based on the structure and construction type (and not a designation as historic). Table 3-7 includes criteria in both VdB and peak particle velocity (PPV).

Table 3-7 FTA Vibration Damage Criteria from Construction

Building Category	PPV (in/sec)	Approximate Lv ^a
I. Reinforced-concrete, steel, or timber (no plaster)	0.5	102
II. Engineered concrete and masonry (no plaster)	0.3	98
III. Non-engineered timber and masonry buildings	0.2	94
IV. Buildings extremely susceptible to vibration damage	0.12	90

Source: FTA, 2018

PPV = peak particle velocity; Lv = vibration level

^a Root Mean Square (RMS) velocity in VdB re 1 micro-inch/second.

4 Impact Assessment Methodology

This section describes the methodology for assessing the potential noise and vibration impact due to the Project.

4.1 Noise

This section describes the methodology for assessing the potential noise impact due to the Project.

Projected noise levels for the Supplemental Draft EIS Detailed Noise Analysis are based on noise measurements of the existing METRO Blue Line LRVs, which were conducted for the Central Corridor Project, and the operating characteristics and current design of the proposed Project. Specific inputs used in the noise impact assessment include the following:

- LRV speeds will generally range from 15 to 55 mph for revenue operations, except for entry and exit from station areas. LRV speeds are based on modeled speed profiles in both directions (i.e., inbound and outbound) that reflect LRV operating characteristics, track geometry, and station locations.
- LRVs will be comprised of three rail cars during hours of operation.
- The operating hours and headways will be as follows:
 - Early morning hours (12:15 to 2 a.m.): 60-minute headways
 - Morning hours (4 to 5:30 a.m.): 30-minute headways
 - Early peak morning operating hours (5:30 to 6:30 a.m.): 15-minute headways
 - Peak operating hours (6:30 a.m. to 9 p.m.): 10-minute headways



- Evening hours (9 to 10:15 p.m.): 20-minute headways
 - Late evening hours (10:15 p.m. to 12:15 a.m.): 30-minute headways
- The reference noise levels are shown in Table 4-1.

Table 4-1 Blue Line Reference Noise Levels

Noise Source	Sound Exposure Level ^a , 50 ft (dBA)
LRT on embedded track	84
LRT on ballast-and-tie track	81
Crossing bells	76 ^b
LRT bells	86/87 ^c

Source: CSA, 2023

^a The sound exposure level is the cumulative noise from a single event, considering both the level and duration of the sound.

^b The maximum noise level from crossing bells is 77 dBA at 10 feet. Crossing bells will be sounded for 20 seconds for each LRV at an at-grade crossing.

^c The maximum noise level from LRT bells is 80 dBA at 50 feet. LRT bells will be sounded three times when entering and exiting stations (sound level exposure of 86 dBA) and will be sounded for 5 seconds at each at-grade crossing (sound level exposure of 87 dBA).

- Locations of elevated structures, crossovers, and embedded track were identified based on plan and profile maps provided by the engineering team.
- Crossovers increase the noise levels by up to 6 dB for nearby sensitive receptors due to the gap in the track.
- Elevated structures increase the noise levels by 4 dB for nearby sensitive receptors due to structure-borne noise.
- Anticipated use of bells at each at-grade crossing and station was determined by Metro Transit Operations and Project staff based on the following considerations:
 - LRV bells will be sounded three times when entering and exiting station platforms
 - LRV bells will be sounded at at-grade crossings.
 - Grade crossing bells will be used at at-grade crossings for 20 seconds for each LRV where there will be flashing lights and gates at the crossing.
- Light rail bells or horns will be sounded in the following manner for locations with stations directly adjacent to at-grade crossings:
 - For the side opposite the station, vehicles will sound their horns or bells in accordance with the procedures above for a grade crossing. No additional sounding will occur upon entering the station.
 - For the side with the station, vehicles will sound their bells in accordance with the procedure above upon entering the station. The LRV will then sound the bell upon exiting the station until the front of the LRV passes through the far side of the crossing.

4.2 Vibration

This section describes the methodology for assessing the potential vibration impact due to the Project. Specific inputs used in the vibration impact assessment include the following:

- Projected LRT operating speeds will range from approximately 15 to 55 mph for LRT revenue operations, except for entry and exit from station areas. LRV speeds are based on modeled speed profiles in both directions (i.e., inbound and outbound) that reflect LRV operating characteristics, track geometry, and station locations.



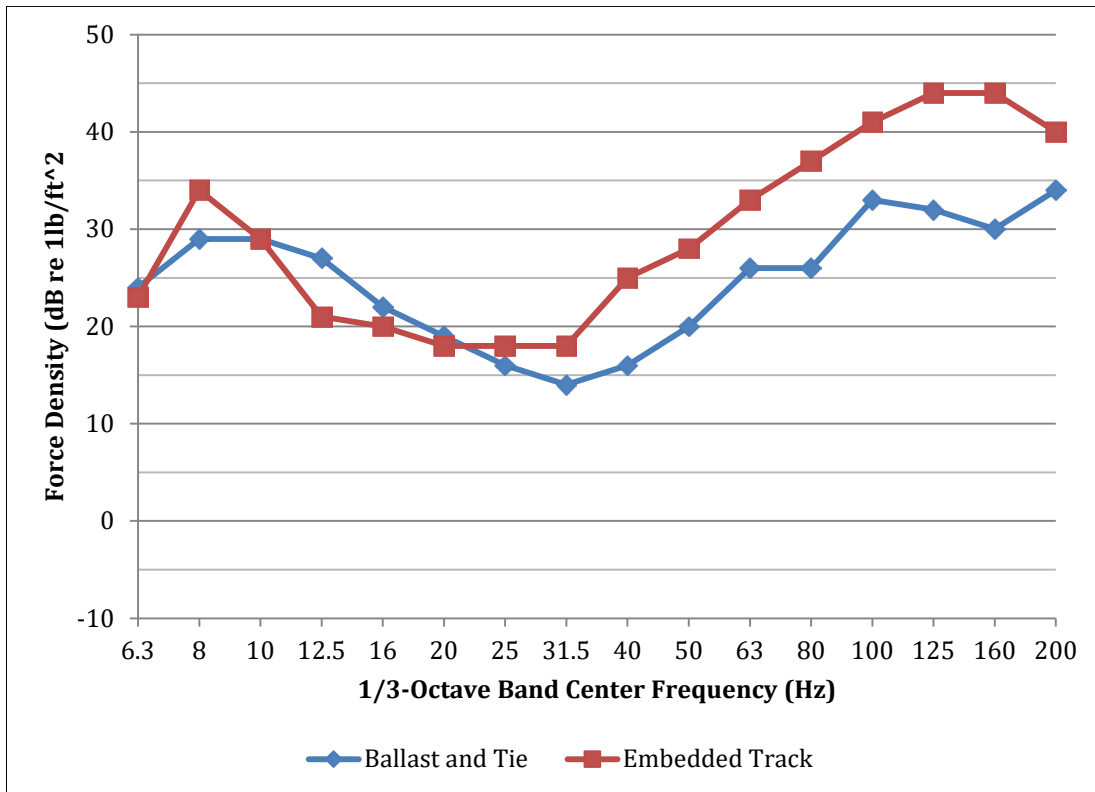
- All LRVs will consist of three cars during hours of operation.
- The operating hours and headways are described in Section 4.1, which will result in “frequent” events, as defined in the vibration criteria section.
- Locations of elevated structures, crossovers, and embedded track were identified based on plan and profile maps provided by the engineering team.
- Crossovers increase the vibration levels by up to 10 dB for nearby sensitive receptors due to the gap in the track.
- Elevated structures decrease the vibration levels by 10 dB for nearby sensitive receptors.
- Future vibration levels from LRT operations were based on a combination of the force density (vehicle) and propagation (soil) data at sensitive locations. The procedure for projecting future vibration levels is to measure the vibration propagation characteristics of the soil (line source transfer mobility [LSTM]) and combine that information with the LRV information independent of the soil (force density [FD]). The formula for calculating the future vibration levels is:

$$Lv = FD + LSTM$$

Where: Lv is the projected LRV vibration level, FD is the LRV force density, and LSTM is the line source transfer mobility at a site.

- LRV FD levels were based on measurements conducted for the Central Corridor LRT Project (ATS Consulting, 2008) for both ballast-and-tie and embedded track. Representative FD spectra for both ballast-and-tie and embedded track are shown on Figure 4-1.

Figure 4-1 Force Density Levels at 40 mph



Source: ATS, 2008.

4.3 Construction Noise Assessment Methodology

Construction noise and impacts are assessed using a combination of the methods and construction source data contained in the FTA guidance manual and the Federal Highway Administration (FHWA) Roadway Construction Noise Model from the FHWA Construction Noise Handbook (Final Report FHWA-HEP-06-015, August 2006). Typical noise levels generated by representative pieces of equipment are listed in Table 4-2. The noise exposure at a receiver location may be calculated using decibel addition of all operating construction equipment using the following equation:

$$Leq(n) = L_{max} + 10 \times \log(U.F.) - 20 \times \log(D/50) - \text{Ashielding}$$

where:

$Leq(n)$ = noise exposure at a receiver resulting from the operation of a single piece of equipment over n hours,

L_{max} = noise emission level of the particular piece of equipment at the reference distance of 50 feet (taken from Table 4-2),

Ashielding = shielding provided by barriers, building, or terrain,

D = distance from the receiver to the piece of equipment in feet, and

U.F. = usage factor that accounts for the fraction of time that the equipment is in use over the specified time period. For $Leq(1)$ assume a U.F. equal to 100 percent, and for 8 hours or more use the values in Table 4-2.

The combination of noise from several pieces of equipment operating during the same time period is obtained from decibel addition of the Leq of each single piece of equipment calculated using the above equations.

Table 4-2 Construction Equipment Noise Emission Levels

Equipment	Typical Noise Level (dBA) 50 feet	Usage Factor (%)
Air Compressor	80	40
Backhoe	80	40
Ballast Equalizer	82	50
Ballast Tamper	83	50
Compactor	82	20
Concrete Mixer	85	40
Concrete Pump	82	20
Crane, Derrick	88	16
Crane, Mobile	83	16
Dozer	85	16
Generator	82	50
Grader	85	40
Impact Wrench	85	50
Jack Hammer	88	20
Loader	80	40
Paver	85	50



Equipment	Typical Noise Level (dBA) 50 feet	Usage Factor (%)
Pile Driver (Impact)	101	20
Pile Driver (Vibratory)	95	20
Pneumatic Tool	85	50
Pump	77	50
Rail Saw	90	20
Rock Drill	85	20
Roller	85	20
Saw	76	20
Scarifier	83	20
Scraper	85	40
Shovel	82	40
Spike Driver	77	20
Tie Cutter	84	20
Tie Handler	80	20
Tie Inserter	85	20
Truck	84	40

Source: FTA, 2018 and FHWA, 2006

4.4 Construction Vibration Assessment Methodology

Construction vibration is assessed for areas where there is potential for impact from construction activities. Such activities include blasting, pile driving, demolition, and drilling or excavation near sensitive structures. Typical vibration levels generated by representative pieces of equipment are listed in Table 4-3. For damage assessment, the following equation is used:

$$PPV_{equip} = PPV_{ref} \times [(25/D)]^{1.5}$$

where:

PPV_{equip} = the peak particle velocity in in/sec of the equipment adjusted for distance,

PPV_{ref} = the reference vibration level in in/sec at 25 feet from Table 4-3, and

D = the distance from the equipment to the receiver in feet.

For annoyance assessment, the following equation is used:

$$Lv(D) = Lv(25\text{ ft}) - 30 \times \log(D/25)$$

where:

Lv(D) = RMS vibration level at distance D,

Lv(25 ft) = RMS vibration level at 25 feet from Table 4-3, and

D = the distance from the equipment to the receiver in feet.



Table 4-3 Construction Equipment Vibration Source Levels

Equipment		PPV at 25 feet (in/sec)	Approximate Level* at 25 feet (VdB)
Pile Driver (impact)	upper range	1.518	112
	typical	0.644	104
Pile Driver (vibratory)	upper range	0.734	105
	typical	0.170	93
Clam shovel drop (slurry wall)		0.202	94
Hydromill (slurry wall)	in soil	0.008	66
	in rock	0.017	75
Vibratory roller		0.210	94
Hoe ram		0.089	87
Large bulldozer		0.089	87
Caisson drilling		0.089	87
Loaded trucks		0.076	86
Jackhammer		0.035	79
Small bulldozer		0.003	58

Source: FTA, 2018

*RMS velocity in decibels (VdB) re 1 micro-inch/second

5 Affected Environment

5.1 Noise

5.1.1 Noise Sensitive Land Use

Noise-sensitive land use for the Project was identified based on aerial photography, Project drawings, and a site survey. Based on the information from these sources, the noise-sensitive land use, from north to south by city is as follows.

5.1.1.1 City of Brooklyn Park

The noise-sensitive land uses for the City of Brooklyn Park include Ebenezer Community Church, Berean Baptist Church, Brooklyn Park Library, Fire International Embassy, North Hennepin Community College, Revive Church, Children’s Music Academy of Brooklyn Park, Hampton Inn Brooklyn Park, and a mixture of single-family and multi-family residences. The dominant existing noise sources are occasional freight trains and traffic on Bottineau Blvd and W Broadway Ave.

5.1.1.2 City of Crystal

The noise-sensitive land uses for the City of Crystal include Crystal Medical Center, North Star Inn and Suites, and single-family and multi-family residences. The dominant existing noise sources are occasional freight trains, traffic on Bottineau Blvd, and flight operations at the Crystal Airport.



5.1.1.3 City of Robbinsdale

The noise-sensitive land uses for the City of Robbinsdale include North Memorial Health Hospital, Elim Lutheran Church, and a mixture of single-family and multi-family residences. The dominant existing noise source is traffic on Bottineau Blvd.

5.1.1.4 City of Minneapolis

The noise-sensitive land uses for the City of Minneapolis include Parkway United Church of Christ, Good News Minneapolis Church, True Vine Missionary Baptist Church, Kipp Legacy School, St Anne-St Joseph Hien Church, Morning Star Assembly of God, All Nations Seventh-day Adventist Church, PYC Arts & Technology Alternative High School, Capri Theater, KMOJ radio station, Star Child Development Center LLC, St. Andrews Episcopal Church, Shiloh Temple International Ministries, Real Believers Faith Center Church, Episcopal Church in Minnesota, Full Proof Ministry COGIC, Liberty Community Church, United Deliverance Temple, Sanctuary Covenant Church, Faith Tabernacle Gospel Fellowship International, Masjid An-Nur Mosque, United Faith Pentecostal Church, Metro Schools College Prep, MN International Middle Charter School, Lundstrom Performing Arts, and a mixture of single-family and multi-family residences. The dominant existing noise sources are traffic on Interstate 94 (I-94), W Broadway Ave, Washington Ave, and Lyndale Ave.

5.1.2 Existing Noise Measurements

5.1.2.1 Noise Measurement Procedures and Equipment

Noise measurements were conducted during the week of April 3, 2023, on May 2, 2023, and on Sept. 6, 2023, at 18 locations along the Project Alignment.

Because the thresholds for impact in the FTA noise criteria are based on the existing noise levels, measuring the existing noise and characterizing noise levels at sensitive locations along the Project Alignment is an important step in the impact assessment. The noise measurements included both long-term (24-hour) and short-term (1-hour) monitoring of the A-weighted sound level at noise-sensitive locations near the Project.

The noise measurements were performed with NTi Audio model XL2 noise monitors and Larson Davis LD831-C noise monitors that conform to American National Standards Institute standards for Type 1 (precision) sound measurement equipment. Calibrations, traceable to the National Institute of Standards and Technology were conducted before and after each measurement. The noise monitors were set to continuously monitor and record multiple noise level metrics, as well as obtain audio recordings during the measurement periods.

In all cases, the measurement microphone was protected by a windscreen and supported on a tripod at a height of 4 to 6 feet above the ground and was positioned to characterize the exposure of the site to the dominant noise sources in the area. For example, microphones were located at the approximate setback lines of the receptors from adjacent roads and were positioned to avoid acoustic shielding by landscaping, fences, or other obstructions.

5.1.2.2 Noise Measurement Locations and Results

Table 5-1 summarizes the results of the existing noise measurement program, and Figure 5-1 shows the location of the 13 long-term noise monitoring sites (designated by LT in the site number) and five short-term noise monitoring sites (designated by ST in the site number) for the Project. The long-term noise measurements were used to characterize the existing noise at residential locations, and the short-term noise measurements were used to characterize the existing noise at non-residential locations.



At each site, the noise measurement was conducted at the approximate set back of the building or buildings relative to the Project location. The results of the existing noise measurements program are used to determine the existing noise levels for all the noise-sensitive locations. The noise measurement results at each location are described below.

Table 5-1 Summary of Existing Noise Level Measurements

Site No.	City	Measurement Location	Measurement Start Date	Measurement Start Time	Meas. Dur. (hrs)	Noise Level Ldn (dBA)	Noise Level Leq (dBA)
LT-13	Minneapolis	1020 N 3rd St	Sept. 6, 2023	2 p.m.	24	69.5*	67.5*
LT-12	Brooklyn Park	8819 Oregon Ave	April 4, 2023	4 p.m.	24	62.0	59.0
LT-11	Brooklyn Park	7431 78th Ct	April 4, 2023	4 p.m.	24	65.3	59.4
LT-10	Brooklyn Park	7013 Dutton Ave	April 4, 2023	5 p.m.	3**	56.4	58.8
LT-9	Crystal	5906 Elmhurst Ave	April 3, 2023	3 p.m.	24	63.4	61.1
LT-8	Crystal	5257 Xenia Ave	April 3, 2023	3 p.m.	24	58.7	57.5
LT-7	Robbinsdale	4536 Regent Ave	April 3, 2023	4 p.m.	24	60.5	58.6
LT-6	Robbinsdale	3369 W Broadway Ave	April 4, 2023	11 a.m.	24	70.2	68.6
LT-5	Minneapolis	2741 N Upton Ave	April 4, 2023	noon	24	69.3	68.1
LT-4	Minneapolis	2239 W Broadway Ave	April 5, 2023	5 p.m.	24	69.1	67.6
LT-3	Minneapolis	1931 N Morgan Ave	May 2, 2023	3 p.m.	24	64.9	61.6
LT-2	Minneapolis	2117 Dupont Ave	April 5, 2023	1 p.m.	24	54.7	53.5
LT-1	Minneapolis	626 Harry Davis Ln	April 5, 2023	10 a.m.	24	62.0	59.7
ST-5	Brooklyn Park	Prince of Peace Lutheran Church	April 6, 2023	10:06 a.m.	1	63.9***	65.9
ST-4	Robbinsdale	3978 W Broadway Ave	April 3, 2023	4 p.m.	1	56.7***	56.7
ST-3	Minneapolis	1127 W Broadway Ave	April 6, 2023	10:30 a.m.	1	66.3***	68.3
ST-2	Minneapolis	277 N 12th Ave	April 5, 2023	2:19 p.m.	1	63.8***	65.8
ST-1	Minneapolis	Element Minneapolis Downtown	April 5, 2023	11:48 a.m.	1	64.5***	66.5

Source: CSA, 2023

LT = long-term; ST = short-term

*The reported existing noise levels were adjusted down by approximately 2 dB to account for the different traffic volumes in the area due to local construction.

** The sound level meter’s battery failed prior to completion of 24-hour measurement. Ldn estimated using methods described in Appendix E of the FTA guidance manual.

*** Ldn estimated using methods described in Appendix E of the FTA guidance manual.



City of Brooklyn Park

LT-12: 8819 Oregon Ave, City of Brooklyn Park – The Ldn measured at this location was 62.0 dBA, and the measured peak hour Leq was 59.0 dBA. This location is representative of all noise-sensitive land uses between 85th Ave and Trunk Highway (TH) 610. The ambient noise levels were dominated by traffic on W Broadway Ave.

LT-11: 7431 78th Ct, City of Brooklyn Park – The Ldn measured at this location was 65.3 dBA, and the measured peak hour Leq was 59.4 dBA. This location is representative of all noise-sensitive land uses between N 73rd Ave and 85th Ave. The ambient noise levels were dominated by traffic on W Broadway Ave.

LT-10: 7013 Dutton Ave, City of Brooklyn Park – The Ldn calculated at this location was 56.4 dBA, and the measured peak hour Leq was 58.8 dBA. This location is representative of all noise-sensitive land uses between 62nd Ave and I-94. The ambient noise levels were dominated by traffic on Bottineau Blvd. This measurement was conducted behind an existing noise barrier. The sound level meter's battery failed prior to completion of 24-hour measurement. The Ldn was estimated using methods described in Appendix E of the FTA guidance manual.

ST-5: Prince of Peace Lutheran Church, City of Brooklyn Park – The hourly Leq measured at this location was 65.9 dBA, and the calculated Ldn was 63.9 dBA. This location is representative of all noise-sensitive land uses along W Broadway Ave between I-94 and 73rd Ave including the Prince of Peace Lutheran Church. The ambient noise levels were dominated by traffic on W Broadway Ave and freight traffic.

City of Crystal

LT-9: 5906 Elmhurst Ave, City of Crystal – The Ldn measured at this location was 63.4 dBA, and the measured peak hour Leq was 61.1 dBA. This location is representative of all noise-sensitive land uses between Bass Lake Rd and 62nd Ave. The ambient noise levels were dominated by traffic on Bottineau Blvd, flight operations at Crystal Airport, and trains on the freight line to the west.

LT-8: 5257 Xenia Ave, City of Crystal – The Ldn measured at this location was 58.7 dBA, and the measured peak hour Leq was 57.5 dBA. This location is representative of all noise-sensitive land uses between the Canadian Pacific Kansas City (CPKC) rail line and Bass Lake Rd. The ambient noise levels were dominated by traffic on Bottineau Blvd and TH 100.

City of Robbinsdale

LT-7: 4536 Regent Ave, City of Robbinsdale – The Ldn measured at this location was 60.5 dBA, and the measured peak hour Leq was 58.6 dBA. This location is representative of all noise-sensitive land uses between Lake Dr and the CPKC rail line. The ambient noise levels were dominated by traffic on Bottineau Blvd. This measurement was conducted behind an existing noise barrier.

LT-6: 3369 W Broadway Ave, City of Robbinsdale – The Ldn measured at this location was 70.2 dBA, and the measured peak hour Leq was 68.6 dBA. This location is representative of all noise-sensitive land uses along W Broadway Ave between Lowry Ave and Lake Ave. The ambient noise levels were dominated by traffic on W Broadway Ave.

ST-4: 3978 W Broadway Ave, City of Robbinsdale – The hourly Leq measured at this location was 56.7 dBA, and the calculated Ldn was 56.7 dBA. This location is representative of the noise at Elim Lutheran Church. The ambient noise levels were dominated by traffic on Bottineau Blvd.



City of Minneapolis

LT-13: 1020 N 3rd Street, City of Minneapolis – The Ldn estimated at this location was 69.5 dBA, and the estimated peak hour Leq was 67.5 dBA. The measured noise levels at this location were adjusted down by approximately 2 dB to account for differences in traffic volumes due to local construction. This location is representative of the residential noise-sensitive land use along N 10th Ave and N Washington Ave. The ambient noise levels were dominated by traffic on N 10th Ave and the I-94 on- and off-ramps to the south.

LT-5: 2741 N Upton Ave, City of Minneapolis – The Ldn measured at this location was 69.3 dBA, and the measured peak hour Leq was 68.1 dBA. This location is representative of all noise-sensitive land uses along W Broadway Ave between 26th Ave and Lowry Ave. The ambient noise levels were dominated by traffic on W Broadway Ave.

LT-4: 2239 W Broadway Ave, City of Minneapolis – The Ldn measured at this location was 69.1 dBA, and the measured peak hour Leq was 67.6 dBA. This location is representative of the residential noise-sensitive land uses along W Broadway Ave between N Logan Ave and 26th Ave. The ambient noise levels were dominated by traffic on W Broadway Ave.

LT-3: 1931 N Morgan Ave, City of Minneapolis – The Ldn measured at this location was 64.9 dBA, and the measured peak hour Leq was 61.6 dBA. This location is representative of the residential noise-sensitive land uses along W Broadway Ave between I-94 and N Logan Ave. The ambient noise levels were dominated by traffic on W Broadway Ave.

LT-2: 2117 Dupont Ave, City of Minneapolis – The Ldn measured at this location was 54.7 dBA, and the measured peak hour Leq was 53.5 dBA. This location is representative of the residential noise-sensitive land uses along N 21st Ave. The ambient noise levels were dominated by local traffic on N 21st Ave.

LT-1: 626 Harry Davis Ln, City of Minneapolis -- The Ldn measured at this location was 61.0 dBA, and the measured peak hour Leq was 59.7 dBA. This location is representative of all noise-sensitive land uses along N Lyndale Ave between I-94 and N 18th Ave. The ambient noise levels were dominated by local traffic and traffic on I-94.

ST-3: 1127 W Broadway Ave, City of Minneapolis – The hourly Leq measured at this location was 68.3 dBA, and the calculated Ldn was 66.3 dBA. This location is representative of the institutional noise-sensitive land uses along 21st Ave N and W Broadway Ave between James Ave and I-94. The ambient noise levels were dominated by traffic on W Broadway Ave.

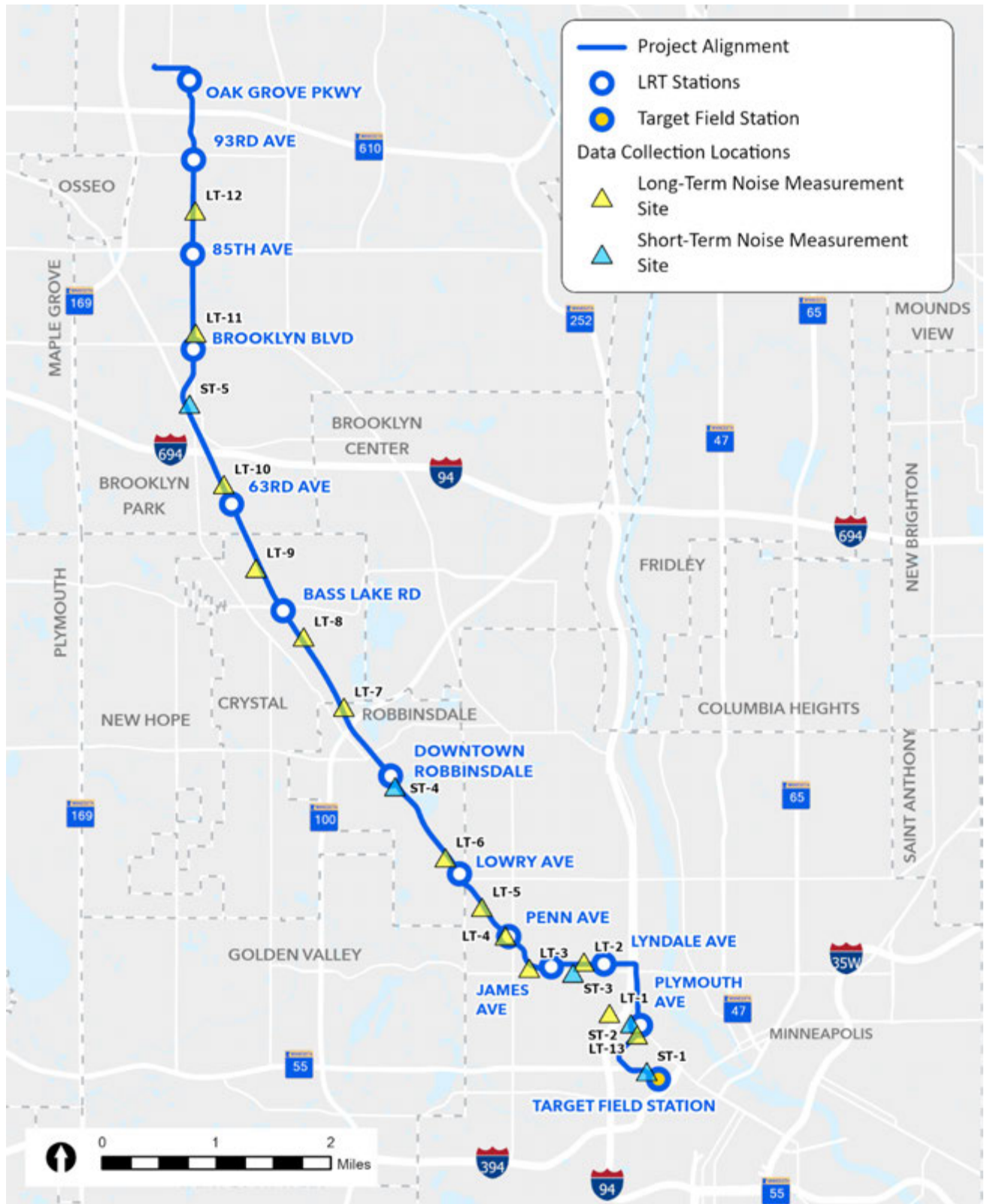
ST-2: 277 N 12th Ave, City of Minneapolis – The hourly Leq measured at this location was 65.8 dBA, and the calculated Ldn was 63.8 dBA. This location is representative of the noise-sensitive land uses on the east side of I-94 north of 7th Ave. The ambient noise levels were dominated by traffic on Plymouth Ave and 3rd St.

ST-1: Element Minneapolis Downtown, City of Minneapolis – The hourly Leq measured at this location was 66.5 dBA, and the calculated Ldn was 64.5 dBA. This location is representative of noise-sensitive land uses along 6th Ave and 7th St between 5th St and Lyndale Ave.

Detailed information regarding the noise measurement results is contained in Appendix A, and photographs of noise measurement sites are contained in Appendix B.



Figure 5-1 Existing Noise Measurement Locations





For the Capri Theater, sound insulation testing was conducted to determine the interior noise levels in sensitive spaces inside the building due to LRV operations. The testing was conducted in accordance with the American Society for Testing and Materials (ASTM) Standard Guide for Field Measurements of Airborne Sound Attenuations of Building Facades and Façade Elements (ASTM E966-10). The sound insulation measurements were conducted with equipment that conforms to American National Standards Institute standards for Type 1 (precision) microphones. Predicted interior Project noise levels were calculated in accordance with ASTM Standard Classification for Rating Outdoor-Indoor Sound Attenuation (ASTM E1332-10a) using a reference source spectrum of a typical LRV passby.

5.1.2.3 MPCA Noise Standards Analysis

Using the noise measurement data gathered at the long-term noise measurement sites described above, an analysis was also conducted using the MPCA L10 and L50 noise standards. At each location where a long-term noise measurement was conducted, the hourly L10 and L50 for both daytime and nighttime over a 24-hour period were calculated.

The results, shown in Table 5-2, show the range of existing (without the Project) L10 and L50 values for both daytime and nighttime. At most locations along the Project Alignment, the L10 and L50 standards are already being exceeded by existing noise sources during many hours of the day. Most of the existing exceedances of the thresholds are due to exempt noise sources, such as roadway noise and aircraft overflights. The higher existing L10 and L50 noise levels are at locations close to major roadways along the Project Alignment. At locations further from roadways, the L10 and L50 noise levels are lower.

Table 5-2 Summary of Existing L10 and L50 Noise Levels at Long-Term Noise Measurement Locations

Site No.	City	Measurement Location	Max L10 (dBA) ^a	Max L50 (dBA) ^b
LT-13	Minneapolis	1020 N 3rd Street	73.5	69.7
LT-12	Brooklyn Park	8819 Oregon Ave	65.1	60.6
LT-11	Brooklyn Park	7431 78th Court	63.9	59.4
LT-10	Brooklyn Park	7013 Dutton Ave	61.8	59.3
LT-9	Crystal	5906 Elmhurst Ave	68.4	64.4
LT-8	Crystal	5257 Xenia Ave	61.7	58.5
LT-7	Robbinsdale	4536 Regent Ave	61.0	58.9
LT-6	Robbinsdale	3369 W Broadway Ave	73.8	69.5
LT-5	Minneapolis	2741 N Upton Ave	73.7	67.8
LT-4	Minneapolis	2239 W Broadway Ave	72.1	66.3
LT-3	Minneapolis	1931 N Morgan Ave	65.9	62.2
LT-2	Minneapolis	2117 Dupont Ave	58.1	53.2
LT-1	Minneapolis	626 Harry Davis Ln	64.4	59.1

Source: CSA, 2023

LT = long-term

^a The L10 descriptor represents noise levels exceeded 10 percent (6 minutes) of the time during an hour (60 minutes). This standard includes both daytime and nighttime limits.

^b The L50 descriptor represents noise levels exceeded 50 percent (30 minutes) of the time during an hour (60 minutes). This standard includes both daytime and nighttime limits.

5.2 Vibration

5.2.1 Vibration Sensitive Land Use

Vibration-sensitive land use for the Project was identified based on aerial photography, Project drawings, and a site survey. Based on the information from these sources, the vibration-sensitive land use, from north to south by city is as follows.

5.2.1.1 City of Brooklyn Park

The vibration-sensitive land uses for the City of Brooklyn Park includes Ebenezer Community Church, Berean Baptist Church, Brooklyn Park Library, Fire International Embassy, North Hennepin Community College, Revive Church, Children's Music Academy of Brooklyn Park, Hampton Inn Brooklyn Park, and a mixture of single-family and multi-family residences.

5.2.1.2 City of Crystal

The vibration-sensitive land uses for the City of Crystal includes Crystal Medical Center, North Star Inn and Suites, and single-family and multi-family residences.

5.2.1.3 City of Robbinsdale

The vibration-sensitive land uses for the City of Robbinsdale includes North Memorial Health Hospital, Elim Lutheran Church, and a mixture of single-family and multi-family residences.

5.2.1.4 City of Minneapolis

The vibration-sensitive land uses for the City of Minneapolis includes Parkway United Church of Christ, Good News Minneapolis Church, True Vine Missionary Baptist Church, Kipp Legacy School, St Anne-St Joseph Hien Church, Morning Star Assembly of God, All Nations Seventh-day Adventist Church, PYC Arts & Technology Alternative High School, Capri Theater, KMOJ radio station, Star Child Development Center LLC, St. Andrews Episcopal Church, Shiloh Temple International Ministries, Real Believers Faith Center Church, Episcopal Church in Minnesota, Full Proof Ministry COGIC, Liberty Community Church, United Deliverance Temple, Sanctuary Covenant Church, Faith Tabernacle Gospel Fellowship International, Masjid An-Nur Mosque, United Faith Pentecostal Church, Metro Schools College Prep, MN International Middle Charter School, Lunstrum Performing Arts, and a mixture of single-family and multi-family residences.

5.2.2 Existing Vibration Measurements

5.2.2.1 Vibration Measurement Procedures and Equipment

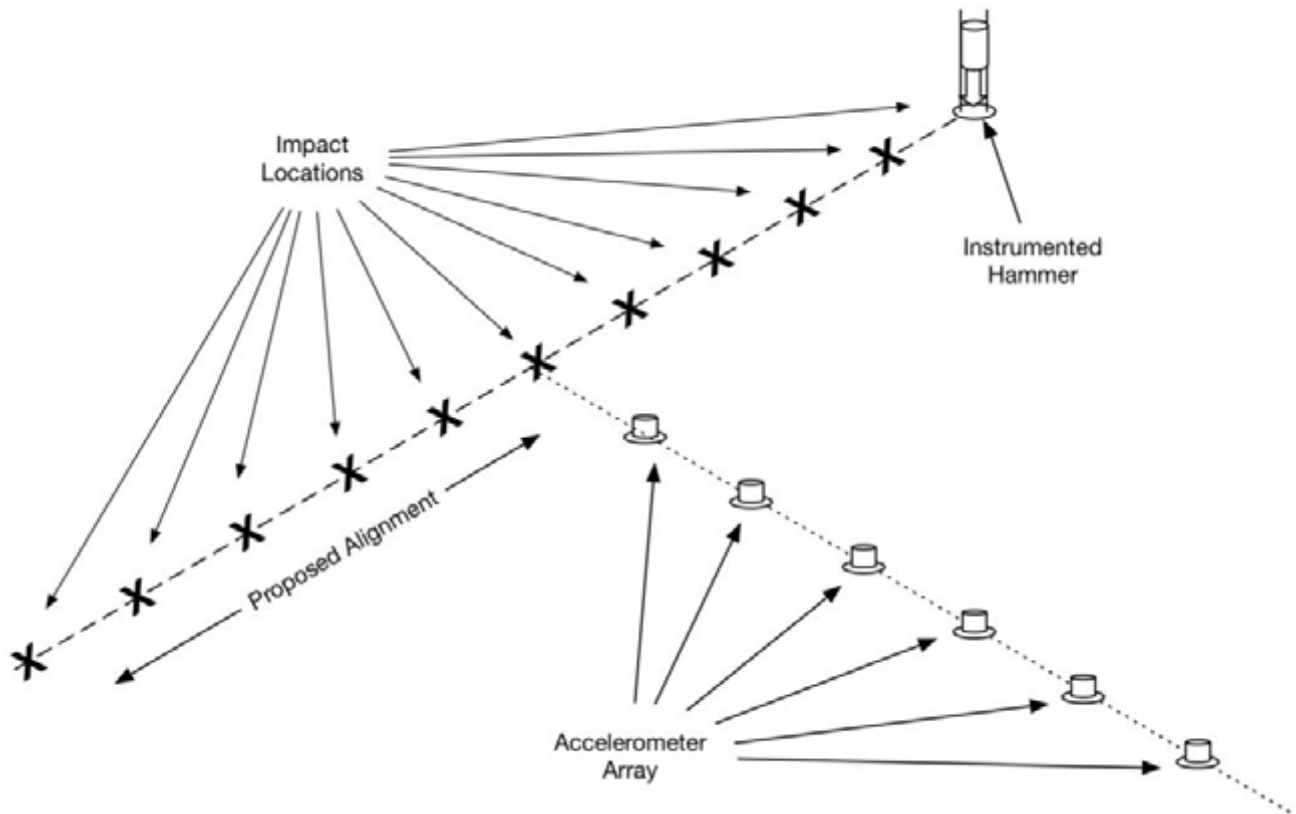
The vibration measurements conducted were used to characterize the response of the soil at locations within the Project Alignment. At each site, vibration propagation tests were conducted by impacting the ground with an instrumented weight and measuring the response of the soil and/or building foundations at various distances (LSTM). The results of the vibration propagation tests were combined with the FD (LRV input force) to Project vibration levels from LRT operations at locations along the Project Alignment.

A custom-built instrumented hammer was used to impart an impulsive force to the ground to determine the ground response. The magnitude of the force was calculated based on the acceleration and mass of the falling hammer. The resulting vibration signals were measured using high-sensitivity accelerometers (PCB Model 393B05) mounted in a vertical direction magnetically adhered to washers on bricks. The signals from the hammer and accelerometers were

recorded using Data Translation DT 9837A digital Acquisition hardware. DATA translation’s QuickDAQ software, running on a laptop computer, was used to review the measurement data.

The vibration propagation test procedure is shown schematically in Figure 5-2. The instrumented hammer was used to generate impulses at specific locations spaced 15 feet apart along a line on or parallel to the Project Alignment. A line of accelerometers was placed perpendicular to the line of impacts as shown in Figure 5-2. The relationship between the input force and the resulting vibration measured by the accelerometers, called the transfer mobility, was calculated using proprietary software in the CSA laboratory. The transfer mobility represents the vibration propagation characteristics of the ground at the measurement site and along the alignment options.

Figure 5-2 Vibration Propagation Measurement Schematic



5.2.2.2 Vibration Measurement Locations and Results

Existing vibration measurements were conducted to supplement the measurements made during the initial Draft EIS for the Project. Because portions of the current Project at the northern end of the Project Alignment are the same as those studied during the Draft and Final EIS for the Project, the vibration measurements conducted in these areas are still valid for use in this assessment.

A series of vibration propagation measurements was conducted during the week of April 3, 2023, at five locations along the Project Alignment.



The locations of the seven vibration propagation measurement sites used in the assessment are shown in Figure 5-3. The location of vibration measurement V-A was selected to be representative of all the alignment options considered between Target Field Station and Lyndale Station. Additional vibration testing for the Build Alternative would be completed for the Supplemental Final EIS. The results of the LSTM tests are shown in Figure 5-4. Detailed information regarding the vibration measurement results for the tests conducted as a part of the Supplemental Draft EIS are contained in Appendix C and photographs of vibration measurement sites are contained in Appendix D.

An additional set of vibration testing was conducted at the Capri Theater to determine specific vibration and ground-borne noise levels in sensitive spaces inside the building. Outdoor-to-indoor vibration measurements were conducted to measure the effect that the building foundation and structure has on vibration levels inside the building.



Figure 5-3 Vibration Propagation Measurement Locations

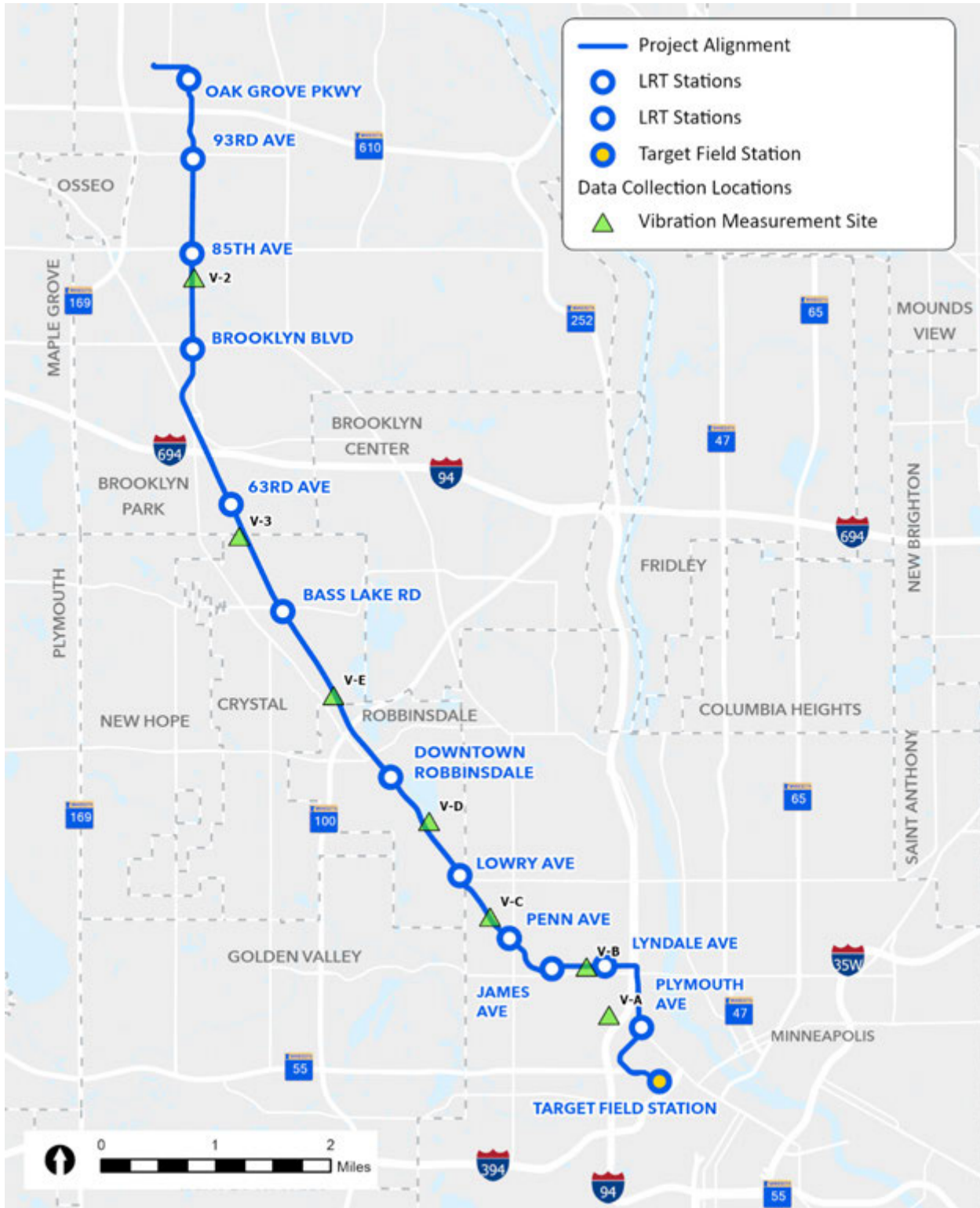
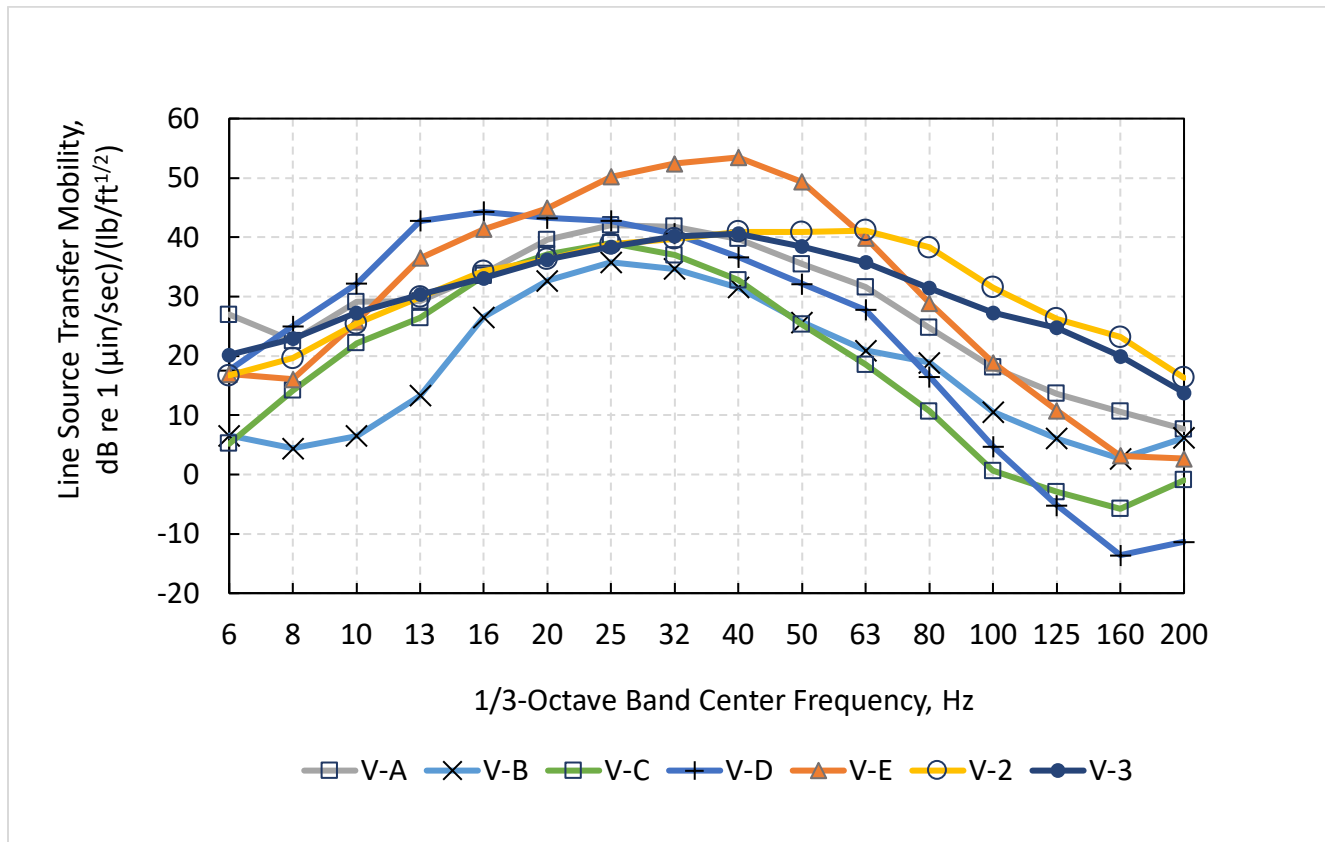


Figure 5-4 Line Source Transfer Mobility Results at 50 feet



6 Environmental Consequences

The FTA noise and vibration guidance manual is the primary source for the noise methodology. Noise impact has been evaluated using the Detailed Noise Assessment methodology contained in Section 6 of the FTA guidance manual. The noise assessment includes the following steps:

- Identified noise-sensitive land uses in the Project Alignment using aerial photography, graphic information system (GIS) data, and field surveys, typically within 350 feet of the alignment.
- Measured the existing noise levels in the Project Alignment at sensitive receptors (See Affected Environment – Section 4.1).
- Projected Project noise levels from transit operations, using Project drawings provided by the engineering team, and information on speeds, headways, track type, LRV type, and at-grade-crossing operations.
- Assessed the impact from transit by comparing the Project noise with the FTA noise impact criteria in Section 4 of the FTA guidance manual.
- Recommended mitigation at locations where Project noise levels exceed the impact criteria.



6.1 Project Noise

This section describes the noise impacts for the Project. Most of the impacts are due to proximity of the tracks (wheel/rail interaction) to sensitive land use, grade crossing bells, and location of crossovers. The detailed results of the noise assessment for Project alignment and design options evaluated in the City of Minneapolis are presented in Appendix E of this report.

Table 6-1 through Table 6-8 present the results of the noise impact assessment for residential and institutional (e.g., churches and schools) land uses for each city. The sources of Project noise are described in Section 3.1 and the specific source of noise for each impact location is described in the text below each table. The results include a tabulation of location information for each sensitive receptor group, the existing noise levels, the Project noise levels, the impact criteria, and whether there will be noise impacts. The tables also show the total number of properties and DUs with moderate and severe noise impacts for each location. Because the Project would never exceed the MPCA standards, the FTA criteria are more protective in assessing impacts from the Project. A summary of each location that will experience noise impacts follows the respective tables.

The moderate and severe noise impact criteria for the noise assessment are determined by the existing noise level, as described in Section 2.1.2.1 and shown in Figure 2.2. The Project noise level is compared to the moderate and severe impact thresholds at each location to determine the potential for noise impact from the Project. If the Project noise level is above the criteria, there would be either a moderate or severe noise impact. If the Project noise level is below the moderate impact criterion, there would be no noise impact.



Table 6-1 Summary of Noise Impacts for Residential Land Use in the City of Brooklyn Park

Location	City	Side of Track	Near Track Dist. (ft)	Speed (mph)	Exist Noise Level Ldn (dBA)	Project Noise Level Ldn (dBA)	FTA Mod Impact Noise Level Ldn (dBA)	FTA Sev Impact Noise Level Ldn (dBA)	Noise Level Increase (dB)	Mod Noise Impacts # of properties /DUs	Sev Noise Impacts # of properties /DUs
93rd Ave N to TH 610	Brooklyn Park	NB	272	35	62	47	59	64	0.1	0	0
93rd Ave N to TH 610	Brooklyn Park	SB	*	*	*	*	*	*	*	*	*
85th Ave N to 93rd Ave N	Brooklyn Park	NB	107	50	62	59	59	64	1.8	1/ 1	0
85th Ave N to 93rd Ave N	Brooklyn Park	SB	91	55	62	60	59	64	2.1	3/12	0
Shingle Creek to 85th Ave N	Brooklyn Park	NB	*	*	*	*	*	*	*	*	*
Shingle Creek to 85th Ave N	Brooklyn Park	SB	88	45	65	59	61	66	1.0	0	0
Brooklyn Blvd to Shingle Creek	Brooklyn Park	NB	98	55	65	60	61	66	1.1	0	0
Brooklyn Blvd to Shingle Creek	Brooklyn Park	SB	*	*	*	*	*	*	*	*	*
N 73rd Ave to Brooklyn Blvd	Brooklyn Park	NB	86	40	65	59	61	66	0.9	0	0
N 73rd Ave to Brooklyn Blvd	Brooklyn Park	SB	169	40	65	52	61	66	0.2	0	0
I-94 to N 73rd Ave	Brooklyn Park	NB	*	*	*	*	*	*	*	*	*
I-94 to N 73rd Ave	Brooklyn Park	SB	271	45	56	49	56	62	0.7	0	0
N 63rd Ave to I-94	Brooklyn Park	NB	109	50	56	52	56	62	1.2	0	0
N 63rd Ave to I-94	Brooklyn Park	SB	226	50	56	52	56	62	1.3	0	0
N 60th Ave to N 63rd Ave	Brooklyn Park	NB	121	50	63	56	60	65	0.7	0	0
N 60th Ave to N 63rd Ave	Brooklyn Park	SB	204	50	63	52	60	65	0.3	0	0

Source: CSA, 2023

Notes:

Predicted noise levels shown for each location are highest for each location. Projected noise levels at other receptors within each location are lower.

The reported noise levels are rounded to the nearest decibel.

Includes the total number of DUs at the affected properties. Additional noise measurements and analysis will be performed to determine potential impacts at each DU and the reasonable and feasible mitigation measures that would be implemented.

Mod = moderate; Sev = severe.

*No noise sensitive land uses.



- **85th Ave N to 93rd Ave N (NB):** There is one single-family residence on the northbound side of the Project Alignment between 85th Ave N and 93rd Ave N predicted to have a moderate noise impact. This impact is due to the speed of the LRV and the grade crossing bells at 89th Ave N and Maplebrook Pkwy N.
- **85th Ave N to 93rd Ave N (SB):** There are three residential properties, each with four dwelling units on the southbound side of the Project Alignment between 85th Ave N and 93rd Ave N predicted to have moderate noise impacts. These impacts are due to the LRV bells in the area and the expansion of County State Aid Highway (CSAH) 103.

Table 6-2 Summary of Noise Impacts for Institutional Land Use in the City of Brooklyn Park

Name	City	Side of Track	Near Track Dist. (ft)	Speed (mph)	Exist Noise Level Leq (dBA)	Project Noise Levels Leq (dBA)	FTA Mod Impact Noise Level Leq (dBA)	FTA Sev Impact Noise Level Leq (dBA)	Noise Level Increase (dB)	Type of Impact
Ebenezer Community Church	Brooklyn Park	NB	136	20	59	47	62	68	0.3	--
Berean Baptist Church	Brooklyn Park	SB	88	50	59	63	62	68	5.7	Moderate
Brooklyn Park Library	Brooklyn Park	NB	99	40	59	53	62	68	1.0	--
Fire International Embassy	Brooklyn Park	SB	333	20	59	34	62	68	0.0	--
North Hennepin Community College	Brooklyn Park	NB	215	45	59	54	62	68	1.1	--
Revive Church	Brooklyn Park	SB	162	55	59	52	62	68	0.8	--
Children's Music Academy of Brooklyn Park	Brooklyn Park	NB	295	35	66	50	66	72	0.1	--

Source: CSA, 2023

Note: The reported noise levels are rounded to the nearest decibel.

Mod = moderate; Sev = severe.

- **Berean Baptist Church:** The Berean Baptist Church is predicted to have a moderate noise impact. This impact is due to the LRV bells in the area and the expansion of CSAH 103.

The locations of the noise impacts for the City of Brooklyn Park are shown in Figure 6-1.



Figure 6-1 Project Noise Impacts in the City of Brooklyn Park

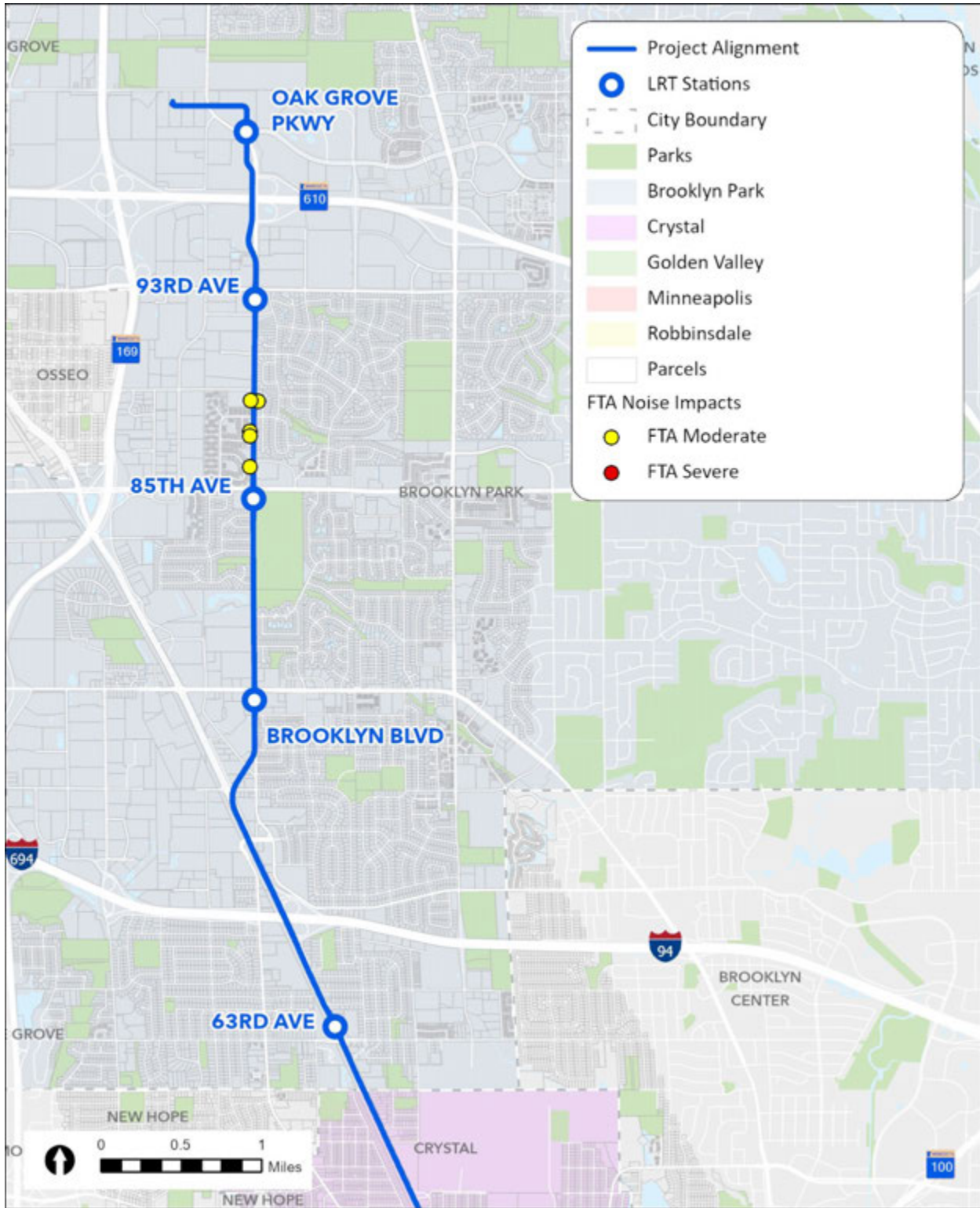




Table 6-3 Summary of Noise Impacts for Residential Land Use in the City of Crystal

Location	City	Side of Track	Near Track Dist. (ft)	Speed (mph) ^a	Exist Noise Level Ldn (dBA)	Project Noise Levels Ldn (dBA)	FTA Mod Impact Noise Level Ldn (dBA)	FTA Sev Impact Noise Level Ldn (dBA)	Noise Level Increase (dB)	Mod Noise Impacts # of properties /DUs	Number of Sev Noise Impacts
N 56th Ave to N 60th Ave	Crystal	NB	349	25	63	38	60	65	0.0	0	0
N 56th Ave to N 60th Ave	Crystal	SB	227	55	63	52	60	65	0.3	0	0
CPKC Rail Line to N 56th Ave	Crystal	NB	146	20	59	57	57	63	2.8	1/14	0
CPKC Rail Line to N 56th Ave	Crystal	SB	280	20	59	53	57	63	1.0	0	0
N 47th Ave to CPKC Rail Line	Crystal	NB	135	55	59	56	57	63	1.9	0	0
N 47th Ave to CPKC Rail Line	Crystal	SB	93	50	59	59	57	63	3.3	4/4	0

Source: CSA, 2023

^a LRV speed varies within the segment. Speed (mph) listed here reflects noise analysis assumptions.

Notes:

Predicted noise levels shown for each location are highest for each location. Projected noise levels at other receptors within each location are lower.

The reported noise levels are rounded to the nearest decibel.

Includes the total number of DUs at the affected properties. Additional noise measurements and analysis will be performed to determine potential impacts at each DU and the reasonable and feasible mitigation measures that would be implemented. Mod = moderate; Sev = severe.

*No noise sensitive land use.

- **CPKC Rail Line to N 56th Ave (NB):** There is one residential property with 14 dwelling units on the northbound side of the Project Alignment between the CPKC Rail Line and N 56th Ave predicted to have moderate noise impacts. These impacts are due to the proximity of the tracks (wheel/rail interaction) and the bells at Bass Lake Rd and Bass Lake Rd Station.
- **N 47th Ave to the CPKC Rail Line (SB):** There are four single-family residences on the southbound side of the Project Alignment between N 47th Ave and the CPKC Rail Line predicted to have moderate noise impacts. These impacts are due to the proximity of the tracks and the speed of the train.



Table 6-4 Summary of Noise Impacts for Institutional Land Use in the City of Crystal

Name	City	Side of Track	Near Track Dist. (ft)	Speed (mph)	Exist Noise Level Leq (dBA)	Project Noise Levels Leq (dBA)	FTA Mod Impact Noise Level Leq (dBA)	FTA Sev Impact Noise Level Leq (dBA)	Noise Level Increase (dB)	Type of Impact
Crystal Medical Center	Crystal	NB	104	42	61	53	63	69	0.7	--

Source: CSA, 2023

Note: The reported noise levels are rounded to the nearest decibel.

Mod = moderate; Sev = severe.

The locations of the noise impacts for the City of Crystal are shown in Figure 6-2.



Figure 6-2 Project Noise Impacts in the City of Crystal

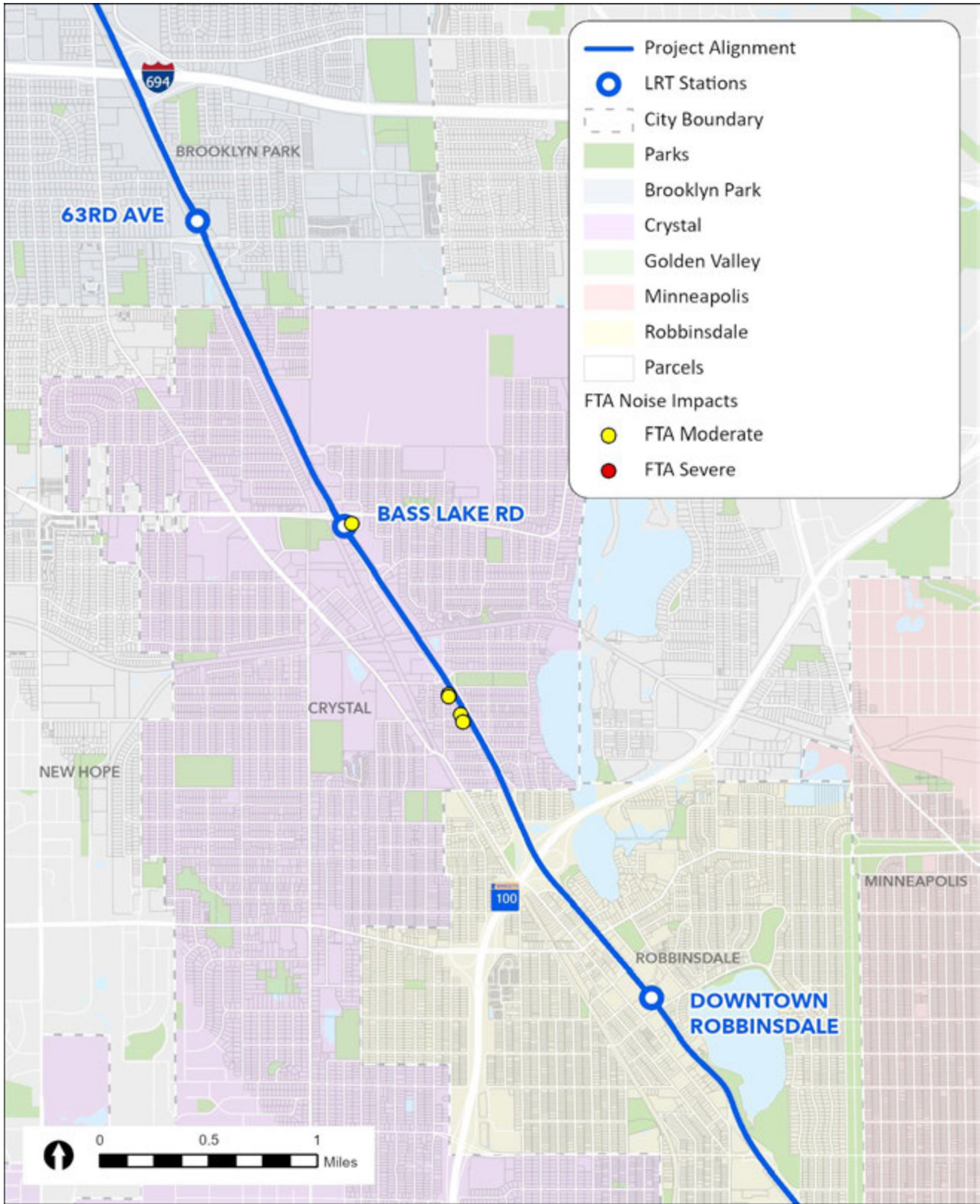




Table 6-5 Summary of Noise Impacts for Residential Land Use in the City of Robbinsdale

Location	City	Side of Track	Near Track Dist. (ft)	Speed (mph)	Exist Noise Level Ldn (dBA)	Project Noise Levels Ldn (dBA)	FTA Mod Impact Noise Level Ldn (dBA)	FTA Sev Impact Noise Level Ldn (dBA)	Noise Level Increase (dB)	Mod Noise Impacts # of properties /DUs	Sev Noise Impacts # of properties /DUs
TH 100 to N 47th Ave	Robbinsdale	NB	139	40	61	54	58	64	0.9	0	0
TH 100 to N 47th Ave	Robbinsdale	SB	254	40	61	50	58	54	0.4	0	0
N 42nd Ave to TH 100	Robbinsdale	NB	89	50	61	59	58	64	2.4	2/2	0
N 42nd Ave to TH 100	Robbinsdale	SB	119	50	61	57	58	64	1.9	0	0
N 40th Ave to N 42nd Ave**	Robbinsdale	NB	112	40	70	57	64	70	0.2	0	0
N 40th Ave to N 42nd Ave**	Robbinsdale	SB	*	*	*	*	*	*	*	*	*
N 36th Ave to N 40th Ave**	Robbinsdale	NB	97	40	70	58	64	70	0.3	0	0
N 36th Ave to N 40th Ave**	Robbinsdale	SB	73	50	70	62	64	70	0.6	0	0
N Lowry Ave to N 36th Ave	Robbinsdale	NB	138	40	70	58	64	70	0.3	0	0
N Lowry Ave to N 36th Ave	Robbinsdale	SB	109	50	70	57	64	70	0.2	0	0

Source: CSA, 2023

Notes:

Predicted noise levels shown for each location are highest for each location. Projected noise levels at other receptors within each location are lower.

The reported noise levels are rounded to the nearest decibel.

Includes the total number of DUs at the affected properties. Additional noise measurements and analysis will be performed to determine potential impacts at each DU and the reasonable and feasible mitigation measures that would be implemented.

Mod = moderate; Sev = severe.

*No noise sensitive land use.

**There are no differences in the predicted noise levels or impacts for the three options for the Downtown Robbinsdale Station.

- **N 42nd Ave to TH 100 (NB):** There are two single-family residences on the northbound side of the Project Alignment between N 42nd Ave and TH 100 predicted to have moderate noise impacts. These impacts are due to the proximity of the tracks and speed of the train.



Table 6-6 Summary of Noise Impacts for Institutional Land Use in the City of Robbinsdale

Name	City	Side of Track	Near Track Dist. (ft)	Speed (mph)	Exist Noise Level Leq (dBA)	Project Noise Levels Leq (dBA)	FTA Mod Impacts Noise Level Leq (dBA)	FTA Sev Impact Noise Level Leq (dBA)	Noise Level Increase (dB)	Type of Impact
Elim Lutheran Church	Robbinsdale	SB	177	40	57	46	61	67	0.3	--

Source: CSA, 2023

Note: The reported noise levels are rounded to the nearest decibel.
Mod = moderate; Sev = severe.

The locations of the noise impacts for the City of Robbinsdale are shown in Figure 6-3.



Figure 6-3 Project Noise Impacts in the City of Robbinsdale

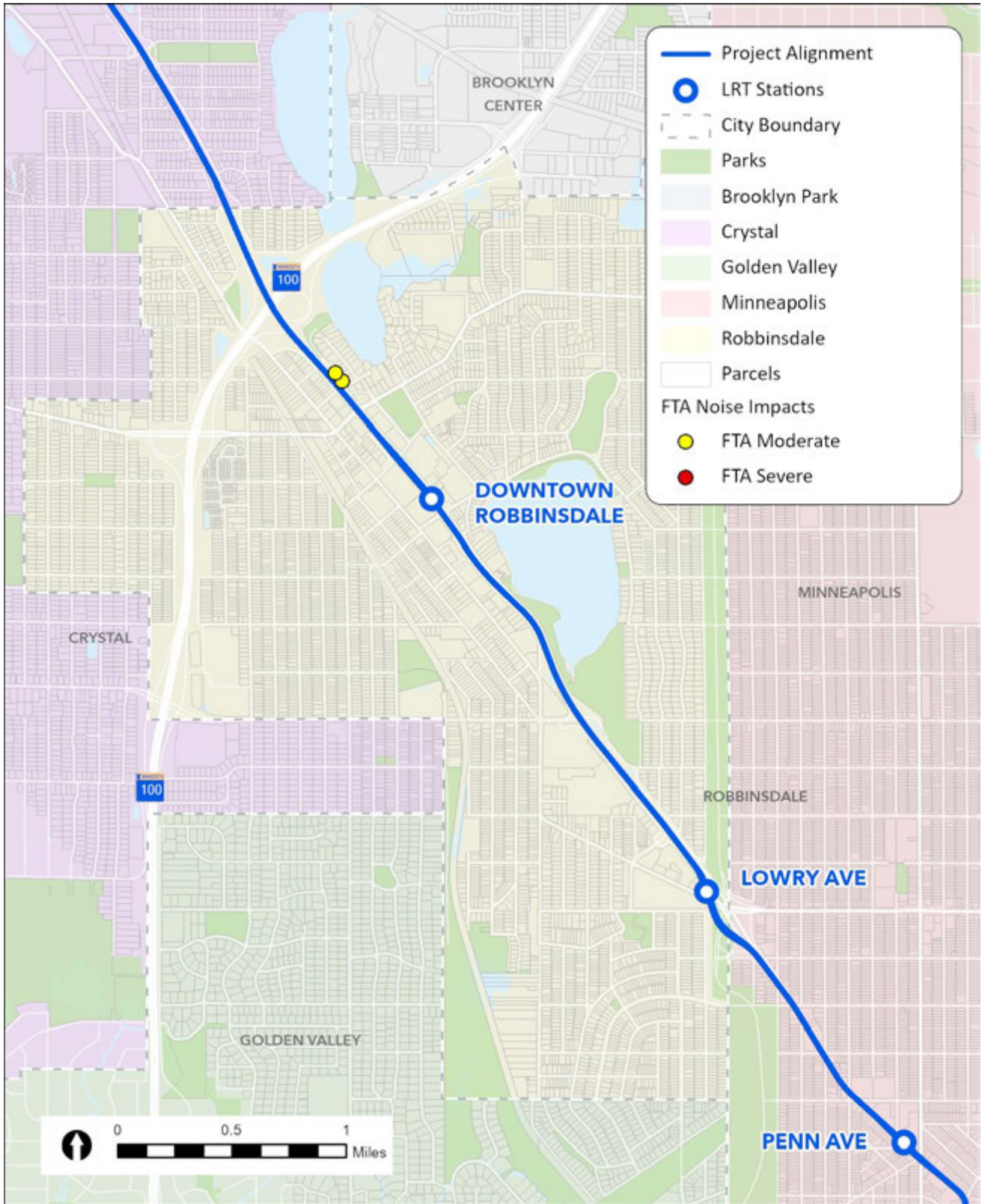




Table 6-7 Summary of Noise Impacts for Residential Land Use in the City of Minneapolis

Location	City	Side of Track	Near Track Dist. (ft)	Speed (mph)	Exist Noise Level Ldn (dBA)	Project Noise Levels Ldn (dBA)	FTA Mod Impact Noise Level Ldn (dBA)	FTA Sev Impact Noise Level Ldn (dBA)	Noise Level Increase (dB)	Mod Noise Impacts # of properties /DUs	Sev Noise Impacts # of properties /DUs
N 26th Ave to N Lowry Ave	Minneapolis	NB	43	45	69	70	64	69	3.6	2/2	2/2
N 26th Ave to N Lowry Ave	Minneapolis	SB	40	45	69	70	64	69	3.6	6/51	1/1
N Knox Ave to N 26th Ave	Minneapolis	NB	56	20	69	64	64	69	1.1	1/104	0
N Knox Ave to N 26th Ave	Minneapolis	SB	53	35	69	60	64	69	0.5	0	0
N Emerson Ave to N Knox Ave	Minneapolis	NB	51	35	55	65	55	61	10.7	1/1	3/4
N Emerson Ave to N Knox Ave	Minneapolis	SB	21	35	55	73	55	61	18.7	0	4/15
Lyndale Ave to N Emerson Ave	Minneapolis	NB	33	35	55	68	55	61	13.3	2/2	2/31
Lyndale Ave to N Emerson Ave	Minneapolis	SB	18	15	55	59	55	61	5.7	1/18	0
I-94 to Lyndale Ave	Minneapolis	NB	52	15	55	62	55	61	7.8	2/3	1/1
I-94 to Lyndale Ave	Minneapolis	SB	*	*	*	*	*	*	*	*	*
I-94 to Plymouth Ave N	Minneapolis	SB	*	*	*	*	*	*	*	*	*
I-94 to Plymouth Ave N	Minneapolis	NB	*	*	*	*	*	*	*	*	*
N 8th Ave to Plymouth Ave N	Minneapolis	NB	29	40	69	67	64	69	2.1	1/30	0
N 8th Ave to Plymouth Ave N	Minneapolis	SB	26	40	69	71	64	69	3.7	0	2/119
Target Field Station to N 8th Ave	Minneapolis	NB	50	15	65	51	60	66	0.2	0	0
Target Field Station to N 8th Ave	Minneapolis	SB	*	*	*	*	*	*	*	*	*

Source: CSA, 2023

Notes:

Predicted noise levels shown for each location are highest for each location. Projected noise levels at other receptors within each location are lower.

The reported noise levels are rounded to the nearest decibel.

Includes the total number of DUs at the affected properties. Additional noise measurements and analysis will be performed to determine potential impacts at each DU and the reasonable and feasible mitigation measures that would be implemented.

Mod = moderate; Sev = severe.

*No noise sensitive land use.



Based on FTA criteria, moderate impacts would occur at 16 residential properties, and severe impacts would occur at 15 residential properties, as summarized:

- **Between N Lowry Ave and N 26th Ave:** Based on FTA criteria, the Council identified seven moderate noise impacts and three severe noise impacts at single-family residences, and a moderate noise impact at an apartment building with 46 units. Compared to existing conditions, outdoor noise levels would increase by up to 3.6 dB at these residences due to the proximity of the tracks (wheel/rail interaction), the speed of the train, and a nearby crossover.
- **Between N 26th Ave and N Knox Ave:** Based on FTA criteria, the Council identified one moderate noise impact at an apartment building with 104 dwelling units. Compared to existing conditions, outdoor noise levels would increase by up to 1.1 dB at this residential property, due to the proximity of the tracks (wheel/rail interaction) and LRV bells at Penn Ave Station.
- **Between N Knox Ave and N Emerson Ave:** Based on FTA criteria, the Council identified one moderate noise impact at a single-family home and severe noise impacts at seven properties, including one two-family and five single-family homes and an apartment building with 12 dwelling units. Compared to existing conditions, outdoor noise levels at these residences would vary, increasing between 5 and 15 dB depending on the location. Existing noise is relatively low along this segment – recorded at 55 dBA – and the proximity of the tracks (wheel/rail interaction) and bells at N Girard Ave, N Fremont Ave, and N Emerson Ave would cause the noise increase.
- **Between N Emerson Ave and N Lyndale Ave:** Based on FTA criteria, the Council identified three moderate noise impacts – two at single-family homes and one at a multi-story building with 18 apartments. The Council identified two severe noise impacts – one at a single-family home and one at a multi-story building with 30 dwelling units. Compared to existing conditions, the increase in outdoor noise levels at these residences would vary, increasing between 3 and 15 dB depending on the location. Existing noise is relatively low along this segment – recorded at 55 dBA – and the proximity of the tracks (wheel/rail interaction) and bells at Bryant Ave and Lyndale Ave would cause the noise increase.
- **Between I-94 and N Lyndale Ave:** Based on FTA criteria, the Council identified two moderate impacts – at a single-family and two-family residence – and one severe noise impact at a single-family residence. Compared to existing conditions, outdoor noise levels at these residences would vary, increasing between 3 and 15 dB depending on the location. Existing noise is relatively low along this segment – recorded at 55 dBA – and the proximity of the tracks (wheel/rail interaction) and the bells at Lyndale Ave would cause the noise increase.
- **Between Plymouth Ave N and N 8th Ave:** Based on FTA criteria, the Council identified one moderate and two severe noise impacts at three apartment buildings with 30, 10, and 109 dwelling units, respectively. Compared to existing conditions, outdoor noise levels at these residential properties would increase by up to 3.7 dB due to the proximity of the tracks and bells at N 3rd Street and N 5th Street.

Additional noise monitoring and analysis will be performed as the design advances to determine potential impacts at each dwelling unit within multi-family properties and whether mitigation measures would be cost effective based on noise mitigation criteria (see Section 5.6.4).

In addition to the noise impacts at residential properties, a moderate noise impact would occur at the Faith Tabernacle Gospel Fellowship International, where outdoor noise levels would increase by 5.1 dB due to the proximity of the tracks (wheel/rail interaction).

The locations of the noise impacts for the City of Minneapolis along the 21st Ave N and east of I-94 to Washington Ave are shown in Figure 6-4



Table 6-8 Summary of Noise Impacts for Institutional Land Use in the City of Minneapolis

Name	City	Side of Track	Near Track Dist. (ft)	Speed (mph)	Exist Noise Level Leq (dBA)	Project Noise Levels Leq (dBA)	FTA Mod Impact Noise Level Leq (dBA)	FTA Sev Impact Noise Level Leq (dBA)	Noise Level Increase	Type of Impact
Parkway United Church of Christ	Minneapolis	NB	338	25	68	46	68	73	0.0	--
Good News Minneapolis Church	Minneapolis	NB	139	25	68	52	68	73	0.4	--
True Vine Missionary Baptist Church	Minneapolis	SB	111	45	68	63	68	73	1.1	--
KIPP Legacy	Minneapolis	NB	200	35	68	51	68	73	0.1	--
St Anne-St Joseph Hien Church	Minneapolis	NB	323	35	68	42	68	73	0.0	--
All Nations Seventh-day Adventist Church	Minneapolis	SB	182	20	68	41	68	73	0.0	--
PYC Arts & Technology Alternative High School	Minneapolis	SB	53	20	62	58	64	69	1.6	--
Capri Theater*	Minneapolis	SB	40	20	62	63	64	69	--	--
Star Child Development Center LLC	Minneapolis	SB	40	20	62	63	64	69	3.7	--
Real Believers Faith Center Church	Minneapolis	SB	236	35	68	43	68	73	0.0	--
Liberty Community Church	Minneapolis	NB	44	35	62	64	64	69	4.1	--
United Deliverance Temple Inc	Minneapolis	NB	250	15	62	36	64	69	0.0	--
Sanctuary Covenant Church	Minneapolis	SB	16	15	62	59	64	69	1.9	--
Faith Tabernacle Gospel Fellowship International	Minneapolis	SB	17	25	68	72	68	73	5.1	Moderate
Metro Schools College Prep	Minneapolis	SB	166	10	67	46	67	72	0.0	--
Lundstrum Performing Arts	Minneapolis	NB	279	40	66	45	66	72	0.1	--
Minnesota International Middle Charter School	Minneapolis	NB	358	40	66	47	66	72	0.0	--

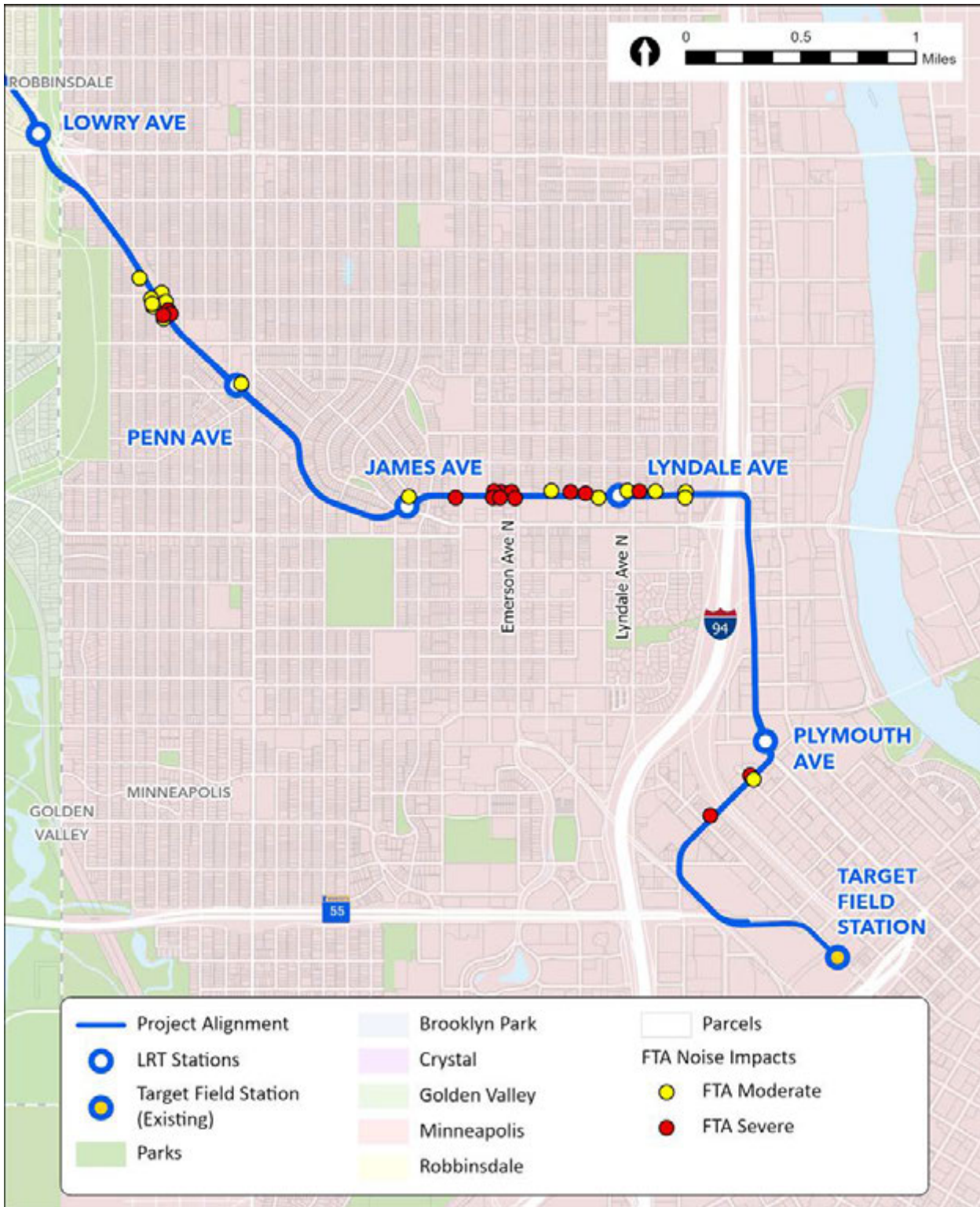
Source: CSA, 2023

The reported noise levels are rounded to the nearest decibel.

*This represents the results for non-special use spaces in the Capri Theater.



Figure 6-4 Project Noise Impacts in the City of Minneapolis



6.1.1 Capri Theater

The Capri Theater is a special use building that contains several different noise and vibration sensitive spaces, including a theater, recording studio, community hall, dance studio, and classrooms. The community hall, dance studio, and classrooms are all Category 3 (institutional) receivers. The noise and vibration assessments for the Category 3 uses at Capri Theater are discussed in Sections 6.1 and 6.2.1, respectively. No noise or vibration impacts are projected for any of the Category 3 uses.

The theater and the recording studio are considered separately from the rest of the building and require site-specific measurements to determine the potential for noise and vibration impact. The FTA Guidance manual includes specific vibration and ground-borne noise criteria for both spaces. For the noise assessment, the calculated indoor Project noise levels in the theater, which has an outer wall facing the Project Alignment, were compared to the measured ambient noise level to determine the potential for impact. Because the recording studio is located in the interior of the building, a noise assessment was not conducted because there is no path for outdoor noise to affect the space. The criteria used in the assessment for both spaces are shown in Table 6-9.

Table 6-9 FTA Noise and Vibration Criteria for the Capri Theater

Location	Existing Noise Level (dBA)	FTA Vibration Criteria (VdB)	FTA Ground-Borne Noise Criteria (dBA)
Theater	46.2	72	35
Recording Studio	--	65	25

Source: CSA, 2023

The outdoor-to-indoor noise measurements conducted for the theater focused on the southeast façade of the building, which is an outer wall for the theater. The northeast façade of the building includes an atrium, and an additional wall and doors between the outside of the building and the theater space. The light rail noise levels inside the theater would be much lower through that façade than the outer wall on the southeast side. The results of the noise measurements inside the theater indicate that noise levels from LRV passbys would be 5 dB below the existing noise levels in the theater. Therefore, there would be no noise impacts from light rail operations.

The results of the vibration and ground-borne noise measurements inside the theater indicate that both the vibration and ground-borne noise levels are well below the impact thresholds and no impacts are projected.

The results of the vibration and ground-borne noise assessment for the recording studio indicate that the vibration levels are below the impact threshold, but the ground-borne noise levels are above the impact threshold. The vibration and ground-borne noise measurements for the recording studio were conducted on the second story of the building, and there was substantial background noise and vibration from sources inside the building interfering with the measurements. The projected ground-borne noise levels would be expected to be similar to or lower than those measured in the theater. Additional investigation will explore potential for ground-borne noise impacts resulting from vibration and results will be presented in the Supplemental Final EIS.

A summary of the noise and vibration impact assessment for the Capri Theater is shown in Table 6-10.

Table 6-10 Summary of Project Noise and Vibration Levels for the Capri Theater

Location	Project Noise Level (dBA)	Project Vibration Level (VdB)	Project Ground-Borne Noise Level (dBA)
Theater	40.9	57	24
Recording Studio	--	58	35

Source: CSA, 2023

6.1.2 Stations

The major noise source at stations, other than LRT operations, is the sounding of the LRT bells as the trains enter and exit the stations. The noise from the LRT bells has been captured in the Project noise assessment detailed above.

6.1.3 Operations and Maintenance Facility

The Operations and Maintenance Facility is located more than 1,000 feet from any noise-sensitive receptors; therefore, no noise impact is projected.

6.1.4 Construction Noise

Elevated noise levels from construction activities are, to a degree, unavoidable for this type of project. Construction noise levels are subject to local noise ordinances and noise rules administered by the MPCA (Minnesota Rules ch. 7030). MPCA administers these noise rules to establish maximum allowable noise levels; where applicable, MPCA procedures allow for the issuance of noise variances. The Council will require that construction equipment used by contractors be properly muffled and in proper working order. Advanced notice will be provided to affected communities of any planned abnormally loud construction activities. In general, construction will occur within daytime hours. However, night construction may sometimes be required, for example to minimize traffic impacts or to improve safety. If nighttime construction is deemed necessary, during the Project’s final design and construction stages, a nighttime construction mitigation plan will be developed.

For most construction equipment, diesel engines are typically the dominant noise source. For other activities such as impact pile driving and jackhammering, noise generated by the actual process dominates. Short-term noise during construction of the Project can be intrusive to residents near the construction sites. Most of the construction will consist of site preparation and laying new tracks, and should occur primarily during daytime hours, except when required and within City noise ordinance procedures for a waiver. At some locations, more extensive work will occur, such as pile driving for elevated structures and retaining walls.

Table 6-11 shows noise levels of typical construction equipment from the FTA guidance manual, in terms of the maximum levels at 50 feet. Construction noise predictions at noise-sensitive locations depends on the amount of noise during each construction phase, the duration of the noise, and the distance from the construction activities to the sensitive receptor. Conducting a construction noise impact assessment requires knowledge of the equipment likely to be used, the duration of its use, and the way it will be used by a contractor. The Leq for a particular set of assumptions is estimated using typical noise levels from Table 6-11.



Table 6-11 Typical Construction Noise Levels

Equipment Type	Typical Noise Level (dBA) 50 ft
Backhoe	80
Compactor	82
Concrete Mixer	85
Concrete Pump	82
Crane, Derrick	88
Crane, Mobile	83
Dozer	85
Grader	85
Loader	85
Paver	89
Pump	76
Roller	74
Truck	88

Source: FTA, 2018

Table 6-12 provides an example of a construction noise projection for typical at-grade track construction. Using these assumptions, an 8-hour Leq of 88 dBA would be projected at a distance of 50 feet from the construction site.

Using the criteria in Section 2.1.2 and the example for at-grade construction in Table 6-11, screening distances for at-grade track construction noise impact can be determined. For residential land use, the potential for short-term at-grade track construction noise (Table 6-12) impact could extend to approximately 120 feet from the Project Alignment; however, if nighttime construction is conducted, the potential for short-term noise impact from at-grade construction could extend to approximately 380 feet from the Project Alignment.

Typically, a contractor will provide this information as a part of a noise control plan for construction. See Section 7.1.4 for more information regarding the approach to mitigating construction noise.



Table 6-12 Summary of Historic and Cultural Resources Noise Assessment

Equipment Type	Typical Noise Level (dBA)		Equipment Utilization Factor (%)	Leq (dBA)
	50 ft			
Grader	85		50	82
Backhoe	80		40	76
Compactor	82		20	75
Loader	85		20	78
Roller	74		20	67
Truck	88		40	84
Crane, Mobile	83		20	76
Total 8-hour workday Leq at 50 ft				88

Source: CSA, 2023

6.2 Project Vibration

The FTA guidance manual on noise and vibration (FTA, 2018) is the primary source for the vibration methodology. The assessment uses the Detailed Vibration Assessment methodology, as described in Section 6 of the FTA guidance manual.

The vibration assessment steps employed includes the following:

- Identified vibration-sensitive land uses in the Project Alignment using aerial photography, GIS data, and field surveys, typically within 350 feet of the alignment.
- Measured vibration-propagation characteristics of the soil in the Project Alignment at sensitive receptors (See Affected Environment – Section 5.2).
- Projected Project vibration levels from transit operations, using Project drawings provided by the engineering team, and information on speeds, headways, track type, and LRV vibration characteristics.
- Assessed the impact from transit by comparing the Project vibration with the FTA vibration impact criteria in Section 6 of the FTA guidance manual.
- Recommended mitigation at locations where Project vibration levels exceed the impact criteria.

6.2.1 Project Vibration

This section describes the vibration impacts for the Project Build Alternative. The detailed results of the vibration assessment for other Project alignment and design options evaluated in the City of Minneapolis are presented in Appendix F of this report.

Table 6-13 through Table 6-20. includes a tabulation of location information for each sensitive receptor group, Project vibration levels, the impact criteria, and whether there will be vibration impacts. The tables also show the total number of dwelling units with vibration impacts for each location.



Table 6-13 Summary of Vibration Impacts for Residential Land Use in the City of Brooklyn Park

Location	City	Side of Track	Near Track Dist. (ft)	Speed (mph)	Max Project Vibration Level (VdB)	FTA Vibration Criteria (VdB)	Number of Impacts
93rd Ave N to TH 610	Brooklyn Park	NB	272	35	48	72	0
93rd Ave N to TH 610	Brooklyn Park	SB	*	*	*	*	*
85th Ave N to 93rd Ave N	Brooklyn Park	NB	110	55	55	72	0
85th Ave N to 93rd Ave N	Brooklyn Park	SB	90	55	58	72	0
Shingle Creek to 85th Ave N	Brooklyn Park	NB	*	*	*	*	*
Shingle Creek to 85th Ave N	Brooklyn Park	SB	83	45	59	72	0
Brooklyn Blvd to Shingle Creek	Brooklyn Park	NB	81	55	60	72	0
Brooklyn Blvd to Shingle Creek	Brooklyn Park	SB	*	*	*	*	*
N 73rd Ave to Brooklyn Blvd	Brooklyn Park	NB	87	45	59	72	0
N 73rd Ave to Brooklyn Blvd	Brooklyn Park	SB	169	40	50	72	0
I-94 to N 73rd Ave	Brooklyn Park	NB	*	*	*	*	*
I-94 to N 73rd Ave	Brooklyn Park	SB	271	45	48	72	0
N 63rd Ave to I-94	Brooklyn Park	NB	109	50	56	72	0
N 63rd Ave to I-94	Brooklyn Park	SB	226	50	53	72	0
N 60th Ave to N 63rd Ave	Brooklyn Park	NB	121	50	56	72	0
N 60th Ave to N 63rd Ave	Brooklyn Park	SB	204	50	53	72	0

Source: CSA, 2023

Note: The vibration levels shown for each location are the highest levels projected for that location. Vibration projections at other receptors within each location will be lower.

*There are no vibration sensitive receivers at this location.



Table 6-14 Summary of Vibration Impacts for Institutional Land Use in the City of Brooklyn Park

Location	City	Side of Track	Near Track Dist. (ft)	Speed (mph)	Max Project Vibration Level (VdB)	FTA Vibration Criteria (VdB)	Impact
Ebenezer Community Church	Brooklyn Park	NB	136	20	48	75	--
Berean Baptist Church	Brooklyn Park	SB	88	50	58	75	--
Brooklyn Park Library	Brooklyn Park	NB	99	40	56	75	--
Fire International Embassy	Brooklyn Park	SB	333	20	43	75	--
North Hennepin Community College	Brooklyn Park	NB	215	45	50	75	--
Revive Church	Brooklyn Park	SB	162	55	53	75	--
Children's Music Academy of Brooklyn Park	Brooklyn Park	NB	295	35	38	75	--

Source: CSA, 2023

Note: The vibration levels shown for each location are the highest levels projected for that location. Vibration projections at other receptors within each location will be lower.

Table 6-15 Summary of Vibration Impacts for Residential Land Use in the City of Crystal

Location	City	Side of Track	Near Track Dist. (ft)	Speed (mph)	Max Project Vibration Level (VdB)	FTA Vibration Criteria (VdB)	Number of Impacts
N 56th Ave to N 60th Ave	Crystal	NB	349	25	48	72	0
N 56th Ave to N 60th Ave	Crystal	SB	227	55	54	72	0
Freight Tracks to N 56th Ave	Crystal	NB	211	55	54	72	0
Freight Tracks to N 56th Ave	Crystal	SB	280	20	47	72	0
N 47th Ave to Freight Tracks	Crystal	NB	135	55	58	72	0
N 47th Ave to Freight Tracks	Crystal	SB	89	55	63	72	0

Source: CSA, 2023

Note: The vibration levels shown for each location are the highest levels projected for that location. Vibration projections at other receptors within each location will be lower.



Table 6-16 Summary of Vibration Impacts for Institutional Land Use in the City of Crystal

Location	City	Side of Track	Near Track Dist. (ft)	Speed (mph)	Max Project Vibration Level (VdB)	FTA Vibration Criteria (VdB)	Impact
Crystal Medical Center	Crystal	NB	104	42	54	75	--

Source: CSA, 2023

Note: The vibration levels shown for each location are the highest levels projected for that location. Vibration projections at other receptors within each location will be lower.

Table 6-17 Summary of Vibration Impacts for Residential Land Use in the City of Robbinsdale

Location	City	Side of Track	Near Track Dist. (ft)	Speed (mph)	Max Project Vibration Level (VdB)	FTA Vibration Criteria (VdB)	Number of Impacts
TH 100 to N 47th Ave	Robbinsdale	NB	139	40	60	72	0
TH 100 to N 47th Ave	Robbinsdale	SB	205	30	54	72	0
N 42nd Ave to TH 100	Robbinsdale	NB	188	50	63	72	0
N 42nd Ave to TH 100	Robbinsdale	SB	126	50	66	72	0
N 40th Ave to N 42nd Ave	Robbinsdale	NB	112	40	58	72	0
N 40th Ave to N 42nd Ave	Robbinsdale	SB	*	*	*	*	*
N 36th Ave to N 40th Ave	Robbinsdale	NB	96	40	65	72	0
N 36th Ave to N 40th Ave	Robbinsdale	SB	73	50	69	72	0
N Lowry Ave to N 36th Ave	Robbinsdale	NB	146	50	46	72	0
N Lowry Ave to N 36th Ave	Robbinsdale	SB	109	50	49	72	0

Source: CSA, 2023

Note: The vibration levels shown for each location are the highest levels projected for that location. Vibration projections at other receptors within each location will be lower.

*There are no vibration sensitive receivers at this location.

Table 6-18 Summary of Vibration Impacts for Institutional Land Use in the City of Robbinsdale

Location	City	Side of Track	Near Track Dist. (ft)	Speed (mph)	Max Project Vibration Level (VdB)	FTA Vibration Criteria (VdB)	Impact
Elim Lutheran Church	Robbinsdale	SB	177	40	61	75	--

Source: CSA, 2023

Note: The vibration levels shown for each location are the highest levels projected for that location. Vibration projections at other receptors within each location will be lower.



Table 6-19 Summary of Vibration Impacts for Residential Land Use in the City of Minneapolis for the Build Alternative

Location	City	Side of Track	Near Track Dist. (ft)	Speed (mph)	Max Project Vibration Level (VdB)	FTA Vibration Criteria (VdB)	Number of Impacts
N 26th Ave to N Lowry Ave	Minneapolis	NB	43	45	60	72	0
N 26th Ave to N Lowry Ave	Minneapolis	SB	54	45	66	72	0
N Knox Ave to N 26th Ave	Minneapolis	NB	41	20	60	72	0
N Knox Ave to N 26th Ave	Minneapolis	SB	36	20	62	72	0
N Emerson Ave to N Knox Ave	Minneapolis	NB	34	15	61	72	0
N Emerson Ave to N Knox Ave	Minneapolis	SB	21	35	71	72	0
Lyndale Ave to N Emerson Ave	Minneapolis	NB	33	35	63	72	0
Lyndale Ave to N Emerson Ave	Minneapolis	SB	18	15	73	72	18 (1)
I-94 to Lyndale Ave	Minneapolis	NB	51	25	54	72	0
I-94 to Lyndale Ave	Minneapolis	SB	*	*	*	*	*
N 8th Ave to Plymouth Ave N	Minneapolis	NB	29	40	71	72	0
N 8th Ave to Plymouth Ave N	Minneapolis	SB	26	40	73	72	10 (1)
Target Field Station to N 8th Ave	Minneapolis	NB	50	15	63	72	0
Target Field Station to N 8th Ave	Minneapolis	SB	*	*	*	*	*

Source: CSA, 2023

Notes:

The vibration levels shown for each location are the highest levels projected for that location. Vibration projections at other receptors within each location will be lower.

The impact numbers outside the parentheses represent the total number DUs impacted (including apartments and other multi-family buildings), and the numbers inside the parentheses represent the total number of buildings impacted.

*There are no vibration sensitive receivers at this location.

- **Lyndale Ave to N Emerson Ave (SB):** There are 18 multi-family residences, representing one building, along the southbound side of the Project Alignment between Lyndale Ave and N Emerson Ave predicted to have a vibration impact. These impacts are due to the proximity of the tracks.
- **N 8th Ave to Plymouth Ave (SB):** There are 10 multi-family residences, representing one building, along the southbound side of the Project Alignment between N 8th Ave and Plymouth Ave predicted to have a vibration impact. These impacts are due to the proximity of the tracks.

Table 6-20 Summary of Vibration Impacts for Institutional Land Use in the City of Minneapolis (21st Ave N to Washington Ave)

Location	City	Side of Track	Near Track Dist. (ft)	Speed (mph)	Max Project Vibration Level (VdB)	FTA Vibration Criteria (VdB)	Impact
Parkway United Church of Christ	Minneapolis	NB	338	25	27	75	--
Good News Minneapolis Church	Minneapolis	NB	139	25	35	75	--
True Vine Missionary Baptist Church	Minneapolis	SB	111	45	52	75	--
KIPP Legacy	Minneapolis	NB	200	35	42	75	--
St Anne-St Joseph Hien Church	Minneapolis	NB	323	35	39	75	--
All Nations Seventh-day Adventist Church	Minneapolis	SB	182	20	40	75	--
PYC Arts & Technology Alternative High School	Minneapolis	SB	53	20	54	75	--
Capri Theater*	Minneapolis	SB	40	20	60	75	--
Star Child Development Center llc	Minneapolis	SB	40	20	59	75	--
Real Believers Faith Center Church	Minneapolis	SB	236	15	33	75	--
Liberty Community Church	Minneapolis	NB	41	35	60	75	--
United Deliverance Temple Inc	Minneapolis	NB	250	15	35	75	--
Sanctuary Covenant Church	Minneapolis	SB	16	15	74	75	--
Faith Tabernacle Gospel Fellowship International	Minneapolis	SB	17	25	74	75	--
Metro Schools College Prep	Minneapolis	SB	166	10	50	75	--
Minnesota International Middle Charter School	Minneapolis	NB	358	40	56	75	--
Lundstrum Performing Arts	Minneapolis	NB	279	40	56	75	--

Source: CSA, 2023

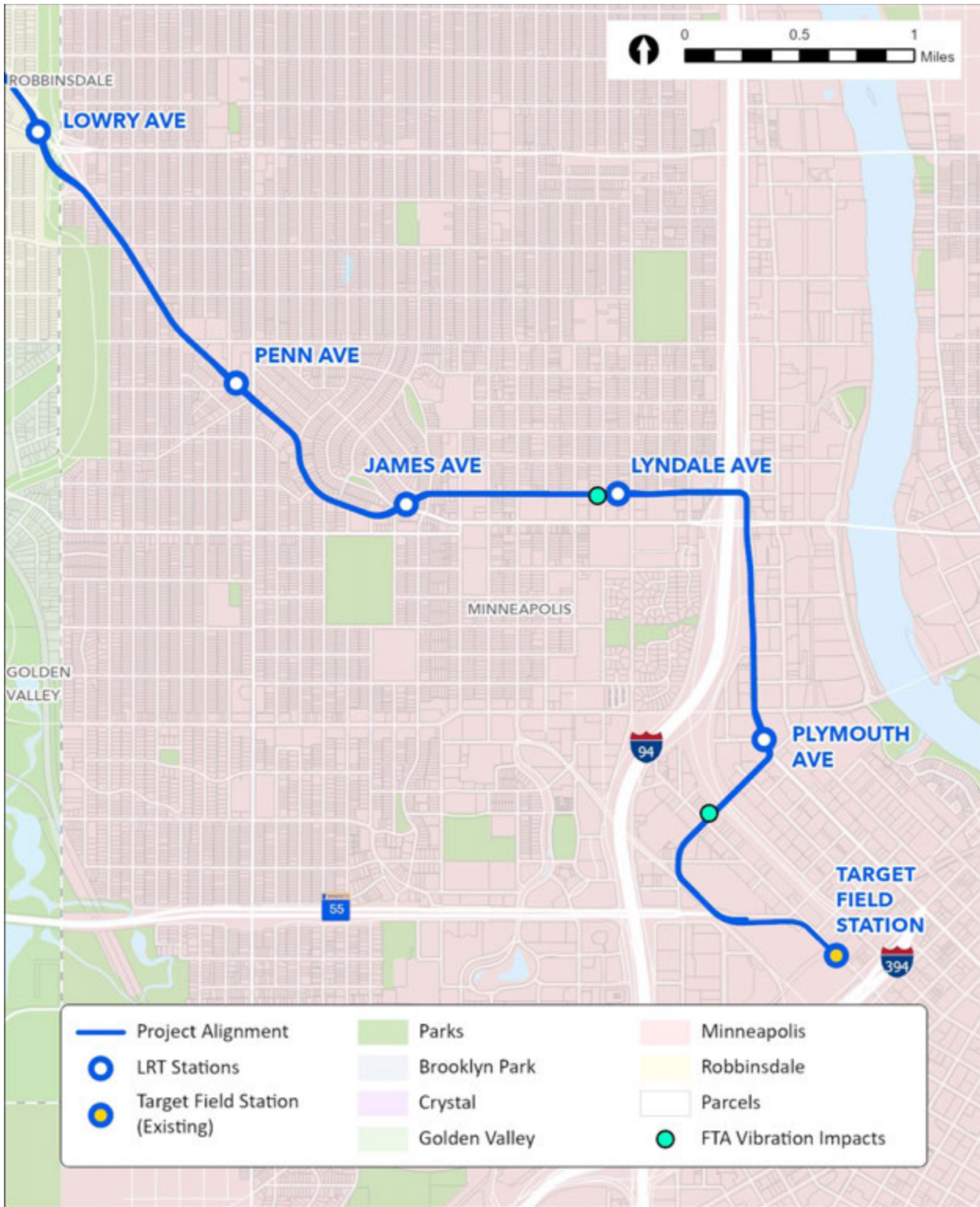
Note: The vibration levels shown for each location are the highest levels projected for that location. Vibration projections at other receptors within each location will be lower.

*This level represents the non-special use spaces in the Capri Theater.

The location of the vibration impacts for the City of Minneapolis along the 21st Ave N and east of I-94 to Washington Ave alignment options are shown in Figure 6-5.



Figure 6-5 Project Vibration Impacts in the City of Minneapolis along the 21st Ave N and Washington Ave Option



6.2.2 Stations

There is no additional vibration associated with stations, and no vibration assessment for stations has been conducted.

6.2.3 Operations and Maintenance Facility

The Operations and Maintenance Facility is located more than 1,000 feet from any vibration-sensitive receptors; therefore, no vibration impact is projected.

6.2.4 Construction Vibration

Unlike typical LRT operations, there is the potential for damage to nearby structures at close distances due to construction vibration from activities such as pile driving, hoe rams, vibratory compaction, and loaded trucks. Most limits on construction vibration are based on reducing the potential for damage to nearby structures. Although construction vibrations are only temporary, it is still reasonable to assess the potential for human annoyance and damage.

Because most of the buildings in the study area are typical engineered concrete and masonry or reinforced concrete, steel, or timber construction, a vibration criterion of 98 VdB has been used to assess potential damage impact and 72 VdB has been used to assess potential vibration annoyance from construction activities. Vibration source levels at 25 feet and the distances to potential residential annoyance and potential damage are shown in Table 6-21. Except for impact pile driving, the potential for damage is limited to within 20 feet of construction activities. For impact pile driving, the distance for the potential for damage is up to 40 feet.

Because the exact location of construction equipment is important in projecting vibration levels, a more detailed assessment of potential vibration damage will be performed during final design when more accurate equipment locations are known. It is important to note that this assessment does not address potential damage to structures due to soil settlement or displacement due to construction activities.

Table 6-21 Summary of Potential Construction Vibration Impacts

Equipment	Vibration Level at 25 ft (VdB)	Distance to Potential Damage (98 VdB), ft	Distance to Potential Annoyance (72 VdB), ft
Impact Pile Driving	104	40	300
Push Piling	84	8	62
Hoe Ram	87	10	80
Caisson Drilling	87	10	80
Loaded Trucks	86	10	75
Clam Shovel	94	20	135
Vibratory Roller	94	20	135

Source: CSA, 2023

7 Mitigation Measures

7.1 Noise

FTA guidance states that severe noise impacts should be mitigated unless there are no feasible or practical means to do so (FTA, 2018). For moderate impacts, discretion should be used, and project-specific factors should be included in the consideration of mitigation. The project-specific factors can include both the existing noise levels and the projected increase in noise levels; the types and number of noise-sensitive land uses with impacts; existing sound insulation of buildings; and the cost-effectiveness of providing noise mitigation. Metro Transit has adopted a mitigation approach that details which moderate impacts will qualify for mitigation. This approach is detailed in Section 7.1.1 below.

7.1.1 Metro Transit Noise Mitigation Approach

7.1.1.1 Noise Mitigation Thresholds (Part A)

Per FTA guidance, noise mitigation will be provided for all “Severe” impacts that meet the criteria for reasonableness, feasibility, and cost effectiveness, as defined under Part B below.

At the “Moderate” impact level, FTA guidance requires the project sponsor to consider mitigation based on several factors, as defined in the FTA guidance manual. For the Project, noise mitigation will be provided for all “Moderate” impacts, caused by the Project, that meet the criteria for reasonableness, feasibility, and cost effectiveness, as defined under Part B below, and at locations where the Project has a “Moderate” impact and one of the following thresholds are exceeded:

1. Location(s) where the existing noise levels without the Project are already 65 dBA Ldn or greater (see Exhibit 2.1-1).³
2. Location(s) where there is an increase of 3 dB or more in the Ldn over the existing level due to the Project.⁴
3. The predicted increase in the Ldn over the existing level is less than 3 dB, the location is adjacent to an area with either “Severe Impact” or “Moderate Impact” with an increase in the Ldn of 3 dB or greater, and the inclusion of the adjacent properties will provide a logical and equitable terminus to the mitigation.

³ A noise level of 65 dBA or greater is considered a “normally unacceptable” noise environment by United States Department of Housing and Urban Development. This threshold is also used by Federal Aviation Administration for compatible land use.

⁴ An increase in noise of 3 dB is generally considered the threshold for a noticeable change in noise in an outdoor setting and falls roughly at the midpoint of the “Moderate” impact range. This is a common threshold used in transit agency noise mitigation policies for an increase requiring mitigation.



7.1.1.2 Noise Mitigation Criteria (Part B)

Criteria for reasonableness, feasibility, and cost effectiveness as included in FTA guidance are described below.

1. Reasonableness: For noise mitigation to be considered reasonable, it must provide at least a 5 dB reduction in Project noise.⁵
2. Feasibility:
 - a. For noise mitigation to be considered feasible it must be practical from engineering, operations, and safety standpoints.
 - b. Other Project factors may need to be considered in determining feasibility of mitigation. These could include community input, visual impacts, and other Project features that might limit mitigation.
3. Cost Effectiveness: For noise mitigation to be considered cost effective, the cost per benefited receptor must not exceed \$43,500.

7.1.2 Noise Mitigation Methods

Several options exist for providing noise mitigation at the source, path, or receiver. The most common noise mitigation measures are described below.

7.1.2.1 Source

Resilient or Damped Wheels: Using either resilient or damped wheels can achieve approximately a 2 dB reduction in wheel/rail noise from transit vehicles on typical track sections.

Track Dampers: Using damping materials on tracks can achieve an approximately 1 to 3 dB reduction in noise radiated from the tracks on typical track sections.

LRV Design: Certain design features of transit vehicles can provide some shielding and/or absorption of the noise generated by the vehicle. Acoustical absorption under the car can provide up to a 5 dB reduction in wheel/rail noise and propulsion-system noise on rapid transit trains. Similarly, LRV skirts (which the existing METRO transit vehicles have) over the wheels can provide up to 5 dB of reduction in noise.

Special Trackwork: Gaps in the rails at crossovers and turnouts generate around 6 dB of increased noise for locations close to the track. If crossovers are located in sensitive areas and cannot be moved, one approach is to use special trackwork, such as spring-rail, moveable point, or flange bearing frogs to eliminate the gap in the rail at the crossover.

7.1.2.2 Path

Noise Barriers: This is the most common approach to reducing noise impacts from transit and rail projects. For noise barriers to be effective, they must break the line-of-sight between the source of the noise and the receiver. Additionally, the barrier must be made of a material that has a minimum surface density of 4 pounds/square foot and not have any gaps or holes that could degrade the performance of the barrier. Noise

⁵ Five dB is a typical minimum reduction used by many agencies for mitigation to be considered an effective and reasonable mitigation measure.



barriers can be made of virtually any material that meets these requirements and can typically provide between 5 and 10 dB of reduction, depending on the design of the barrier. Project features, such as retaining walls or crash walls can act as effective noise barriers.

Berms: Berms are another approach to mitigating noise at the path. Berms work in much the same way as barriers and need to block the line of sight between the source and the receiver to be effective. Berms can also provide between 5 and 10 dB of reduction but are not commonly used in transit applications due to the space requirements (a berm typically must be twice as wide as it is tall).

7.1.2.3 Receiver

Building Sound Insulation: When other noise mitigation measures are not feasible, the only practical noise mitigation measure may be to provide sound insulation for individual buildings. This mitigation only treats the indoor sound level and is not recommended for places that rely on outdoor use. Depending on the original construction, sound insulation can improve noise reduction by 5 to 20 dB. However, due to the nature of modifying buildings, this is one of the least cost-effective mitigation measures.

7.1.3 Project Noise Mitigation

There are few locations where source or path mitigation is feasible along the Project Alignment. The projected noise impacts are due to a combination of speed, proximity to the tracks, LRV bells, and crossovers. Per the Metro transit noise mitigation policy, severe noise impacts are required to be mitigated if they meet the feasibility criteria, and certain moderate impacts should be mitigated as well. However, in all locations where noise mitigation thresholds are met, noise barriers would not be effective due to gaps at cross streets nor would barriers meet the cost effectiveness threshold.

Because noise barriers would not be feasible, other methods of noise mitigation would potentially be required. There are two locations with moderate and severe impacts due to crossovers. The two locations where crossovers are generating severe noise impacts are:

- W Broadway Ave between Thomas Ave and Upton Ave. This crossover is causing noise impact at up to 56 single and multi-family receivers.
- Lyndale Ave between 18th St and W Broadway Ave. This crossover is causing noise impact at the Masjid An-Nur Mosque and a nearby multi-family building.

The two mitigation options are relocating the crossovers to non-sensitive areas (which may not be feasible operationally) or to use special crossovers, such as spring rail frogs, as discussed above. With either of these options, all the severe impacts would be reduced to moderate impacts and all but one of the moderate impacts would be eliminated.

The severe noise impacts along 21st Ave and moderate noise impacts that meet the Metro transit mitigation criteria at other locations along the Project Alignment could be mitigated by sound insulation depending on the effectiveness and cost of the insulation. Sound insulation would be explored during engineering design. Sound insulation testing would be conducted during the Supplemental Final EIS stage of the Project.

Sound insulation programs are developed to reduce the interior noise levels in sleeping and living quarters in residential and institutional uses to within the guidelines set by the United States Department of Housing and Urban Development. Under these guidelines, interior noise levels for residential land uses should not exceed an Ldn of 45 dBA and a form of fresh air exchange must be maintained. Sound insulation is normally only typically



used on older dwellings with single-paned windows or in buildings with double-paned windows that are no longer effective because of leakage. Sound insulation would not reduce exterior noise levels. Additional monitoring and analysis will be performed to identify the specific number of dwelling units that may be subject to moderate or severe impacts.

7.1.4 Construction Noise Mitigation

The primary means of mitigating noise from construction activities is to require the contractors to prepare a detailed Noise Control Plan. A noise control engineer or acoustician will work with the contractor to prepare a Noise Control Plan in conjunction with the contractor's specific equipment and methods of construction. Key elements of a Plan include:

- Contractor's specific equipment types
- Schedule and methods of construction
- Maximum noise limits for each piece of equipment with certification testing
- Prohibitions on certain types of equipment and processes during the nighttime hours without local agency coordination and approved variances
- Identification of specific sensitive sites where near construction sites
- Methods for projecting construction noise levels
- Implementation of noise control measures where appropriate
- Methods for responding to community complaints

7.2 Vibration

Vibration and ground-borne noise impacts that exceed the FTA criteria are considered significant and should be mitigated unless there are no feasible or practical means to do so. Vibration mitigation is primarily applied at the source, generally the track structure, and is dependent on the frequency content of the vibration and any resonances of the materials. The most common vibration mitigation measures are described below.

7.2.1 Vibration Mitigation Methods

Ballast Mats: A ballast mat is a pad made of rubber or other material placed underneath the ballast and mounted on top of an asphalt or concrete base. Ballast mats provide a modest reduction in vibration levels at frequencies above 40 Hz.

Tire Derived Aggregate: Tire Derived Aggregate, or shredded tires, consists of a layer of tire shreds wrapped in geotechnical fabric placed underneath the ballast and placed on hard packed ground. This is a low-cost, but still unproven, mitigation option that provides a reduction in vibration levels at frequencies above 25 Hz.

Resilient Rail Fasteners: Resilient fasteners are typically used on direct fixation track on aerial structures or in tunnels. They include a resilient component in the fastener to provide vibration isolation. Resilient rail fasteners provide a reduction in vibration at frequencies above 40 Hz.

Resiliently Supported Concrete Ties: Resiliently supported concrete ties, or undertie pads, consist of a rubber pad mounted on the bottom of a concrete tie. The pads provide vibration isolation at frequencies above 25 Hz.

Floating Slabs: Floating slabs consist of thick concrete slabs mounted on rubber or steel springs pads on a concrete foundation. Floating slabs can provide vibration isolation at very low frequencies but are expensive to build and maintain.



Special Trackwork: Gaps in the rails at crossovers and turnouts generate around 10 dB of increased vibration for locations close to the track. If crossovers are located in sensitive areas and cannot be moved, one approach is to use special trackwork, such as spring-rail, moveable point, or flange bearing frogs to eliminate the gap in the rail at the crossover.

7.2.2 Project Vibration Mitigation

There are four locations where vibration mitigation is recommended, three along 21st Ave and one along 10th Ave. The first location is a 300-foot section starting approximately 30 feet west of Fremont Ave and stretching east for all alignment options except the Washington Ave alignment option. The second location is a 300-foot section centered between Aldritch Ave and the alley between Aldritch Ave and Bryant Ave for the one station option and the Washington Ave design option. The third location is a 500-foot section centered on Aldritch Ave for the two station design option. The fourth location is a 200-foot section on 10th Ave stretching north for the Washington Ave design option. The specific mitigation method would need to be determined during design, but a ballast mat would be effective at eliminating the impacts.

7.2.3 Construction Vibration Mitigation

The most effective methods for minimizing the impact from construction vibration are to limit the use of high-vibration activities such as impact pile driving and vibratory rolling and to include vibration limits in the construction specifications. To mitigate potential vibration impact from construction activities, the following measures will be applied where feasible:

- **Limit Construction Hours:** Prohibit high-vibration activities at night.
- **Construction Specifications:** Include limits on vibration in the construction specifications, especially at locations where high-vibration activities such as impact pile driving may occur.
- **Alternative Construction Methods:** Minimize the use of impact and vibratory equipment, where possible and appropriate. Use low vibration alternatives, such as push piling or pre-drilled holes for piling.
- **Truck Routes:** Use truck haul routes that minimize exposure to sensitive receptors and minimize damage to roadway surfaces, where appropriate.
- **Pre-Construction Survey:** Perform pre-construction surveys to document the existing conditions of all structures in the vicinity of sites where high-vibration construction activities will be performed.
- **Vibration Monitoring:** If a construction activity has the potential to exceed the damage criteria at any building, the contractor is required to conduct for vibration monitoring and, if the vibration exceeds the limit, the activity must be modified or terminated.



8 References

Federal Transit Administration (FTA), 2018, *Transit Noise and Vibration Impact Assessment* guidance manual (FTA, 2018)

Vibration Measurements and Predictions for Central Corridor LRT Project, ATS Consulting, 2008

Bottineau Transitway Draft EIS, Noise and Vibration Technical Report, HMMH, 2012.

West Broadway Ave (CSAH 103) Reconstruction Project Environmental Assessment Worksheet, Hennepin County, 2015



Appendix A Existing Outdoor Noise Measurement Location Photographs

Figure A-1 Long-Term Noise Measurement Location LT-13: 1020 N 3rd St





Figure A-2 Long-Term Noise Measurement Location LT-12: 8819 Oregon Ave



Figure A-3 Long-Term Noise Measurement Location LT-11: 7431 78th Ct





Figure A-4 Long-Term Noise Measurement Location LT-10: 7013 Dutton Ave



Figure A-5 Long-Term Noise Measurement Location LT-9: 5906 Elmhurst Ave





Figure A-6 Long-Term Noise Measurement Location LT-8: 5257 Xenia Ave



Figure A-7 Long-Term Noise Measurement Location LT-7: 4536 Regent Ave





Figure A-8 Long-Term Noise Measurement Location LT-6: 3369 Broadway Ave



Figure A-9 Long-Term Noise Measurement Location LT-5: 2741 Upton Ave





Figure A-10 Long-Term Noise Measurement Location LT-4: 2239 W Broadway Ave



Figure A-11 Long-Term Noise Measurement Location LT-3: 1927 N Morgan Ave





Figure A-12 Long-Term Noise Measurement Location LT-2: 2117 Dupont Ave



Figure A-13 Long-Term Noise Measurement Location LT-1: 626 Harry Davis Ln





Figure A-14 Short-Term Noise Measurement Location ST-5: Prince of Peace Lutheran Church



Figure A-15 Short-Term Noise Measurement Location ST-4: 3978 W Broadway Ave





Figure A-16 Short-Term Noise Measurement Location ST-3: 1127 W Broadway Ave



Figure A-17 Short-Term Noise Measurement Location ST-2: 277 N 12th Ave





Figure A-18 Short-Term Noise Measurement Location ST-1: Element Minneapolis Downtown



Appendix B Noise Measurement Data

Figure B-1 Long-Term Noise Measurement Location LT-13: 1020 N 3rd St

Site LT-13: 1020 N 3rd St., Minneapolis; Wed -- Sept 6, 2023 to Thurs -- Sept 7, 2023;
Ldn: 72 dBA

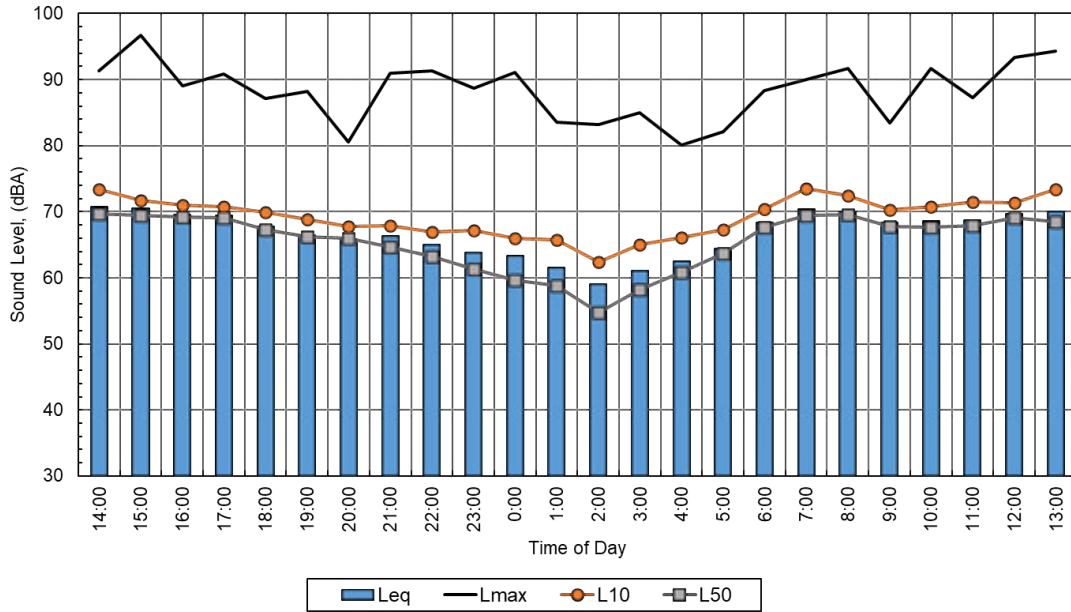


Figure B-2 Long-Term Noise Measurement Location LT-12: 8819 Oregon Ave

Site LT-12: 8819 Oregon Ave. N., Minneapolis; Tues -- April 4, 2023 to Wed -- April 5, 2023; Ldn: 62 dBA

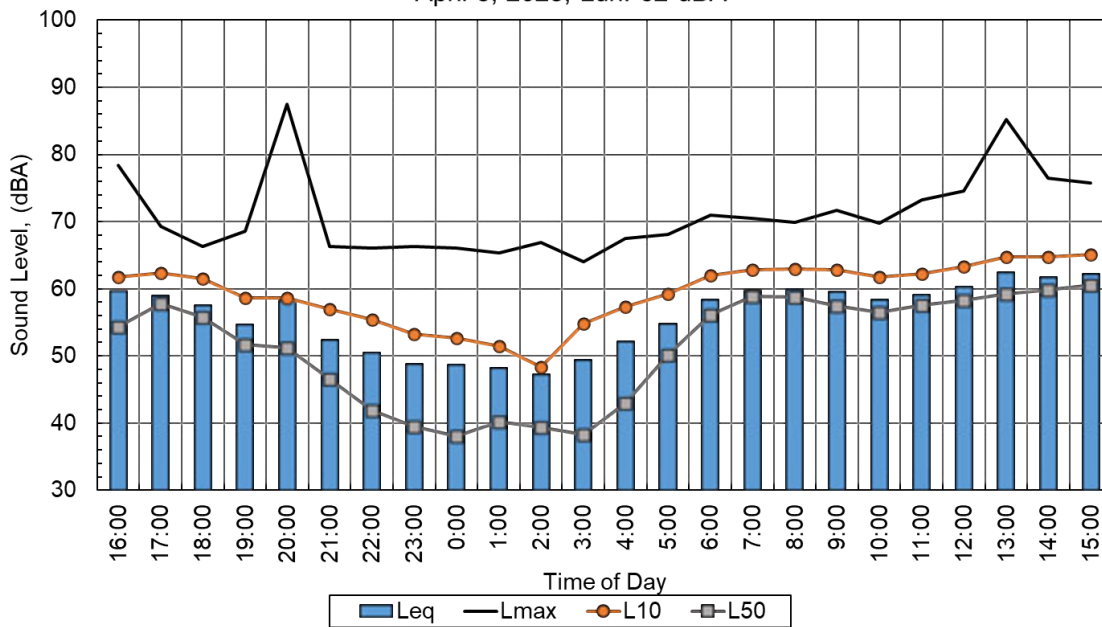


Figure B-3 Long-Term Noise Measurement Location LT-11: 7431 78th Ct

Site LT-11: 7431 78th Ct. N., Minneapolis; Tues -- April 4, 2023 to Wed -- April 5, 2023 Ldn: 65 dBA

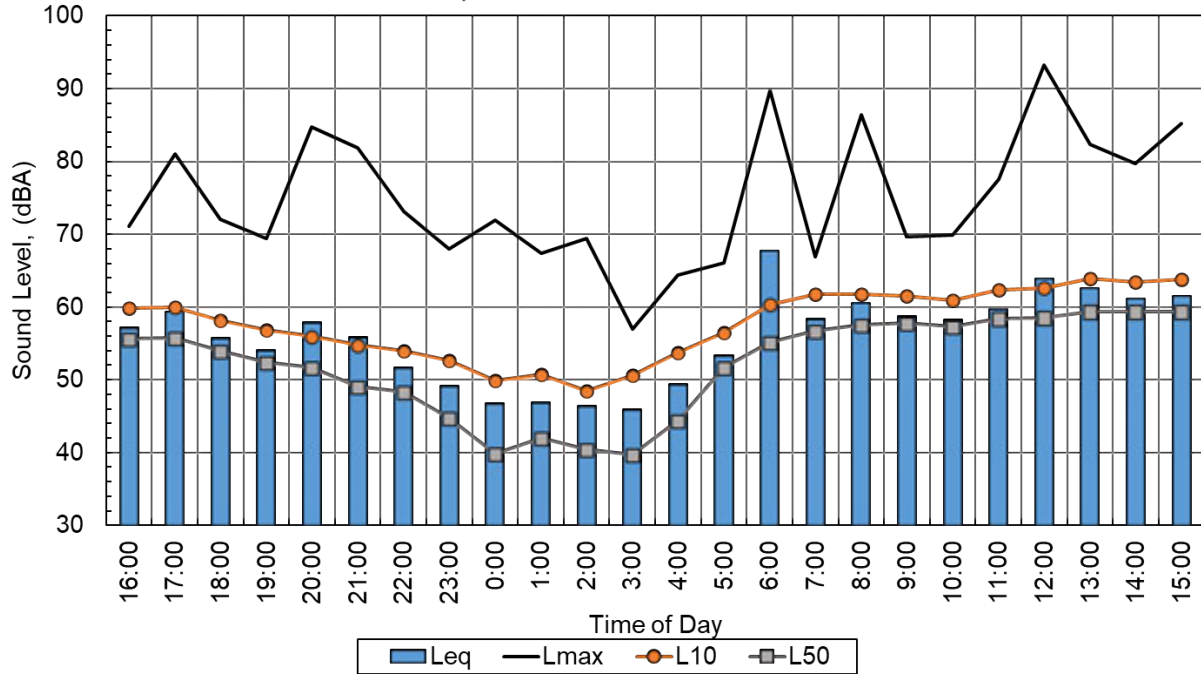
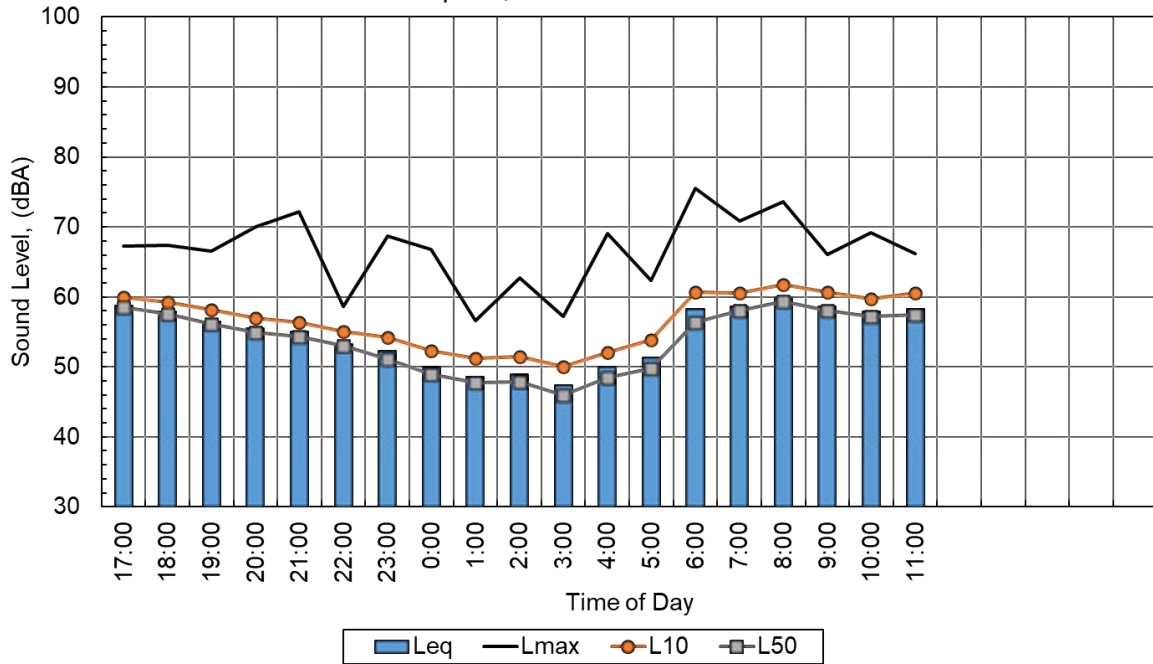


Figure B-4 Long-Term Noise Measurement Location LT-10: 7017 Dutton Ave⁶

Site LT-10: 7013 Dutton Ave, Brooklyn Park; Tues -- April 4, 2023 to Wed -- April 5, 2023 Ldn: 60 dBA



⁶ Sound level meter's battery failed prior to completion of 24-hour measurement.

Figure B-5 Long-Term Noise Measurement Location LT-9: 5906 Elmhurst Ave
 Site LT-9: 5906 Elmhurst Ave., Minneapolis; Mon -- April 3, 2023 to Tues --
 April 4, 2023; Ldn: 63 dBA

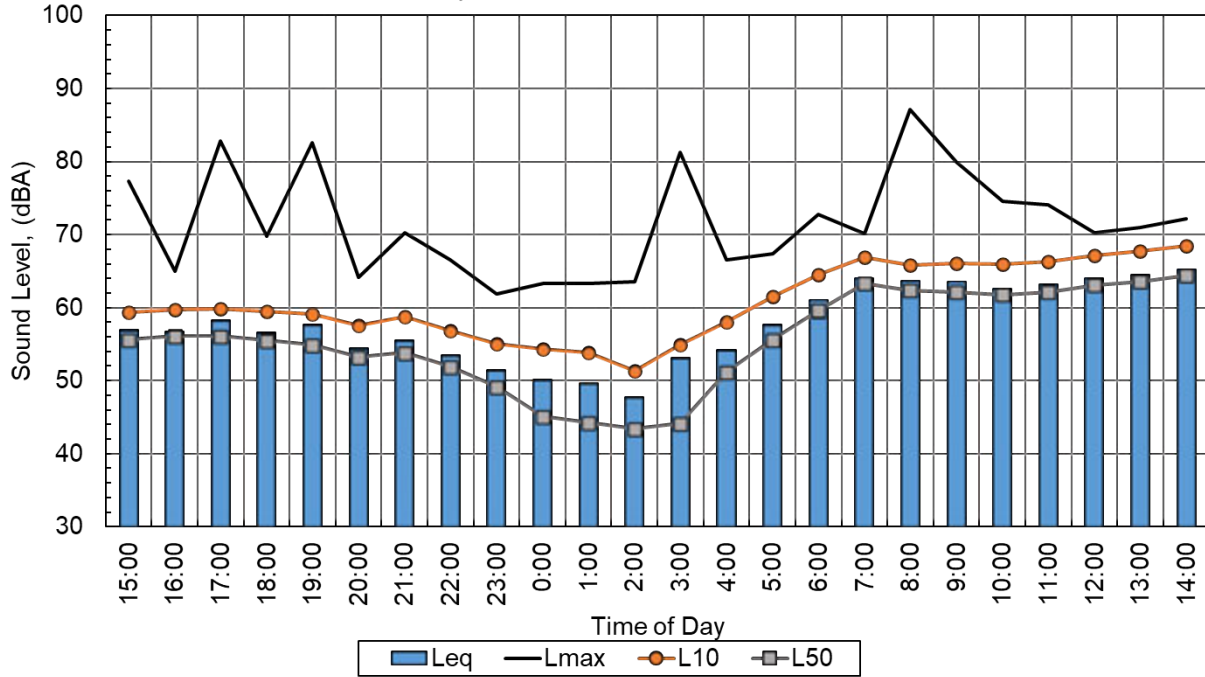


Figure B-6 Long-Term Noise Measurement Location LT-8: 5257 Xenia Ave

Site LT-8: 5257 Xenia Ave. N., Minneapolis; Mon -- April 3, 2023 to Tues --
 April 4, 2023; Ldn: 59 dBA

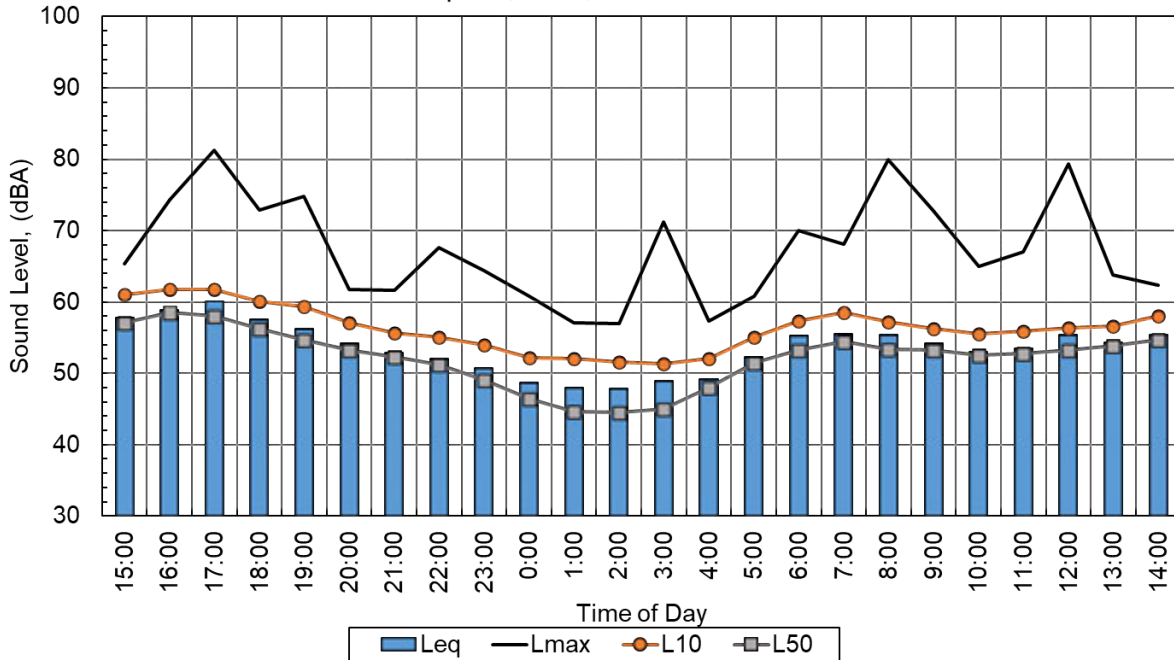


Figure B-7 Long-Term Noise Measurement Location LT-7: 4536 Regent Ave

Site LT-7: 4536 Regent Ave. N., Minneapolis; Mon -- April 3, 2023 to Tues -- April 4, 2023; Ldn: 60 dBA

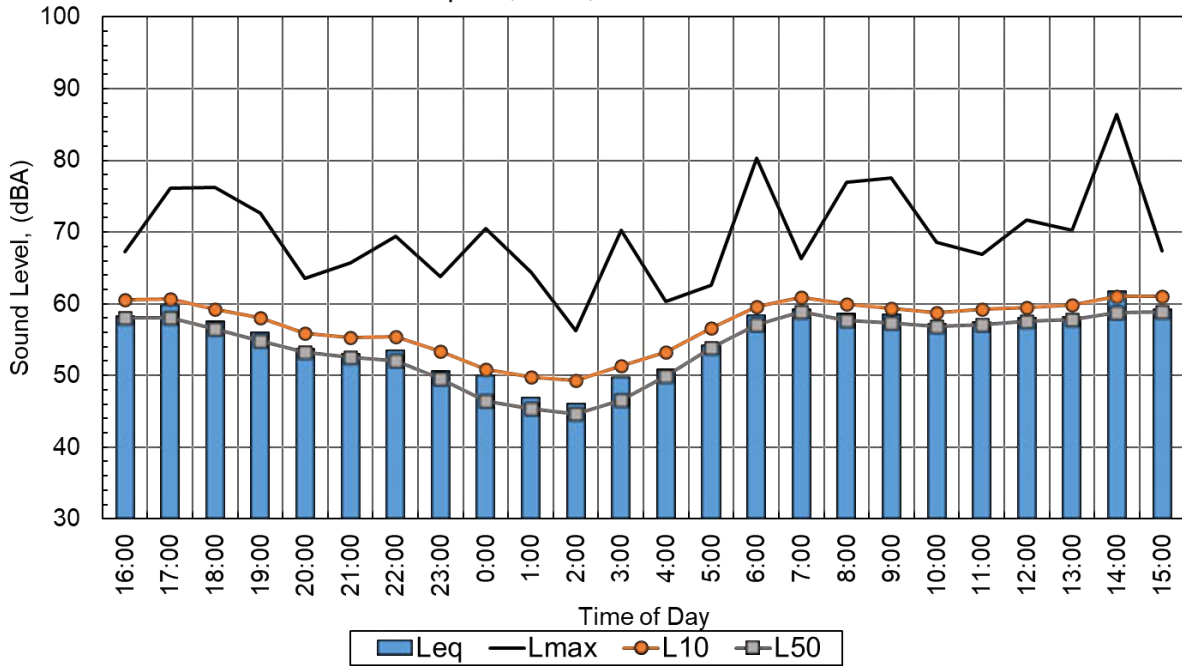


Figure B-8 Long-Term Noise Measurement Location LT-6: 3369 Broadway Ave

Site LT-6: 3369 W. Broadway Ave., Minneapolis; Tues -- April 4, 2023 to Wed -- April 5, 2023; Ldn: 70 dBA

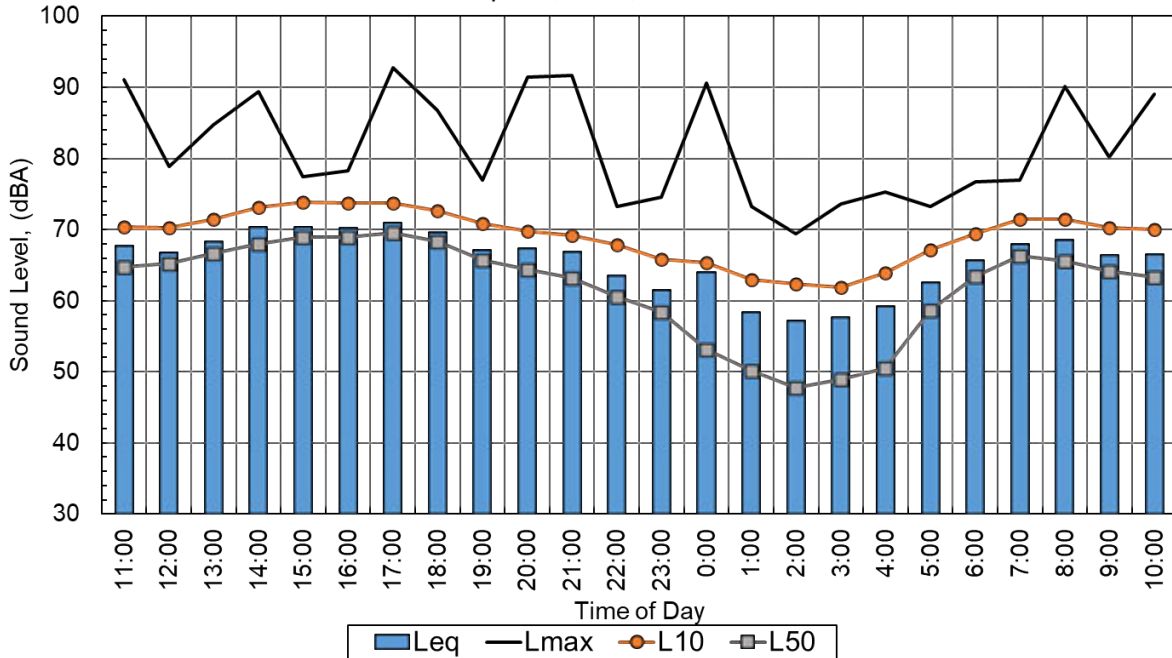


Figure B-9 Long-Term Noise Measurement Location LT-5: 2741 Upton Ave

Site LT-5: 2741 N. Upton Ave., Minneapolis; Tues -- April 4, 2023 to Wed -- April 5, 2023; Ldn: 69 dBA

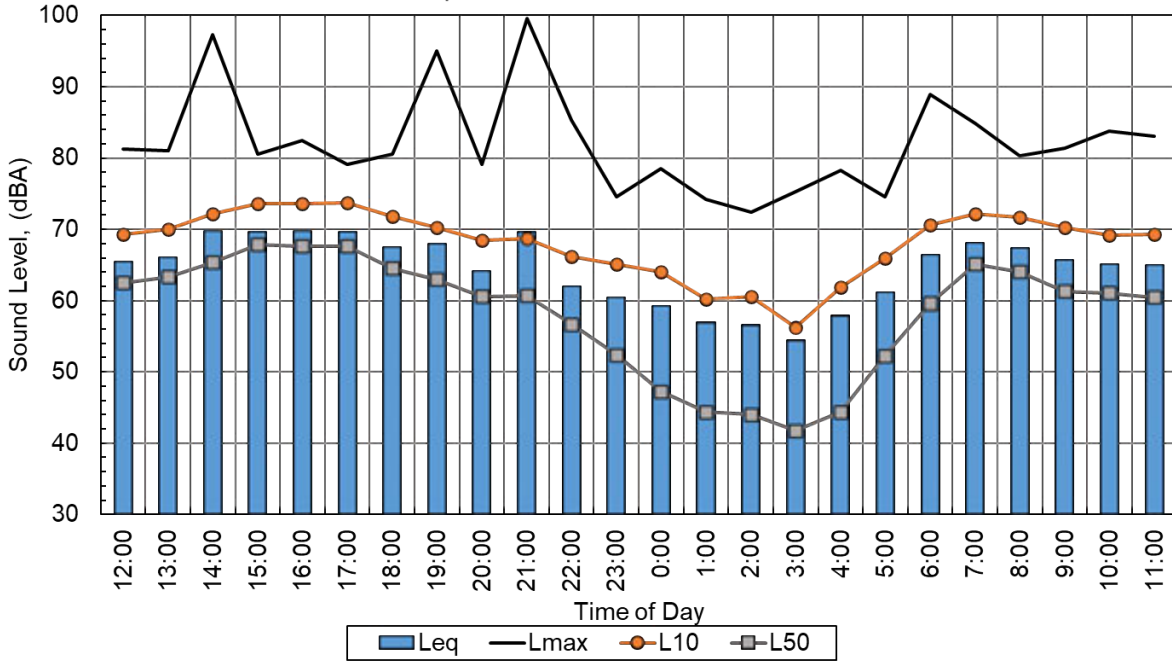


Figure B-10 Long-Term Noise Measurement Location LT-4: 2235 Broadway Ave

Site LT-4: 2239 W. Broadway Ave., Minneapolis; Wed -- April 5, 2023 to Thurs -- April 6, 2023; Ldn: 69 dBA

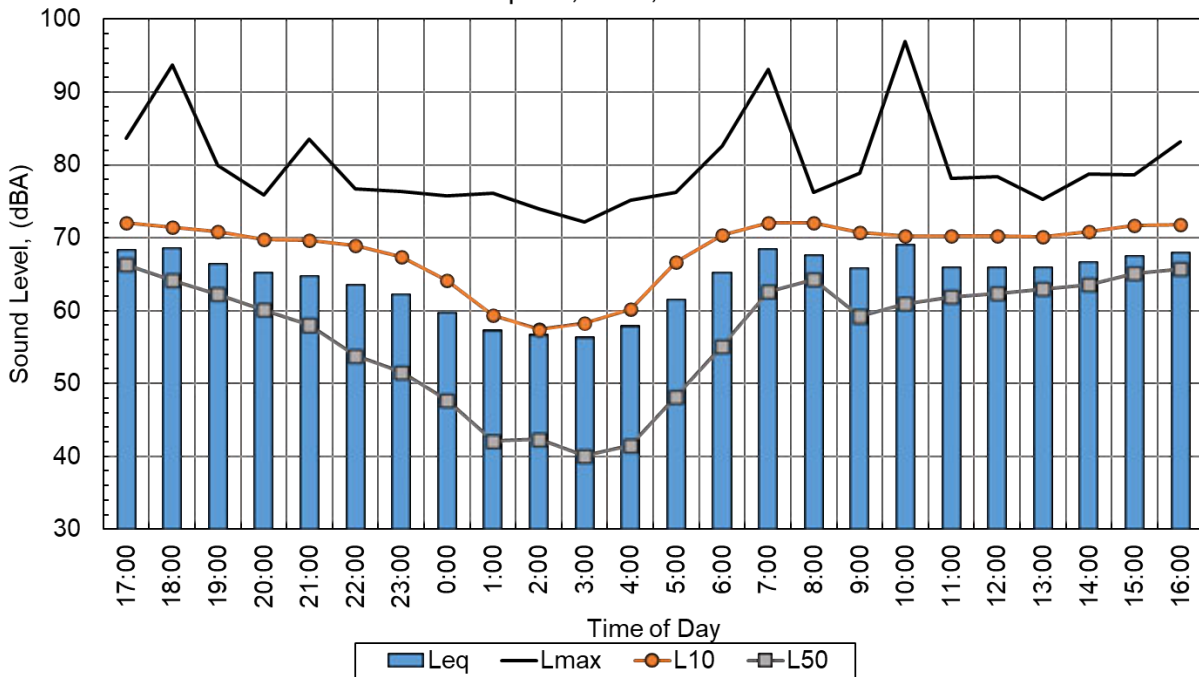


Figure B-11 Long-Term Noise Measurement Location LT-3: 1927 Morgan Ave

Site LT-3: 1931 N Morgan Ave, Minneapolis; Tue -- May 2, 2023 to Wed -- May 3, 2023; Ldn: 69 dBA

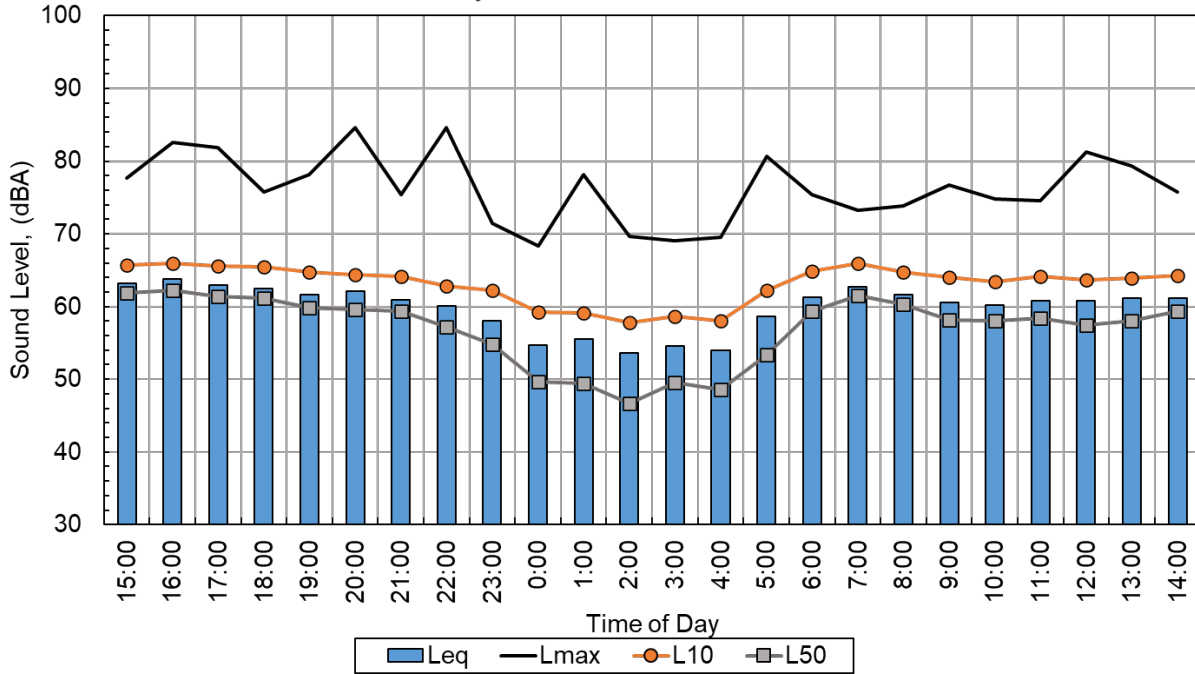


Figure B-12 Long-Term Noise Measurement Location LT-2: 2117 Dupont Ave

Site LT-2: 2117 Dupont Ave N., Minneapolis; Wed -- April 5, 2023 to Thurs -- April 6, 2023; Ldn: 54 dBA

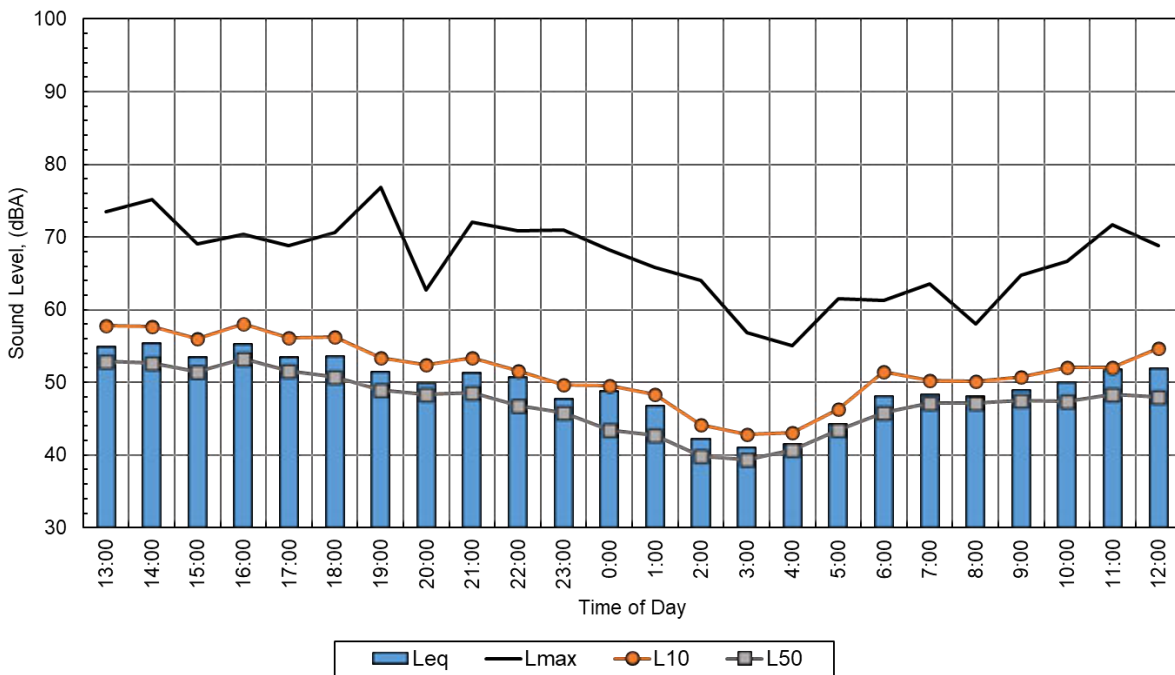
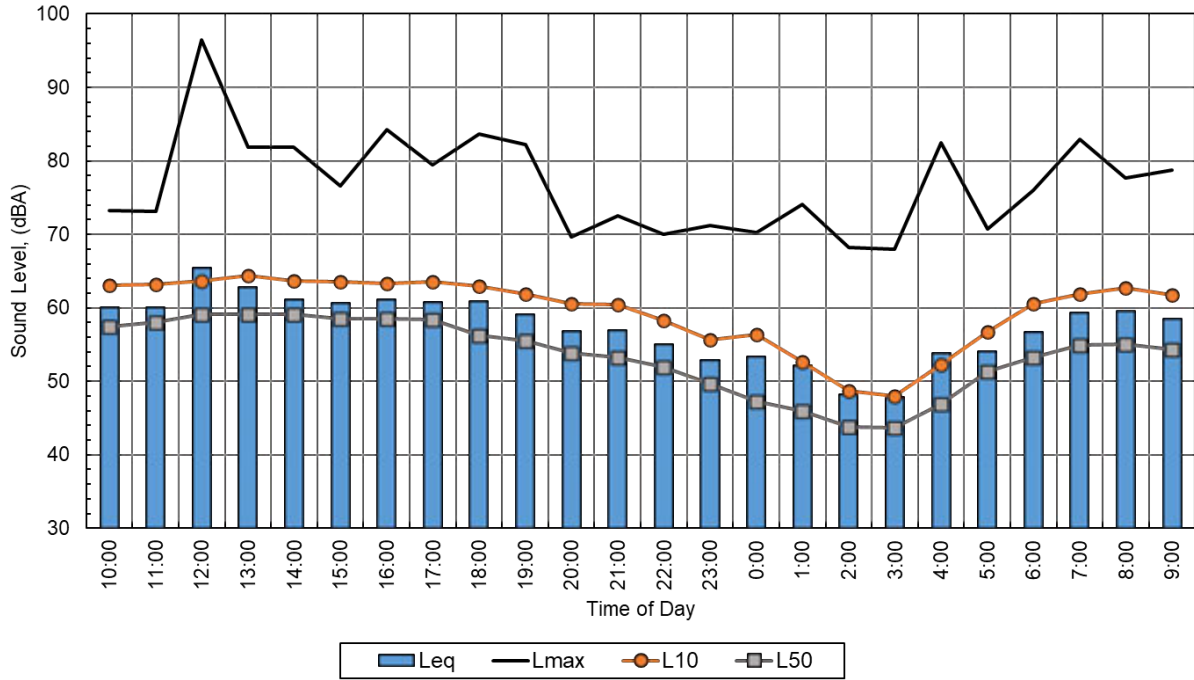


Figure B-13 Long-Term Noise Measurement Data – LT-1: 626 Harry Davis Ln

Site LT-1: 626 Harry Davis Ln., Minneapolis; Wed -- April 5, 2023 to Thurs -- April 6, 2023; Ldn: 62 dBA





Appendix C Vibration Measurement Location Photographs

Figure C-1 Vibration Measurement Location VP-E: 5200 48th Ave



Figure C-2 Vibration Measurement Location VP-D: Lakeview Terrace Park





Figure C-3 Vibration Measurement Location VP-C: 2700 27th Ave



Figure C-4 Vibration Measurement Location VP-B: 21st Ave and Dupont Ave





Figure C-5 Vibration Measurement Location VP-A: Lyndale Ave and 14th Ave





Appendix D Vibration Measurement Data

Table D-1 Location VP-2 North Hennepin Community College 1/3-Octave Band Transfer Mobility Coefficients

Coeff.	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
A	32.5	41	45.3	52	57.7	61.1	22.6	24.8	20.9	18.1	24.5	25.2	41.2	94.9	88.6	76.1
B	-9.3	-12.6	-11.7	-13	-13.8	-14.6	38.8	39.7	49	55.7	49.7	50	28.8	-40.4	-38.5	-35.2
C	0	0	0	0	0	0	-17.2	-18.2	-21.9	-24.9	-23.5	-24.9	-20.3	0	0	0

$$LSTM = A + B * \log(dist) + C * \log(dist)^2$$

Figure D-1 Line Source Transfer Mobility Location VP-2 North Hennepin Community College

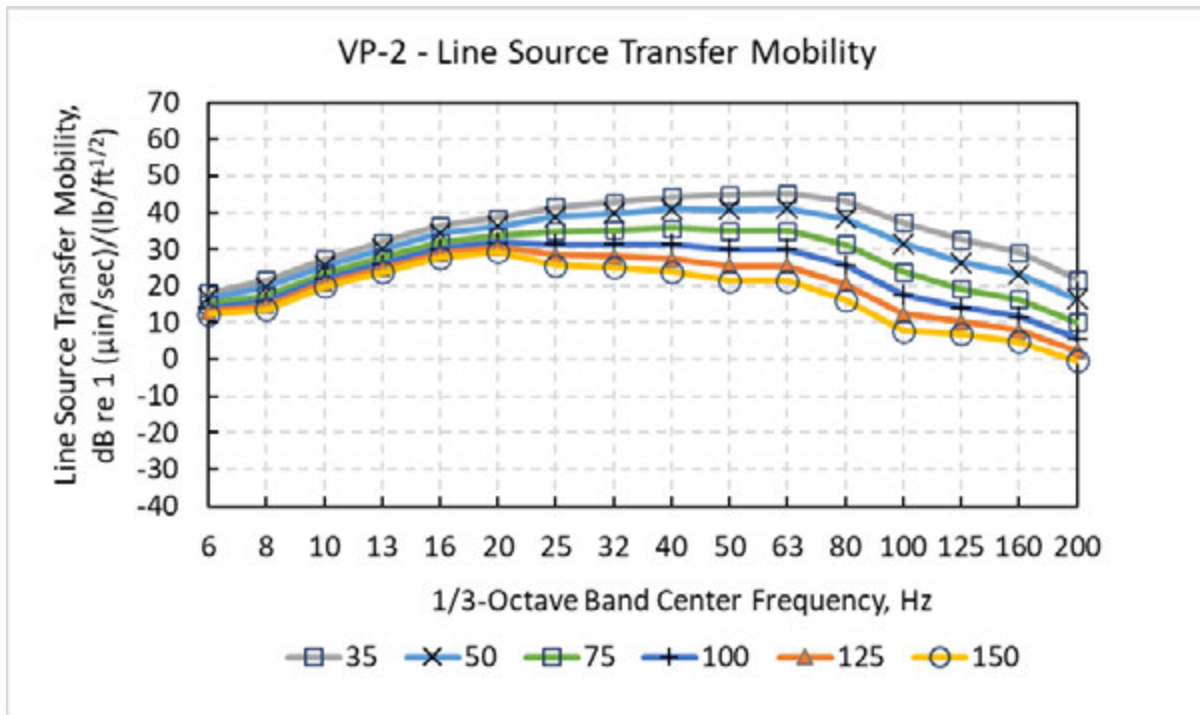




Table D-2 Location VP-3 62nd Ave and Hampshire Ave 1/3-Octave Band Transfer Mobility Coefficients

Coeff.	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
A	34.6	34.6	42.2	47	54.5	62.7	70.3	78.4	89	97.4	104.4	98.7	98.8	92.7	72.1	57.3
B	-8.5	-6.9	-8.8	-9.8	-12.6	-15.6	-18.8	-22.5	-28.5	-34.7	-40.4	-39.6	-42.1	-40	-30.7	-25.6
C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

$$LSTM = A + B * \log(dist) + C * \log (dist)^2$$

Figure D-2 Line Source Transfer Mobility Location VP-3 62nd Ave and Hampshire Ave

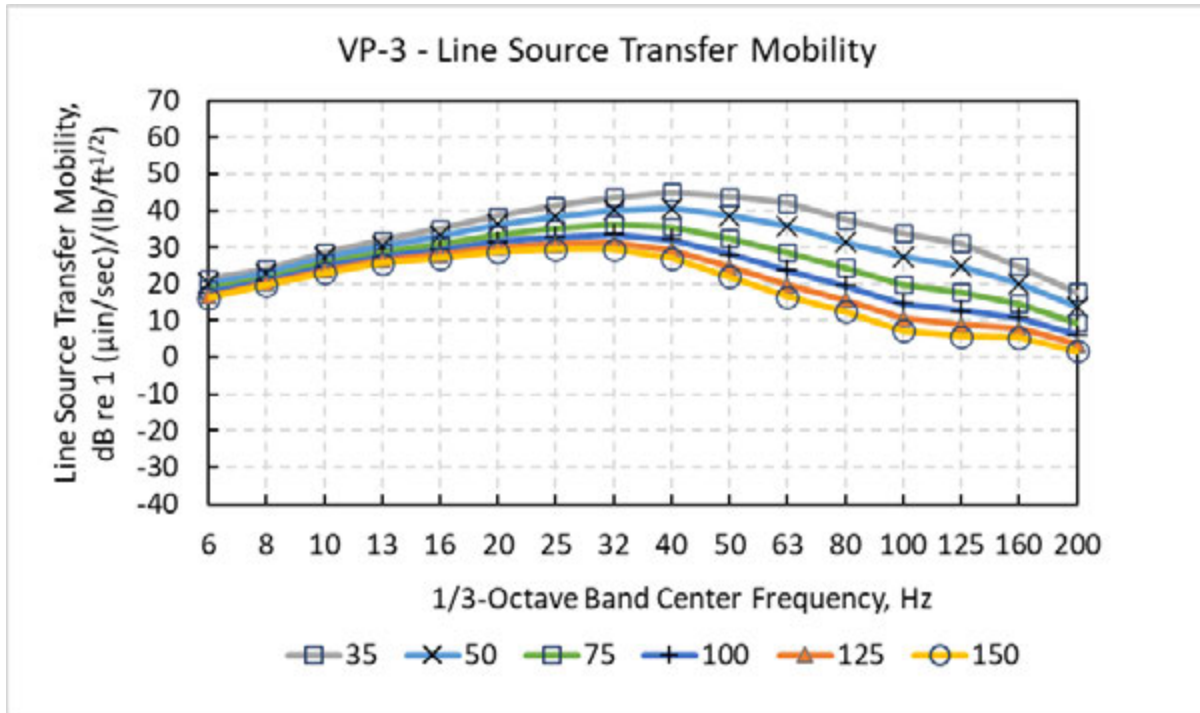


Table D-3 Location VP-E 5200 48th Ave 1/3-Octave Band Transfer Mobility Coefficients

Coeff.	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
A	54.1	38.0	46.1	69.5	79.0	77.6	98.4	113.6	145.2	147.1	110.5	76.3	43.7	50.4	38.0	25.5
B	-21.9	-13.0	-11.9	-19.4	-22.2	-19.3	-28.4	-36.0	-54.0	-57.5	-41.6	-27.9	-14.6	-23.3	-20.5	-13.4
C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

$$LSTM = A + B * \log(dist) + C * \log(dist)^2$$

Figure D-3 Line Source Transfer Mobility Location VP-E 5200 48th Ave

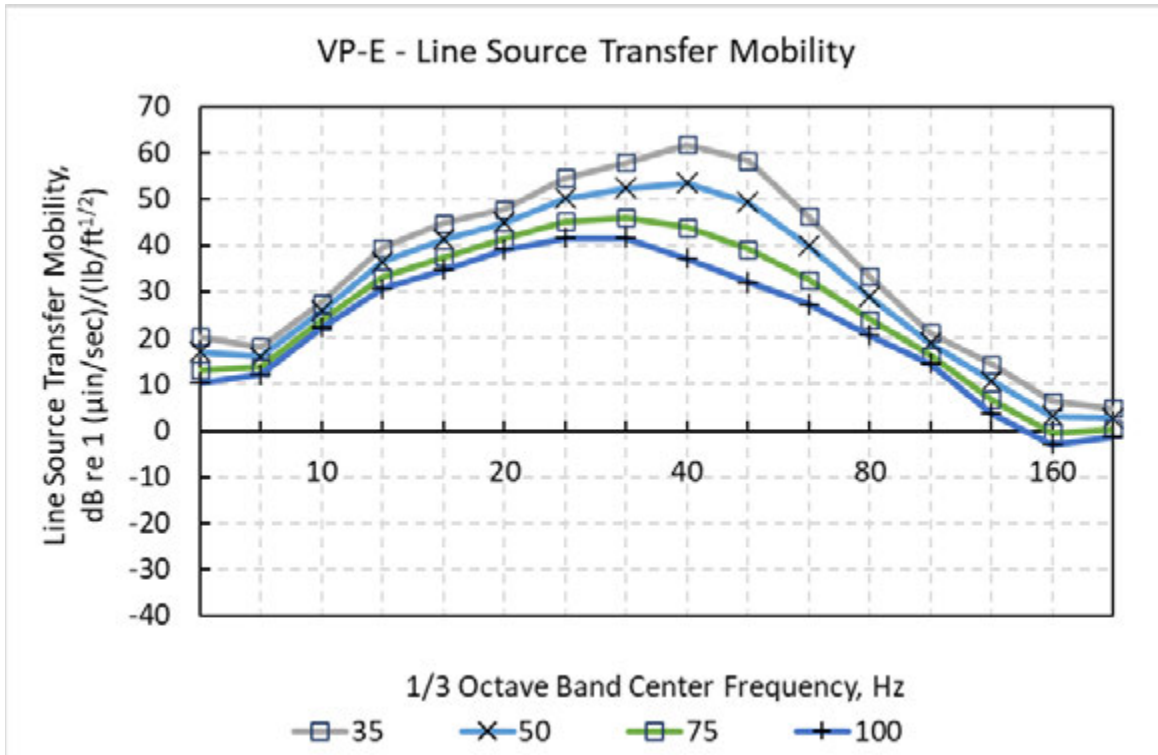


Table D-4 Location VP-D Lakeview Terrace Park 1/3-Octave Band Transfer Mobility Coefficients

Coeff.	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
A	45.9	55.9	50.8	68.6	101.2	104.9	110.4	115.4	110.1	83.5	98.5	118.5	88.8	78.1	38.4	22.6
B	-16.7	-18.2	-10.9	-15.2	-33.5	-36.3	-39.8	-44.0	-43.2	-30.3	-41.6	-60.0	-49.5	-49.0	-30.6	-20.0
C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

$$LSTM = A + B * \log(dist) + C * \log(dist)^2$$

Figure D-4 Line Source Transfer Mobility Location VP-D Lakeview Terrace Park

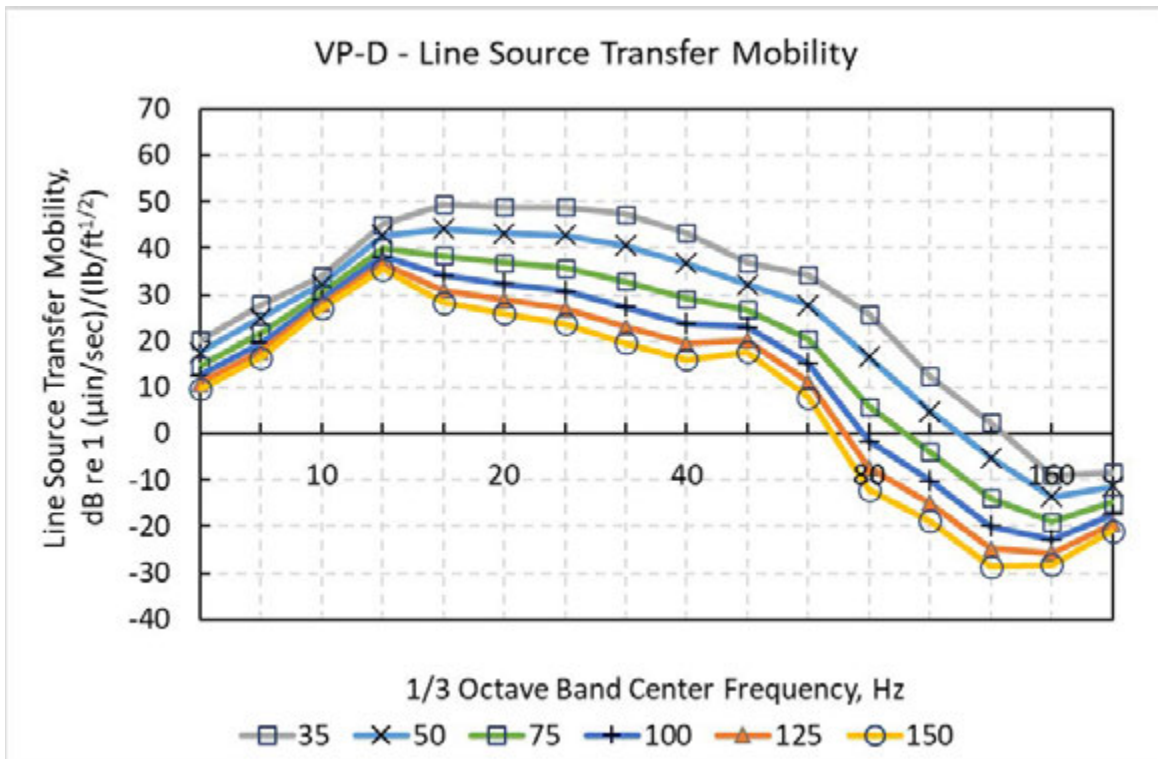


Table D-5 Location VP-C 2700 27th Ave 1/3-Octave Band Transfer Mobility Coefficients

Coeff.	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
A	37.0	40.1	45.4	60.8	74.3	98.1	107.7	113.3	102.2	87.6	80.5	83.2	70.4	72.2	50.1	34.7
B	-18.8	-15.3	-13.6	-20.2	-24.1	-35.9	-40.4	-44.9	-40.9	-36.7	-36.5	-42.7	-41.1	-44.2	-32.9	-21.0
C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

$$LSTM = A + B * \log(dist) + C * \log(dist)^2$$

Figure D-5 Line Source Transfer Mobility Location VP-C 2700 27th Ave

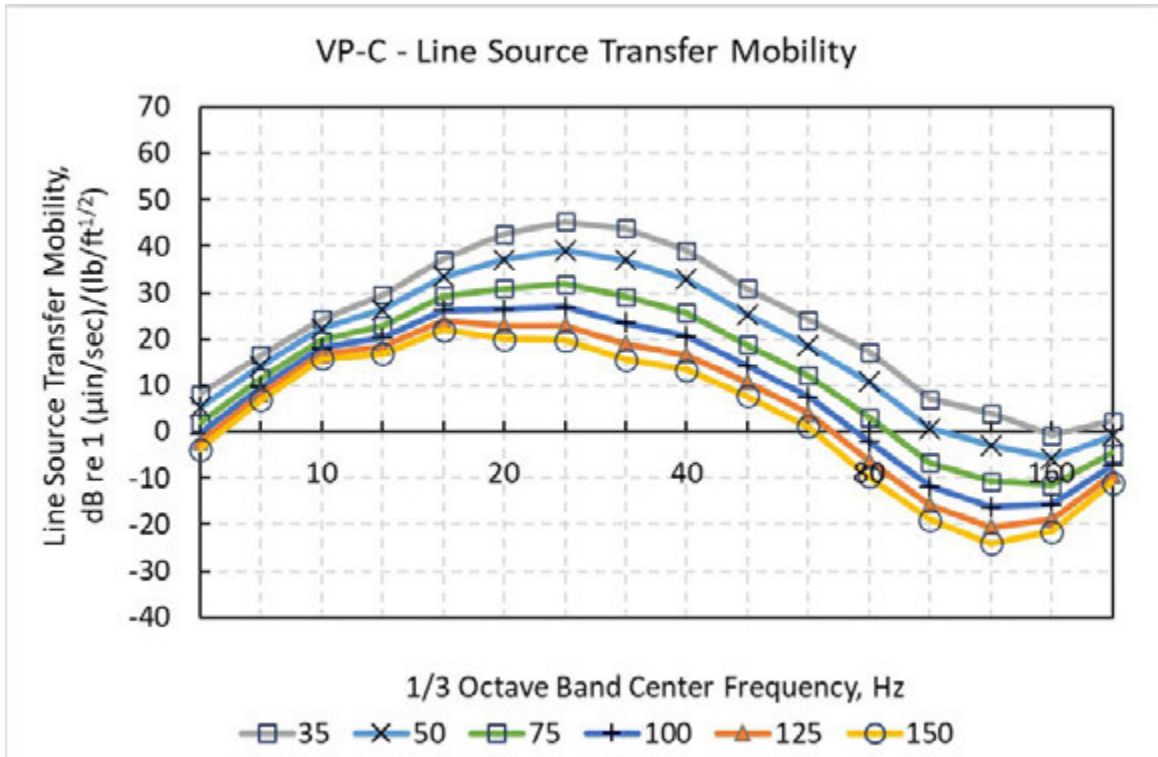


Table D-6 Location VP-B 21st Ave and Dupont Ave 1/3-Octave Band Transfer Mobility Coefficients

Coeff.	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
A	33.1	29.5	29.7	32.8	54.6	80.5	107.9	110.3	96.5	85.8	77.1	85.2	76.6	49.3	28.0	26.6
B	-15.6	-14.8	-13.7	-11.5	-16.5	-28.2	-42.5	-44.5	-38.2	-35.4	-33.1	-39.1	-38.8	-25.5	-14.9	-12.0
C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

$$LSTM = A + B * \log(dist) + C * \log(dist)^2$$

Figure D-6 Line Source Transfer Mobility Location VP-B 21st Ave and Dupont Ave

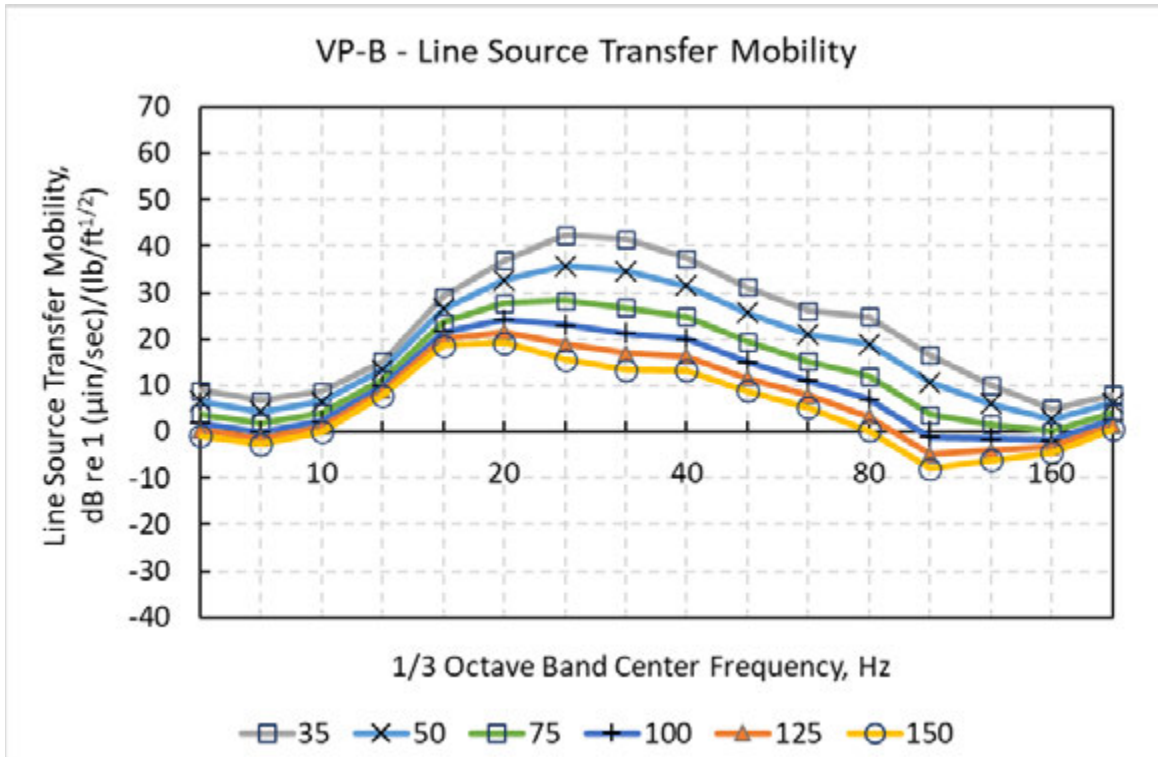
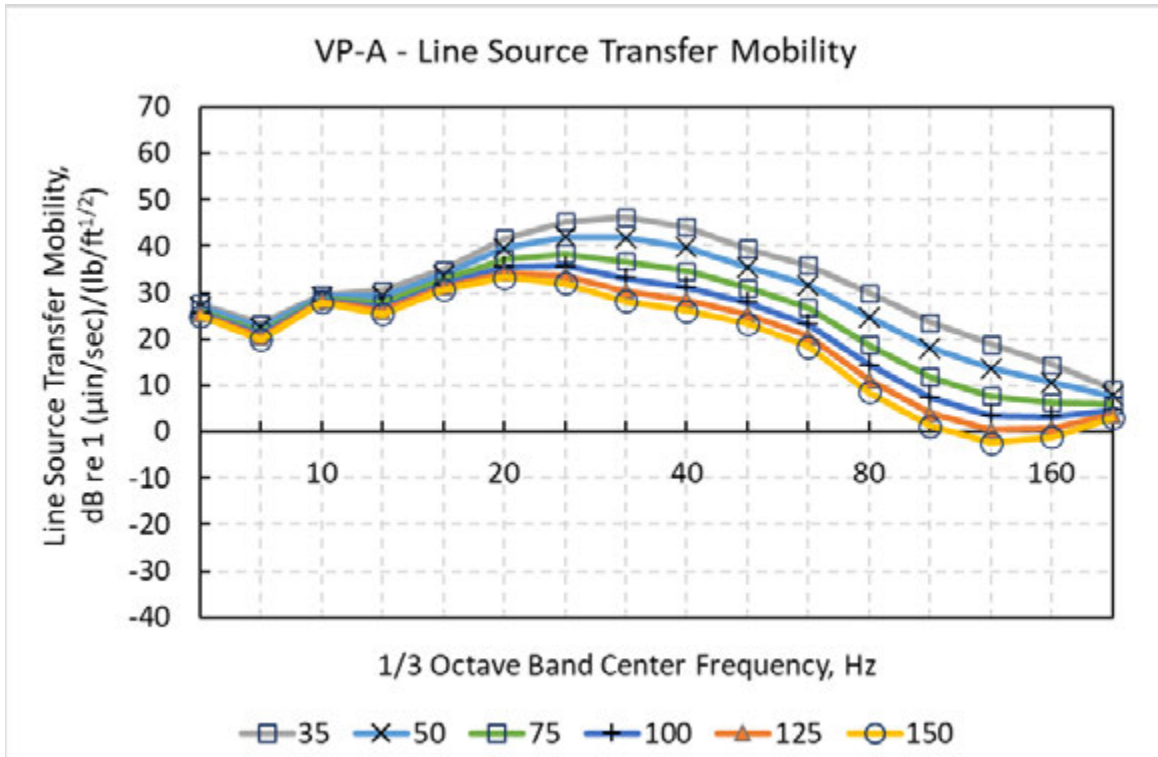


Table D-7 Location VP-A Lyndale Ave and 14th Ave 1/3-Octave Band Transfer Mobility Coefficients

Coeff.	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
A	34.0	31.8	33.5	42.8	45.4	62.2	77.8	90.5	88.2	78.7	78.9	82.5	78.3	70.6	52.5	24.5
B	-4.1	-5.4	-2.6	-8.0	-6.8	-13.3	-21.1	-28.6	-28.5	-25.4	-27.8	-34.0	-35.5	-33.5	-24.7	-9.9
C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

$$LSTM = A + B * \log(dist) + C * \log(dist)^2$$

Figure D-7 Line Source Transfer Mobility Location VP-A Lyndale Ave and 14th Ave



Appendix E Project Noise Analysis from Project Alignment and Design Options Evaluated

This appendix presents results from the analysis of noise impacts for the Project alignment and design options evaluated. The East of I-94 segment for the Project alignment and design options shown below differs from the East of I-94 segment in the Build Alternative. The Project alignment and design options are on Washington Ave N and diverge from Washington Ave N south of N 17th Ave to intersect 10th Ave N near the intersection of 4th St. The Project Alignment remains on Washington Ave N to the intersection of 10th St. The W Broadway Ave N to East of I-94 (either one or two station option) alignment has the fewest noise impacts – with moderate impacts at eight residential properties (153 dwelling units) and severe impacts at two residential properties (three dwelling units). Of the alignments analyzed, the Build Alternative (shown in last row of the table below) has the most noise impacts – with moderate impacts at 16 residential properties (211 dwelling units) and severe impacts at 15 residential properties (173 dwelling units). As shown on Figures E-1 through E-6 and Tables E-1 through E-9, the design options primarily affect the number and severity of the noise impacts east of James Station. The differences in the number and severity of the noise impacts are a result of differences in the existing noise levels and the number of sensitive properties along the alignments.

A relatively low noise level (for an urban environment) of 55 dBA was measured to represent existing noise levels at the residential properties on 21st Ave, which has a mix of residential, commercial, and light industrial uses. Under the options that traverse 21st Ave (including the Build Alternative), noise levels would increase between 3 and 18.7 dB depending on the location and design option. Existing noise measured to represent residences on Lyndale Ave was also relatively low. By comparison, existing noise along W Broadway Ave N is more representative of an urban environment at 68 dBA Ldn. As shown on Tables E-1 through E-9, the Project Noise Level varies depending on the distance between the Project Alignment and the receptor, and the impact is determined by considering the existing and Project noise levels, as per FTA criteria. The difference in the number of noise impacts among the design options is primarily due to the existing noise levels. Those that traverse 21st and Lyndale Aves the longest distance have the highest number of noise impacts, and those that avoid 21st and Lyndale Aves have the fewest.

Table E-1 Summary of Residential Noise Impacts by Project Cities and Option

City and Option	# of Moderate Impacts**	# of Severe Impacts**
Brooklyn Park	13	0
Robbinsdale*	18	0
Crystal	2	0
Minneapolis by Option	NA	NA
Minneapolis <i>21st Ave N to East of I-94 One Station</i>	169	74
Minneapolis <i>21st St N to East of I-94 Two Stations</i>	169	43



City and Option	# of Moderate Impacts**	# of Severe Impacts**
Minneapolis <i>21st St N to Lyndale Ave One Station</i>	178	123
Minneapolis <i>21st St N to Lyndale Ave Two Stations</i>	178	92
Minneapolis <i>W Broadway Ave to East of I-94 One Station</i>	153	3
Minneapolis <i>W Broadway Ave to East of I-94 Two Stations</i>	153	3
Minneapolis <i>W Broadway Ave to Lyndale Ave One Station</i>	168	54
Minneapolis <i>W Broadway Ave to Lyndale Ave Two Stations</i>	168	54
Minneapolis <i>21st St N to East of I-94 along Washington Ave (Build Alternative)</i>	211	173

Source: CSA, 2023

*All station options in Robbinsdale have the same number of noise impacts.

**The impact numbers represent the total number DUs (including apartments and other multi-family buildings), not the number of buildings, impacted.

Table E-2 Summary of Noise Impacts for Residential Land Use in the City of Minneapolis (21st Ave to East of I-94)

Option	Location	City	Side of Track	Near Track Dist. (ft)	Speed (mph)	Exist Noise Level Ldn (dBA)	Project Noise Levels Ldn (dBA)	FTA Mod Impact Noise Level Ldn (dBA)	FTA Sev Impact Noise Level Ldn (dBA)	Number of Mod Noise Impacts	Number of Sev Noise Impacts
	N 26th Ave to N Lowry Ave	Minneapolis	NB	43	45	69	70	64	69	2	2
	N 26th Ave to N Lowry Ave	Minneapolis	SB	40	45	69	70	64	69	51	1
	N Knox Ave to N 26th Ave	Minneapolis	NB	56	20	69	64	64	69	104	0
	N Knox Ave to N 26th Ave	Minneapolis	SB	53	35	69	60	64	69	0	0
One Station	N Emerson Ave to N Knox Ave	Minneapolis	NB	54	30	55	64	55	61	1	4
	N Emerson Ave to N Knox Ave	Minneapolis	SB	18	30	55	75	55	61	0	16
	Lyndale Ave to N Emerson Ave	Minneapolis	NB	34	30	55	67	55	61	5	31
	Lyndale Ave to N Emerson Ave	Minneapolis	SB	17	30	55	66	55	61	0	18
Two Stations	N Emerson Ave to N Knox Ave	Minneapolis	NB	54	30	55	64	55	61	1	4
	N Emerson Ave to N Knox Ave	Minneapolis	SB	18	30	55	75	55	61	0	16
	Lyndale Ave to N Emerson Ave	Minneapolis	NB	55	30	55	61	55	61	5	0
	Lyndale Ave to N Emerson Ave	Minneapolis	SB	17	20	55	72	55	61	0	18
	I-94 to Lyndale Ave	Minneapolis	NB	56	40	55	64	55	61	5	2
	I-94 to Lyndale Ave	Minneapolis	SB	*	*	*	*	*	*	*	*
	N 17th Ave to I-94	Minneapolis	NB	*	*	*	*	*	*	*	*



Option	Location	City	Side of Track	Near Track Dist. (ft)	Speed (mph)	Exist Noise Level Ldn (dBA)	Project Noise Levels Ldn (dBA)	FTA Mod Impact Noise Level Ldn (dBA)	FTA Sev Impact Noise Level Ldn (dBA)	Number of Mod Noise Impacts	Number of Sev Noise Impacts
	N 17th Ave to I-94	Minneapolis	SB	*	*	*	*	*	*	*	*
	Plymouth Ave to N 17th Ave	Minneapolis	NB	*	*	*	*	*	*	*	*
	Plymouth Ave to N 17th Ave	Minneapolis	SB	*	*	*	*	*	*	*	*
	N 8th Ave to Plymouth Ave N	Minneapolis	NB	241	20	64	51	60	65	0	0
	N 8th Ave to Plymouth Ave N	Minneapolis	SB	*	*	*	*	*	*	*	*
	Target Field Station to N 8th Ave	Minneapolis	NB	43	20	65	59	60	66	0	0
	Target Field Station to N 8th Ave	Minneapolis	SB	*	*	*	*	*	*	*	*

Source: CSA, 2023

Notes:

Predicted noise levels shown for each location are highest for each location. Projected noise levels at other receptors within each location are lower.

The reported noise levels are rounded to the nearest decibel.

Mod = moderate; Sev = severe.

*No noise sensitive land use or property would be acquired in this design option.



- **N 26th Ave to N Lowry Ave (NB):** There are four single-family residences on the northbound side of the Project Alignment between N 26th Ave and N Lowry Ave predicted to have moderate and severe noise impacts. These impacts are due to the proximity of the tracks, the speed of the train, and a nearby crossover.
- **N 26th Ave to N Lowry Ave (SB):** There are 52 single and multi-family residences, representing seven buildings, on the southbound side of the Project Alignment between N 26th Ave and N Lowry Ave predicted to have moderate and severe noise impacts. These impacts are due to the proximity of the tracks, the speed of the train, and a nearby crossover.
- **N Knox Ave to N 26th Ave (NB):** There are 104 single and multi-family residences, representing two buildings, on the northbound side of the Project Alignment between N Knox Ave and N 26th Ave predicted to have moderate noise impacts. These impacts are due to the proximity of the tracks and bells at Penn Ave Station.
- **N Emerson Ave to N Knox Ave One Station Option (NB):** There are five single and multi-family residences, representing four buildings, on the northbound side of the Project Alignment between N Emerson Ave and N Knox Ave predicted to have moderate and severe noise impacts. These impacts are due to the proximity of the tracks and bells at N Girard Ave, N Fremont Ave, and N Emerson Ave.
- **N Emerson Ave to N Knox Ave Two Station Option (NB):** There are five single and multi-family residences, representing four buildings, on the northbound side of the Project Alignment between N Emerson Ave and N Knox Ave predicted to have moderate and severe noise impacts. These impacts are due to the proximity of the tracks and bells at N Girard Ave, N Fremont Ave, and N Emerson Ave.
- **N Emerson Ave to N Knox Ave One Station Option (SB):** There are 16 single and multi-family residences, representing five buildings, on the southbound side of the Project Alignment between N Emerson Ave and N Knox Ave predicted to have severe noise impacts. These impacts are due to the proximity of the tracks and bells at N Girard Ave, N Fremont Ave, and N Emerson Ave.
- **N Emerson Ave to N Knox Ave Two Station Option (SB):** There are 16 single and multi-family residences, representing five buildings, on the southbound side of the Project Alignment between N Emerson Ave and N Knox Ave predicted to have severe noise impacts. These impacts are due to the proximity of the tracks and bells at N Girard Ave, N Fremont Ave, and N Emerson Ave.
- **N Lyndale Ave to N Emerson Ave One Station Option (NB):** There are 36 single and multi-family residences on the northbound side of the Project Alignment between N Lyndale Ave and N Emerson Ave predicted to have moderate and severe noise impacts. These impacts are due to the proximity of the tracks and bells at Bryant Ave and Lyndale Ave.
- **N Lyndale Ave to N Emerson Ave Two Station Option (NB):** There are five single-family residences on the northbound side of the Project Alignment between N Lyndale Ave and N Emerson Ave predicted to have moderate noise impacts. These impacts are due to the proximity of the tracks and bells at Bryant Ave and Lyndale Ave.
- **N Lyndale Ave to N Emerson Ave One Station Option (SB):** There are 18 multi-family residences southbound, representing one building, on the southbound side of the Project Alignment between N Lyndale Ave and N Emerson Ave predicted to have severe noise impacts. These impacts are due to the proximity of the tracks and bells at Bryant Ave and Lyndale Ave.
- **N Lyndale Ave to N Emerson Ave Two Station Option (SB):** There are 16 multi-family residences southbound, representing one building, on the southbound side of the Project Alignment between N Lyndale Ave and N Emerson Ave predicted to have severe noise impacts. These impacts are due to the proximity of the tracks and bells at Bryant Ave and Lyndale Ave.



- **I-94 to N Lyndale Ave (NB):** There are seven single and multi-family residences, representing five buildings, on the northbound side of the Project Alignment between I-94 and N Lyndale Ave predicted to have moderate and severe noise impacts. These impacts are due to the proximity of the tracks, bells at Lyndale Ave, and the additional noise generated by the elevated structure.

Table E-3 Summary of Noise Impacts for Institutional Land Use in the City of Minneapolis (21st Ave to East of I-94)

Option	Name	City	Side of Track	Near Track Dist. (ft)	Speed (mph)	Exist Noise Level Leq (dBA)	Project Noise Levels Leq (dBA)	FTA Mod Impact Noise Level Leq (dBA)	FTA Sev Impact Noise Level Leq (dBA)	Type of Impact
	Parkway United Church of Christ	Minneapolis	NB	338	25	68	46	68	73	--
	Good News Minneapolis Church	Minneapolis	NB	139	25	68	52	68	73	--
	True Vine Missionary Baptist Church	Minneapolis	SB	111	45	68	63	68	73	--
	KIPP Legacy	Minneapolis	NB	200	35	68	51	68	73	--
	St Anne-St Joseph Hien Church	Minneapolis	NB	323	35	68	42	68	73	--
	Morning Star Assembly of God	Minneapolis	SB	17	20	68	61	68	73	--
	All Nations Seventh-day Adventist Church	Minneapolis	SB	182	20	68	41	68	73	--
	PYC Arts & Technology Alternative High School	Minneapolis	SB	53	20	62	58	64	69	--
	Capri Theater*	Minneapolis	SB	40	20	62	63	64	69	--
	Star Child Development Center LLC	Minneapolis	SB	40	20	62	63	64	69	--
	Real Believers Faith Center Church	Minneapolis	SB	233	30	68	42	68	73	--



Option	Name	City	Side of Track	Near Track Dist. (ft)	Speed (mph)	Exist Noise Level Leq (dBA)	Project Noise Levels Leq (dBA)	FTA Mod Impact Noise Level Leq (dBA)	FTA Sev Impact Noise Level Leq (dBA)	Type of Impact
One Station	Liberty Community Church	Minneapolis	NB	43	25	68	62	68	73	--
	United Deliverance Temple Inc	Minneapolis	NB	259	15	68	32	68	73	--
	Sanctuary Covenant Church	Minneapolis	SB	16	30	68	66	68	73	--
Two Stations	Liberty Community Church	Minneapolis	NB	43	30	68	63	68	73	--
	United Deliverance Temple Inc	Minneapolis	NB	259	20	68	37	68	73	--
	Sanctuary Covenant Church	Minneapolis	SB	16	20	68	68	68	73	--
	Faith Tabernacle Gospel Fellowship International	Minneapolis	SB	14	40	68	69	68	73	Moderate
	Metro Schools College Prep	Minneapolis	SB	166	25	67	50	67	72	--
	Minnesota International Middle Charter School	Minneapolis	NB	99	30	66	53	66	72	--

Source: CSA, 2023

Note: The reported noise levels are rounded to the nearest decibel.

*This represents the results for non-special use spaces in the Capri Theater.

- **Faith Tabernacle Gospel Fellowship International:** The Faith Tabernacle Gospel Fellowship International is predicted to have a moderate noise impact. This noise impact is due to the proximity of the tracks.

The locations of the noise impacts for the City of Minneapolis along the 21st Ave and East of I-94 are shown in figures below for the one station and two station design options, respectively.

Figure E-1 Project Noise Impacts in the City of Minneapolis along the 21st Ave N and East of I-94 One Station Option

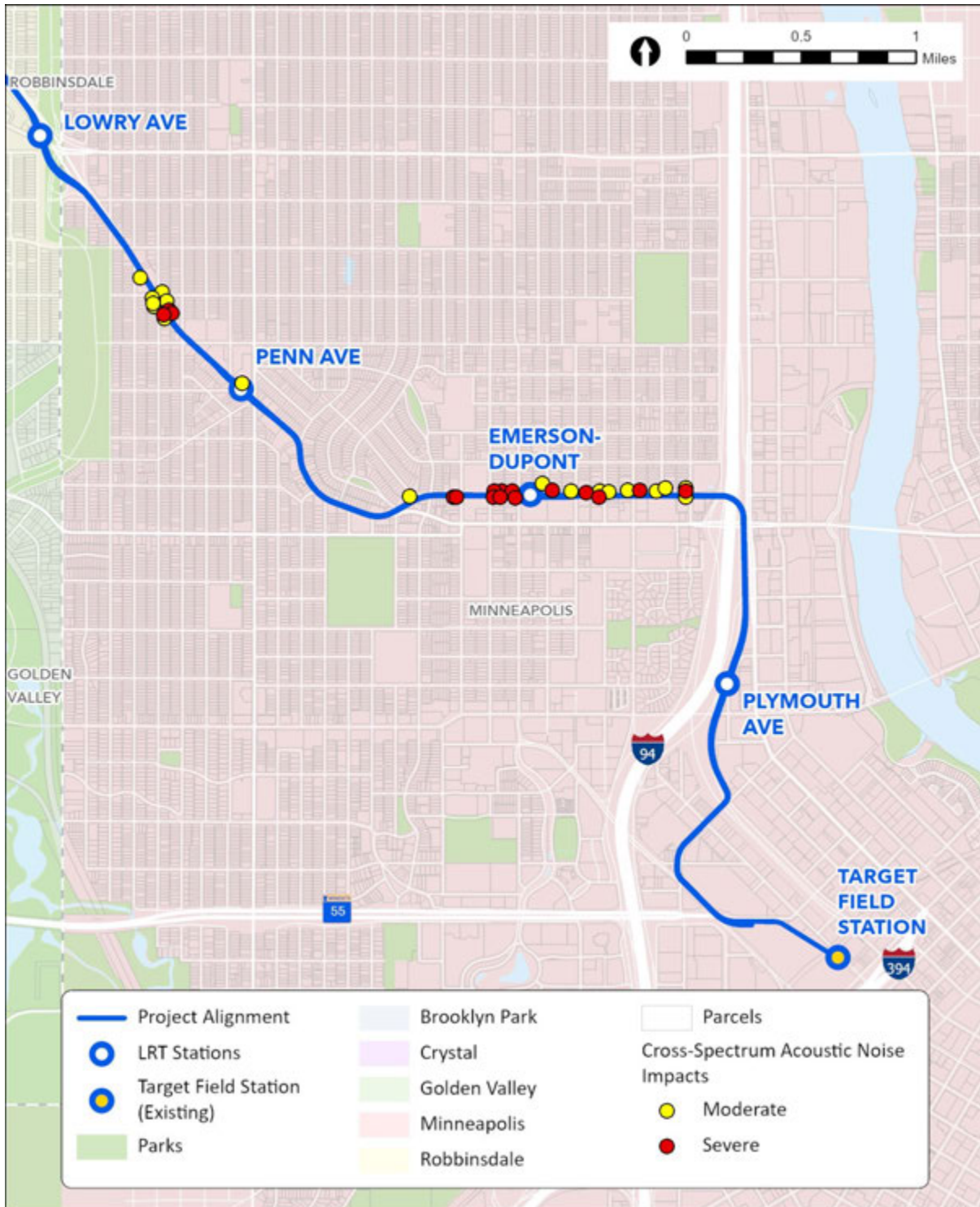


Figure E-2 Project Noise Impacts in the City of Minneapolis along the 21st Ave N and East of I-94 Two Stations Option



Table E-4 Summary of Noise Impacts for Residential Land Use in the City of Minneapolis (21st Ave N to Lyndale Ave)

Option	Location	City	Side of Track	Near Track Dist. (ft)	Speed (mph)	Exist Noise Level Ldn (dBA)	Project Noise Levels Ldn (dBA)	FTA Mod Impact Noise Level Ldn (dBA)	FTA Sev Impact Noise Level Ldn (dBA)	Number of Mod Noise Impacts	Number of Sev Noise Impacts
	N 26th Ave to N Lowry Ave	Minneapolis	NB	43	45	69	70	64	69	2	2
	N 26th Ave to N Lowry Ave	Minneapolis	SB	40	45	69	70	64	69	51	1
	N Knox Ave to N 26th Ave	Minneapolis	NB	56	20	69	64	64	69	104	0
	N Knox Ave to N 26th Ave	Minneapolis	SB	50	35	69	60	64	69	0	0
One Station	N Emerson Ave to N Knox Ave	Minneapolis	NB	54	30	55	64	55	61	1	4
	N Emerson Ave to N Knox Ave	Minneapolis	SB	18	30	55	75	55	61	0	16
	Lyndale Ave to N Emerson Ave	Minneapolis	NB	34	30	55	67	55	61	5	31
	Lyndale Ave to N Emerson Ave	Minneapolis	SB	17	30	55	66	55	61	0	18
Two Stations	N Emerson Ave to N Knox Ave	Minneapolis	NB	54	30	55	64	55	61	1	4
	N Emerson Ave to N Knox Ave	Minneapolis	SB	18	30	55	75	55	61	0	16
	Lyndale Ave to N Emerson Ave	Minneapolis	NB	55	30	55	61	55	61	5	0
	Lyndale Ave to N Emerson Ave	Minneapolis	SB	17	20	55	72	55	61	0	18
	Plymouth Ave to N 17th Ave	Minneapolis	NB	55	35	62	66	59	64	2	50



Option	Location	City	Side of Track	Near Track Dist. (ft)	Speed (mph)	Exist Noise Level Ldn (dBA)	Project Noise Levels Ldn (dBA)	FTA Mod Impact Noise Level Ldn (dBA)	FTA Sev Impact Noise Level Ldn (dBA)	Number of Mod Noise Impacts	Number of Sev Noise Impacts
	Plymouth Ave to N 17th Ave	Minneapolis	SB	63	40	62	62	59	64	13	0
	N 8th Ave to Plymouth Ave N	Minneapolis	NB	*	*	*	*	*	*	*	*
	N 8th Ave to Plymouth Ave N	Minneapolis	SB	163	35	62	58	59	64	0	0
	Target Field Station to N 8th Ave	Minneapolis	NB	50	10	65	53	60	66	0	0
	Target Field Station to N 8th Ave	Minneapolis	SB	*	*	*	*	*	*	*	*

Source: CSA, 2023

Notes:

Predicted noise levels shown for each location are highest for each location. Projected noise levels at other receptors within each location are lower.

The reported noise levels are rounded to the nearest decibel.

Mod = moderate; Sev = severe.

*No noise sensitive land use or property would be acquired in this design option.



- **N 26th Ave to N Lowry Ave (NB):** There are four single-family residences on the northbound side of the Project Alignment between N 26th Ave and N Lowry Ave predicted to have moderate and severe noise impacts. These impacts are due to the proximity of the tracks, the speed of the train, and a nearby crossover.
- **N 26th Ave to N Lowry Ave (SB):** There are 52 single and multi-family residences, representing seven buildings, on the southbound side of the Project Alignment between N 26th Ave and N Lowry Ave predicted to have moderate and severe noise impacts. These impacts are due to the proximity of the tracks, the speed of the train, and a nearby crossover.
- **N Knox Ave to N 26th Ave (NB):** There are 104 single and multi-family residences, representing two buildings, on the northbound side of the Project Alignment between N Knox Ave and N 26th Ave predicted to have moderate noise impacts. These impacts are due to the proximity of the tracks and bells at Penn Ave Station.
- **N Emerson Ave to N Knox Ave One Station Option (NB):** There are five single and multi-family residences, representing four buildings, on the northbound side of the Project Alignment between N Emerson Ave and N Knox Ave predicted to have moderate and severe noise impacts. These impacts are due to the proximity of the tracks and bells at N Girard Ave, N Fremont Ave, and N Emerson Ave.
- **N Emerson Ave to N Knox Ave Two Stations Option (NB):** There are five single and multi-family residences, representing four buildings, on the northbound side of the Project Alignment between N Emerson Ave and N Knox Ave predicted to have moderate and severe noise impacts. These impacts are due to the proximity of the tracks and bells at N Girard Ave, N Fremont Ave, and N Emerson Ave.
- **N Emerson Ave to N Knox Ave One Station Option (SB):** There are 16 single and multi-family residences, representing five buildings, on the southbound side of the Project Alignment between N Emerson Ave and N Knox Ave predicted to have severe noise impacts. These impacts are due to the proximity of the tracks and bells at N Girard Ave, N Fremont Ave, and N Emerson Ave.
- **N Emerson Ave to N Knox Ave Two Stations Option (SB):** There are 16 single and multi-family residences, representing five buildings, on the southbound side of the Project Alignment between N Emerson Ave and N Knox Ave predicted to have severe noise impacts. These impacts are due to the proximity of the tracks and bells at N Girard Ave, N Fremont Ave, and N Emerson Ave.
- **N Lyndale Ave to N Emerson Ave One Station Option (NB):** There are 36 single and multi-family residences on the northbound side of the Project Alignment between N Lyndale Ave and N Emerson Ave predicted to have moderate and severe noise impacts. These impacts are due to the proximity of the tracks and bells at Bryant Ave and the Emerson/Dupont Station.
- **N Lyndale Ave to N Emerson Ave Two Stations Option (NB):** There are five single-family residences on the northbound side of the Project Alignment between N Lyndale Ave and N Emerson Ave predicted to have moderate noise impacts. These impacts are due to the proximity of the tracks and bells at Bryant Ave and the Aldrich/Bryant Station.
- **N Lyndale Ave to N Emerson Ave One Station Option (SB):** There are 18 multi-family residences, representing one building, on the southbound side of the Project Alignment between N Lyndale Ave and N Emerson Ave predicted to have severe noise impacts. These impacts are due to the proximity of the tracks and bells at Bryant Ave and the Emerson/Dupont Station.
- **N Lyndale Ave to N Emerson Ave Two Stations Option (SB):** There are 18 multi-family residences, representing one building, on the southbound side of the Project Alignment between N Lyndale Ave and N Emerson Ave predicted to have severe noise impacts. These impacts are due to the proximity of the tracks and bells at Bryant Ave and the Aldrich/Bryant Station.



- **N Plymouth Ave to N 18th Ave (NB):** There are 52 single and multi-family residences on the northbound side of the Project Alignment between N Plymouth Ave and N 18th Ave predicted to have moderate and severe noise impacts. These impacts are due to the bells in the area and the proximity of a crossover.
- **N Plymouth Ave to N 18th Ave (SB):** There are 13 single and multi-family residences, representing seven buildings, on the southbound side of the Project Alignment between N Plymouth Ave and N 18th Ave predicted to have moderate noise impacts. These impacts are due to the proximity of the tracks and bells in the area.

Table E-5 Summary of Noise Impacts for Institutional Land Use in the City of Minneapolis (21st Ave N to Lyndale Ave)

Option	Name	City	Side of Track	Near Track Dist. (ft)	Speed (mph)	Exist Noise Level Leq (dBA)	Project Noise Levels Leq (dBA)	FTA Mod Impact Noise Level Leq (dBA)	FTA Sev Impact Noise Level Leq (dBA)	Type of Impact
	Parkway United Church of Christ	Minneapolis	NB	338	25	68	46	68	73	--
	Good News Minneapolis Church	Minneapolis	NB	139	25	68	52	68	73	--
	True Vine Missionary Baptist Church	Minneapolis	SB	111	45	68	63	68	73	--
	KIPP Legacy	Minneapolis	NB	200	35	68	51	68	73	--
	St Anne-St Joseph Hien Church	Minneapolis	NB	323	35	68	42	68	73	--
	Morning Star Assembly of God	Minneapolis	SB	17	20	68	61	68	73	--
	All Nations Seventh-day Adventist Church	Minneapolis	SB	182	20	68	41	68	73	--
	PYC Arts & Technology Alternative High School	Minneapolis	SB	53	20	62	58	64	69	--
	Capri Theater*	Minneapolis	SB	40	20	62	63	64	69	--



Option	Name	City	Side of Track	Near Track Dist. (ft)	Speed (mph)	Exist Noise Level Leq (dBA)	Project Noise Levels Leq (dBA)	FTA Mod Impact Noise Level Leq (dBA)	FTA Sev Impact Noise Level Leq (dBA)	Type of Impact
	Star Child Development Center LLC	Minneapolis	SB	40	20	62	63	64	69	--
	Real Believers Faith Center Church	Minneapolis	SB	233	30	68	42	68	73	--
One Station	Liberty Community Church	Minneapolis	NB	43	25	68	62	68	73	--
	United Deliverance Temple Inc	Minneapolis	NB	288	15	68	32	68	73	--
	Sanctuary Covenant Church	Minneapolis	SB	16	30	68	66	68	73	--
Two Stations	Liberty Community Church	Minneapolis	NB	43	30	68	63	68	73	--
	United Deliverance Temple Inc	Minneapolis	NB	288	20	68	37	68	73	--
	Sanctuary Covenant Church	Minneapolis	SB	16	20	68	68	68	73	--
	Masjid An-Nur Mosque	Minneapolis	SB	30	40	60	71	63	68	Severe
	United Faith Pentecostal Church	Minneapolis	SB	50	10	60	60	63	68	--
	Metro Schools College Prep	Minneapolis	SB	166	25	67	50	67	72	--

Source: CSA, 2023

Note: The reported noise levels are rounded to the nearest decibel.

Mod = moderate; Sev = severe.

*This represents the results for non-special use spaces in the Capri Theater.



- **Masjid An-Nur Mosque:** The Masjid An-Nur Mosque is predicted to have a severe noise impact. This noise impact is due to the proximity of the track and a nearby crossover.

The locations of the noise impacts for the City of Minneapolis along the 21st Ave N and Lyndale Ave are shown in figures below for the one station and two station design options, respectively.

Figure E-3 Project Noise Impacts in the City of Minneapolis along the 21st Ave N and Lyndale Ave One Station Option

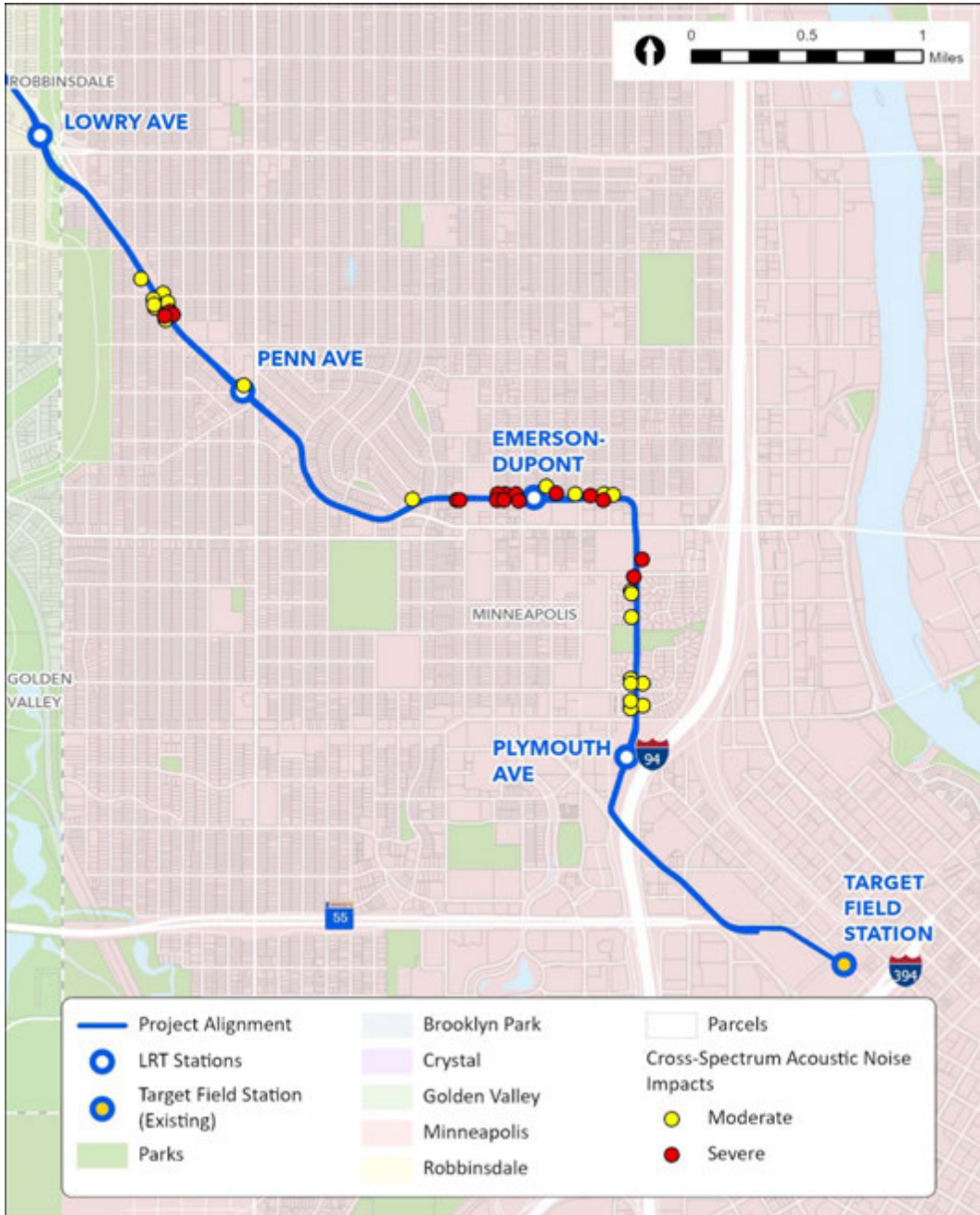




Figure E-4 Project Noise Impacts in the City of Minneapolis along the 21st Ave N and Lyndale Ave Two Stations Option

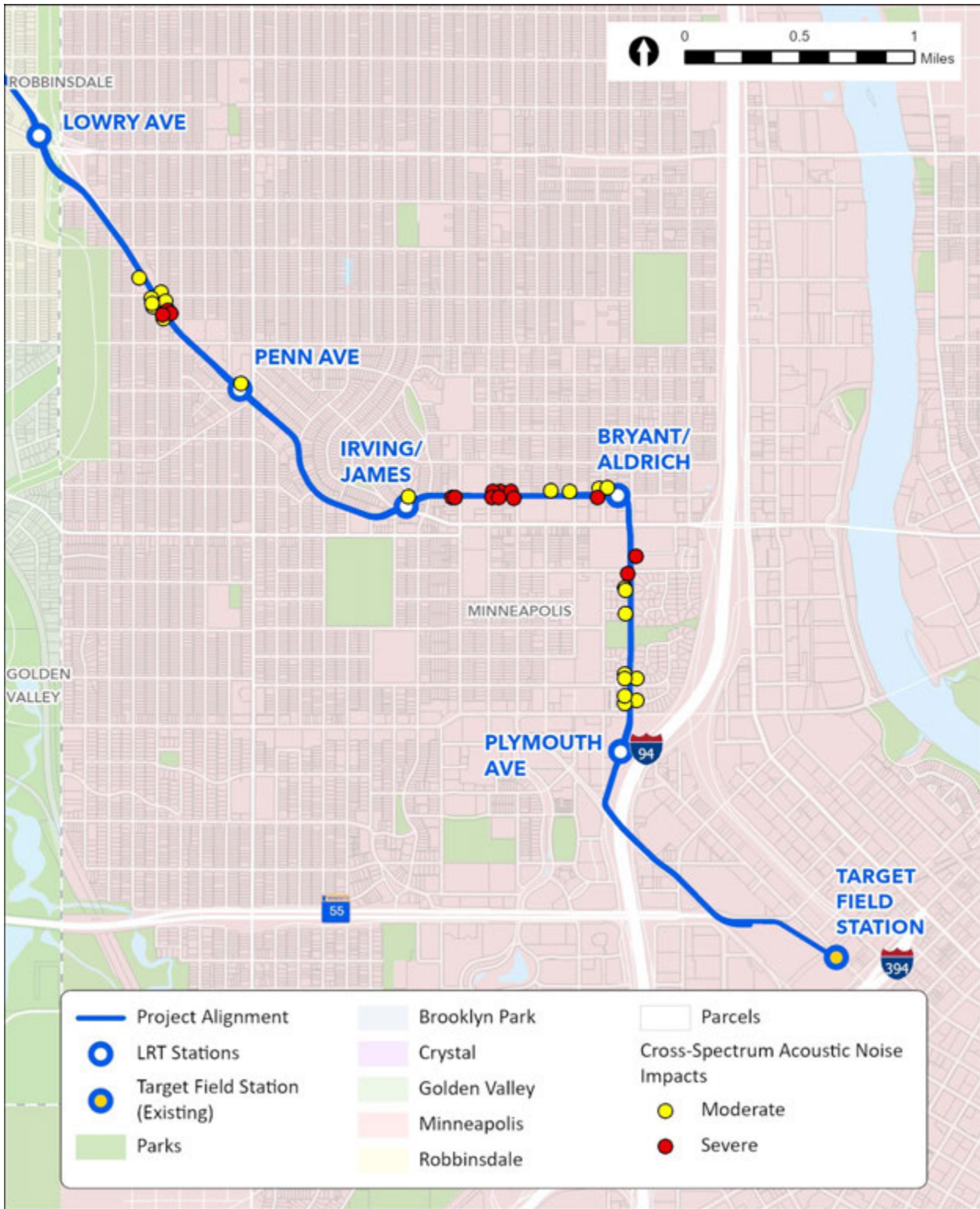


Table E-6 Summary of Noise Impacts for Residential Land Use in the City of Minneapolis (W Broadway Ave to East of I-94)

Option	Location	City	Side of Track	Near Track Dist. (ft)	Speed (mph)	Exist Noise Level Ldn (dBA)	Project Noise Levels Ldn (dBA)	FTA Mod Impact Noise Level Ldn (dBA)	FTA Sev Impact Noise Level Ldn (dBA)	Number of Mod Noise Impacts	Number of Sev Noise Impacts
	N 26th Ave to N Lowry Ave	Minneapolis	NB	43	45	69	70	64	69	2	2
	N 26th Ave to N Lowry Ave	Minneapolis	SB	40	45	69	70	64	69	51	1
	N Knox Ave to N 26th Ave	Minneapolis	NB	56	20	69	64	64	69	104	0
	N Knox Ave to N 26th Ave	Minneapolis	SB	50	35	69	60	64	69	0	0
One Station	N Emerson Ave to N Knox Ave	Minneapolis	NB	195	20	65	49	61	66	0	0
	N Emerson Ave to N Knox Ave	Minneapolis	SB	128	27	65	54	61	66	0	0
	Lyndale Ave to N Emerson Ave	Minneapolis	NB	*	*	*	*	*	*	*	*
	Lyndale Ave to N Emerson Ave	Minneapolis	SB	217	20	65	51	61	66	0	0
Two Station	N Emerson Ave to N Knox Ave	Minneapolis	NB	209	20	65	55	61	66	0	0
	N Emerson Ave to N Knox Ave	Minneapolis	SB	129	23	65	58	61	66	0	0
	Lyndale Ave to N Emerson Ave	Minneapolis	NB	*	*	*	*	*	*	*	*
	Lyndale Ave to N Emerson Ave	Minneapolis	SB	215	20	65	44	61	66	0	0
	I-94 to Lyndale Ave	Minneapolis	NB	*	*	*	*	*	*	*	*
	I-94 to Lyndale Ave	Minneapolis	SB	307	30	69	46	64	69	0	0



Option	Location	City	Side of Track	Near Track Dist. (ft)	Speed (mph)	Exist Noise Level Ldn (dBA)	Project Noise Levels Ldn (dBA)	FTA Mod Impact Noise Level Ldn (dBA)	FTA Sev Impact Noise Level Ldn (dBA)	Number of Mod Noise Impacts	Number of Sev Noise Impacts
	Plymouth Ave to N 17th Ave	Minneapolis	NB	*	*	*	*	*	*	*	*
	Plymouth Ave to N 17th Ave	Minneapolis	SB	*	*	*	*	*	*	*	*
	N 8th Ave to Plymouth Ave N	Minneapolis	NB	241	20	64	51	60	65	0	0
	N 8th Ave to Plymouth Ave N	Minneapolis	SB	*	*	*	*	*	*	*	*
	Target Field Station to N 8th Ave	Minneapolis	NB	50	20	65	59	60	66	0	0
	Target Field Station to N 8th Ave	Minneapolis	SB	*	*	*	*	*	*	*	*

Source: CSA, 2023

Notes:

Predicted noise levels shown for each location are highest for each location. Projected noise levels at other receptors within each location are lower.

The reported noise levels are rounded to the nearest decibel.

Mod = moderate; Sev = severe.

*No noise sensitive land use.



- **N 26th Ave to N Lowry Ave (NB):** There are four single-family residences on the northbound side of the Project Alignment between N 26th Ave and N Lowry Ave predicted to have moderate and severe noise impacts. These impacts are due to the proximity of the tracks, the speed of the train, and a nearby crossover.
- **N 26th Ave to N Lowry Ave (SB):** There are 52 single and multi-family residences, representing seven buildings, on the southbound side of the Project Alignment between N 26th Ave and N Lowry Ave predicted to have moderate and severe noise impacts. These impacts are due to the proximity of the tracks, the speed of the train, and a nearby crossover.
- **N Knox Ave to N 26th Ave (NB):** There are 104 single and multi-family residences, representing two buildings, on the northbound side of the Project Alignment between N Knox Ave and N 26th Ave predicted to have moderate noise impacts. These impacts are due to the proximity of the tracks and bells at Penn Ave Station.

Table E-7 Summary of Noise Impacts for Institutional Land Use in the City of Minneapolis (W Broadway Ave to East of I-94)

Option	Name	City	Side of Track	Near Track Dist. (ft)	Speed (mph)	Exist Noise Level Leq (dBA)	Project Noise Levels Leq (dBA)	FTA Mod Impact Noise Level Leq (dBA)	FTA Sev Impact Noise Level Leq (dBA)	Type of Impact
	Parkway United Church of Christ	Minneapolis	NB	338	25	68	46	68	73	--
	Good News Minneapolis Church	Minneapolis	NB	139	25	68	52	68	73	--
	True Vine Missionary Baptist Church	Minneapolis	SB	111	45	68	63	68	73	--
	KIPP Legacy	Minneapolis	NB	200	35	68	51	68	73	--
	St Anne-St Joseph Hien Church	Minneapolis	NB	323	35	68	42	68	73	--
	Morning Star Assembly of God	Minneapolis	SB	17	20	68	61	68	73	--
	All Nations Seventh-day Adventist Church	Minneapolis	SB	182	20	68	41	68	73	--



Option	Name	City	Side of Track	Near Track Dist. (ft)	Speed (mph)	Exist Noise Level Leq (dBA)	Project Noise Levels Leq (dBA)	FTA Mod Impact Noise Level Leq (dBA)	FTA Sev Impact Noise Level Leq (dBA)	Type of Impact
	PYC Arts & Technology Alternative High School	Minneapolis	SB	53	20	62	58	64	69	--
	Capri Theater*	Minneapolis	SB	40	20	62	63	64	69	--
	Star Child Development Center LLC	Minneapolis	SB	40	20	62	63	64	69	--
	St. Andrews Episcopal Church	Minneapolis	SB	326	20	68	35	68	73	--
One Station	Shiloh Temple International Ministries	Minneapolis	SB	53	30	68	62	68	73	--
	Real Believers Faith Center Church	Minneapolis	NB	129	26	68	52	68	73	--
Two Stations	Shiloh Temple International Ministries	Minneapolis	SB	44	30	68	64	68	73	--
	Real Believers Faith Center Church	Minneapolis	NB	138	26	68	52	68	73	--
	Episcopal Church in Minnesota	Minneapolis	SB	48	20	68	61	68	73	--
	Full Proof Ministry COGIC	Minneapolis	SB	343	20	68	37	68	73	--
	Sanctuary Covenant Church	Minneapolis	NB	237	20	68	46	68	73	--
	Minnesota International Middle Charter School	Minneapolis	SB	99	25	66	52	66	72	--



Option	Name	City	Side of Track	Near Track Dist. (ft)	Speed (mph)	Exist Noise Level Leq (dBA)	Project Noise Levels Leq (dBA)	FTA Mod Impact Noise Level Leq (dBA)	FTA Sev Impact Noise Level Leq (dBA)	Type of Impact
	Metro Schools College Prep	Minneapolis	SB	166	25	67	50	67	72	--

Source: CSA, 2023

Note: The reported noise levels are rounded to the nearest decibel.

Mod = moderate; Sev = severe.

*This represents the results for non-special use spaces in the Capri Theater.

The locations of the noise impacts for the City of Minneapolis along the W Broadway Ave and East of I-94 alignment option are shown in the figure below.

Figure E-5 Project Noise Impacts in the City of Minneapolis along the W Broadway Ave and East of I-94 Option

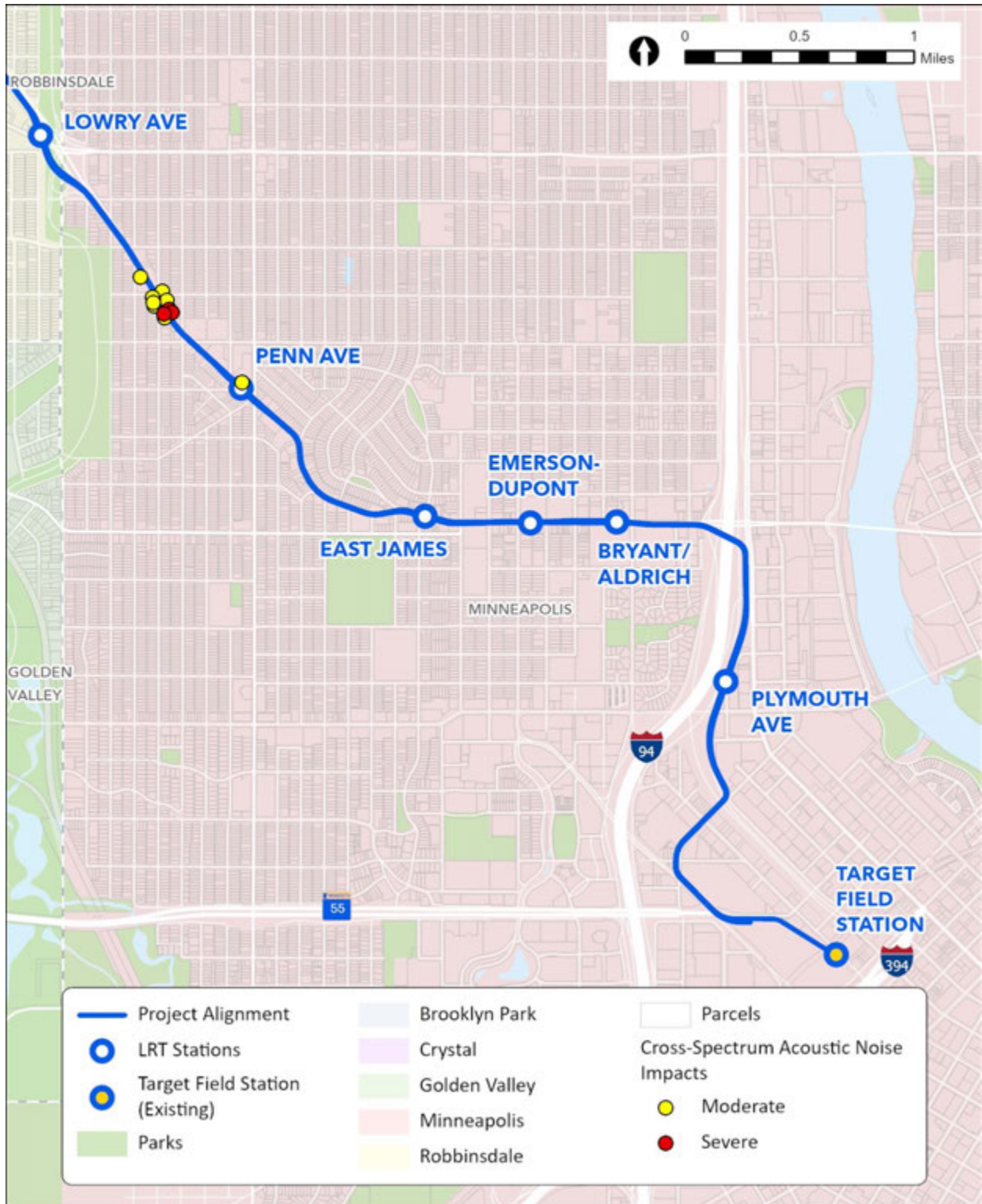


Table E-8 Summary of Noise Impacts for Residential Land Use in the City of Minneapolis (W Broadway Ave to Lyndale Ave)

Option	Location	City	Side of Track	Near Track Dist. (ft)	Speed (mph)	Exist Noise Level Ldn (dBA)	Project Noise Levels Ldn (dBA)	FTA Mod Impact Noise Level Ldn (dBA)	FTA Sev Impact Noise Level Ldn (dBA)	Number of Mod Noise Impacts	Number of Sev Noise Impacts
	N 26 th Ave to N Lowry Ave	Minneapolis	NB	43	45	69	70	64	69	2	2
	N 26 th Ave to N Lowry Ave	Minneapolis	SB	40	45	69	70	64	69	51	1
	N Knox Ave to N 26 th Ave	Minneapolis	NB	56	20	69	64	64	69	104	0
	N Knox Ave to N 26 th Ave	Minneapolis	SB	50	35	69	60	64	69	0	0
One Station	N Emerson Ave to N Knox Ave	Minneapolis	NB	195	20	65	49	61	66	0	0
	N Emerson Ave to N Knox Ave	Minneapolis	SB	128	27	65	54	61	66	0	0
	Lyndale Ave to N Emerson Ave	Minneapolis	NB	*	*	*	*	*	*	*	*
	Lyndale Ave to N Emerson Ave	Minneapolis	SB	217	20	65	51	61	66	0	0
Two Stations	N Emerson Ave to N Knox Ave	Minneapolis	NB	209	20	65	55	61	66	0	0
	N Emerson Ave to N Knox Ave	Minneapolis	SB	129	23	65	58	61	66	0	0
	Lyndale Ave to N Emerson Ave	Minneapolis	NB	*	*	*	*	*	*	*	*
	Lyndale Ave to N Emerson Ave	Minneapolis	SB	215	20	65	44	61	66	0	0
	Plymouth Ave to N 17 th Ave	Minneapolis	NB	55	35	62	66	59	64	2	50
	Plymouth Ave to N 17 th Ave	Minneapolis	SB	63	40	62	62	59	64	13	0



Option	Location	City	Side of Track	Near Track Dist. (ft)	Speed (mph)	Exist Noise Level Ldn (dBA)	Project Noise Levels Ldn (dBA)	FTA Mod Impact Noise Level Ldn (dBA)	FTA Sev Impact Noise Level Ldn (dBA)	Number of Mod Noise Impacts	Number of Sev Noise Impacts
	N 8 th Ave to Plymouth Ave N	Minneapolis	NB	*	*	*	*	*	*	*	*
	N 8 th Ave to Plymouth Ave N	Minneapolis	SB	163	35	62	58	59	64	0	0
	Target Field Station to N 8 th Ave	Minneapolis	NB	50	10	65	53	60	66	0	0
	Target Field Station to N 8 th Ave	Minneapolis	SB	*	*	*	*	*	*	*	*

Source: CSA, 2023

Notes:

Predicted noise levels shown for each location are highest for each location. Projected noise levels at other receptors within each location are lower.

The reported noise levels are rounded to the nearest decibel.

Mod = moderate; Sev = severe.

*No noise sensitive land use or property would be acquired in this design option.



- **N 26th Ave to N Lowry Ave (NB):** There are four single-family residences on the northbound side of the Project Alignment between N 26th Ave and N Lowry Ave predicted to have moderate and severe noise impacts. These impacts are due to the proximity of the tracks, the speed of the train, and a nearby crossover.
- **N 26th Ave to N Lowry Ave (SB):** There are 52 single and multi-family residences, representing seven buildings, on the southbound side of the Project Alignment between N 26th Ave and N Lowry Ave predicted to have moderate and severe noise impacts. These impacts are due to the proximity of the tracks, the speed of the train, and a nearby crossover.
- **N Knox Ave to N 26th Ave (NB):** There are 104 single and multi-family residences, representing two buildings, on the northbound side of the Project Alignment between N Knox Ave and N 26th Ave predicted to have moderate noise impacts. These impacts are due to the proximity of the tracks and bells at Penn Ave Station.
- **N Plymouth Ave to N 18th Ave (NB):** There are 52 single and multi-family residences on the northbound side of the Project Alignment between N Plymouth Ave and N 18th Ave predicted to have moderate and severe noise impacts. These impacts are due to the bells in the area and the proximity of a crossover.
- **N Plymouth Ave to N 18th Ave (SB):** There are 13 single and multi-family residences, representing seven buildings, on the southbound side of the Project Alignment between N Plymouth Ave and N 18th Ave predicted to have moderate noise impacts. These impacts are due to the proximity of the tracks and bells at N 14th Ave and Plymouth Ave.

Table E-9 Summary of Noise Impacts for Institutional Land Use in the City of Minneapolis (W Broadway Ave to Lyndale Ave)

Option	Name	City	Side of Track	Near Track Dist. (ft)	Speed (mph)	Exist Noise Level Leq (dBA)	Project Noise Levels Leq (dBA)	FTA Mod Impact Noise Level Leq (dBA)	FTA Sev Impact Noise Level Leq (dBA)	Type of Impact
	Parkway United Church of Christ	Minneapolis	NB	338	25	68	46	68	73	--
	Good News Minneapolis Church	Minneapolis	NB	139	25	68	52	68	73	--
	True Vine Missionary Baptist Church	Minneapolis	SB	111	45	68	63	68	73	--
	KIPP Legacy	Minneapolis	NB	200	35	68	51	68	73	--
	St Anne-St Joseph Hien Church	Minneapolis	NB	323	35	68	42	68	73	--



Option	Name	City	Side of Track	Near Track Dist. (ft)	Speed (mph)	Exist Noise Level Leq (dBA)	Project Noise Levels Leq (dBA)	FTA Mod Impact Noise Level Leq (dBA)	FTA Sev Impact Noise Level Leq (dBA)	Type of Impact
	Morning Star Assembly of God	Minneapolis	SB	17	20	68	61	68	73	--
	All Nations Seventh-day Adventist Church	Minneapolis	SB	182	20	68	41	68	73	--
	PYC Arts & Technology Alternative High School	Minneapolis	SB	53	20	62	58	64	69	--
	Capri Theater*	Minneapolis	SB	40	20	62	63	64	69	--
	Star Child Development Center LLC	Minneapolis	SB	40	20	62	63	64	69	--
	St. Andrews Episcopal Church	Minneapolis	SB	326	20	68	35	68	73	--
One Station	Shiloh Temple International Ministries	Minneapolis	SB	53	30	68	62	68	73	--
	Real Believers Faith Center Church	Minneapolis	NB	129	26	68	52	68	73	--
Two Stations	Shiloh Temple International Ministries	Minneapolis	SB	44	30	68	64	68	73	--
	Real Believers Faith Center Church	Minneapolis	NB	138	26	68	52	68	73	--
	Episcopal Church in Minnesota	Minneapolis	SB	48	20	68	61	68	73	--
	Full Proof Ministry COGIC	Minneapolis	SB	343	20	68	37	68	73	--



Option	Name	City	Side of Track	Near Track Dist. (ft)	Speed (mph)	Exist Noise Level Leq (dBA)	Project Noise Levels Leq (dBA)	FTA Mod Impact Noise Level Leq (dBA)	FTA Sev Impact Noise Level Leq (dBA)	Type of Impact
	Sanctuary Covenant Church	Minneapolis	NB	197	30	68	51	68	73	--
	Masjid An-Nur Mosque	Minneapolis	SB	34	40	60	70	63	68	Severe
	United Faith Pentecostal Church	Minneapolis	SB	50	20	60	61	63	68	--
	Metro Schools College Prep	Minneapolis	NB	166	35	67	52	67	72	--

Source: CSA, 2023

Note: The reported noise levels are rounded to the nearest decibel.

Mod = moderate; Sev = severe.

*This represents the results for non-special use spaces in the Capri Theater.

- **Masjid An-Nur Mosque:** The Masjid An-Nur Mosque is predicted to have a severe noise impact. This noise impact is due to the proximity of the tracks and a nearby crossover.

The locations of the noise impacts for the City of Minneapolis along the W Broadway Ave and Lyndale Ave alignment option are shown in the figure below.

Figure E-6 Project Noise Impacts in the City of Minneapolis along the W Broadway Ave and Lyndale Ave Option

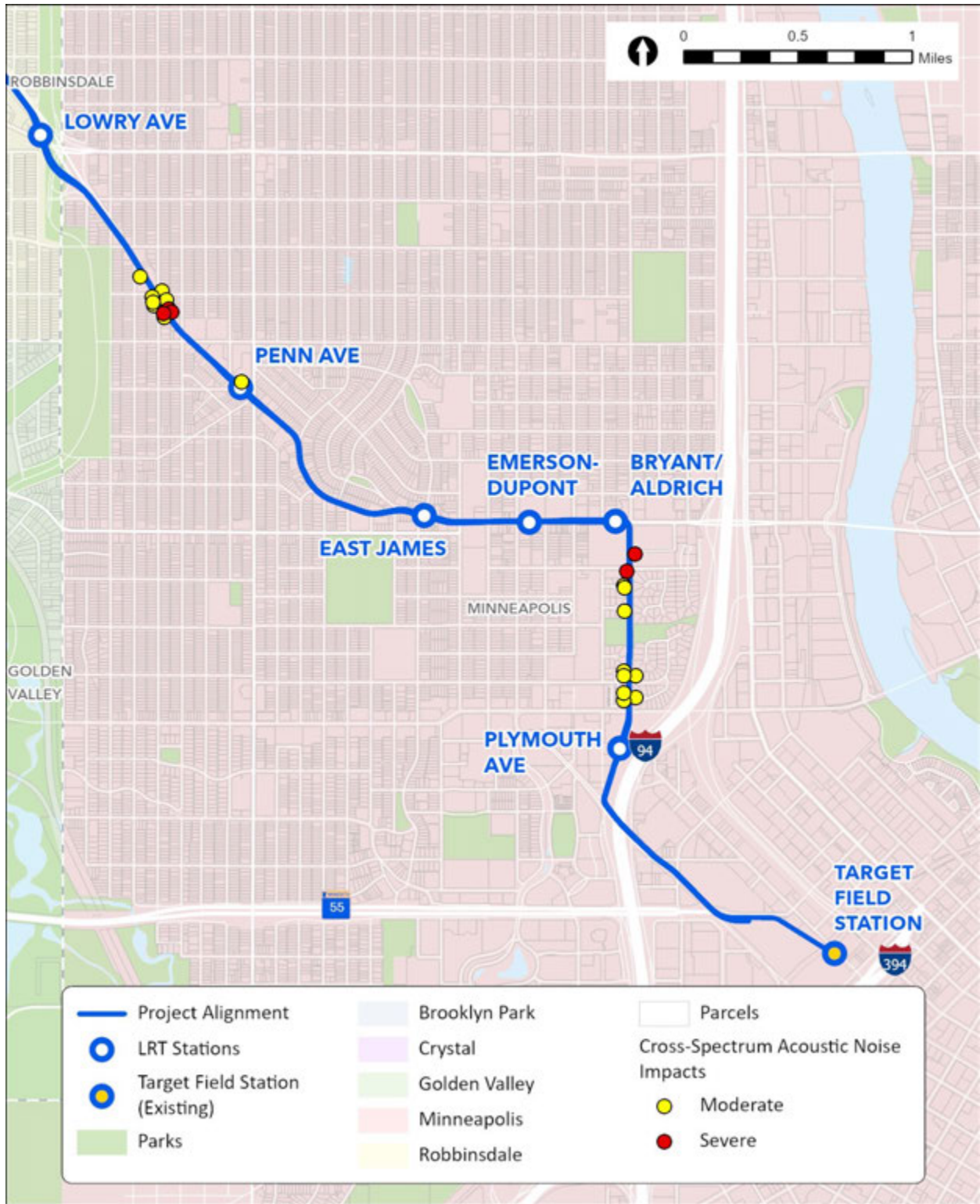
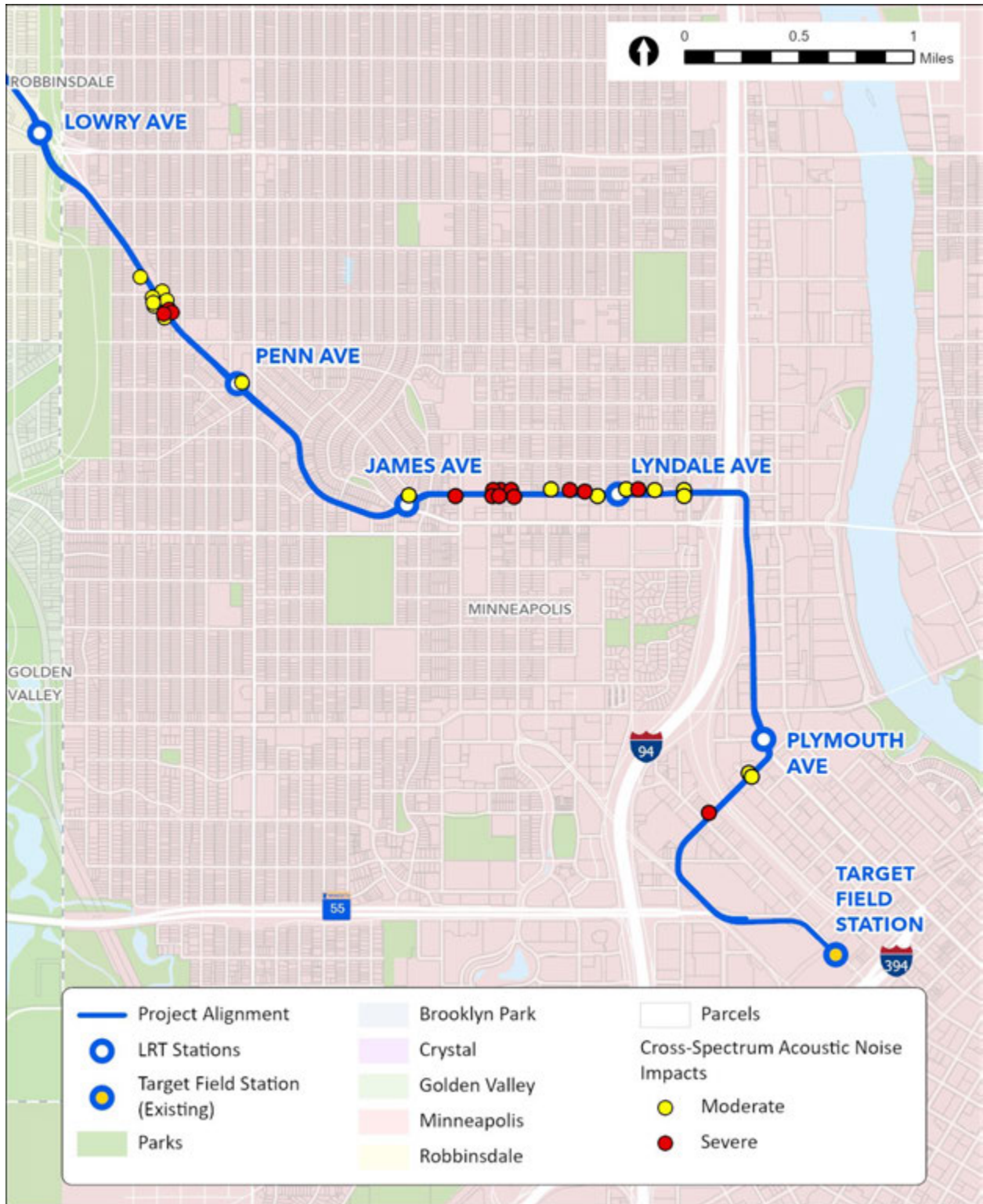




Figure E-7 Project Noise Impacts in the City of Minneapolis along the 21st Ave N and Washington Ave Option



Appendix F Project Vibration Analysis from Other Project Alignment and Design Options Evaluated

This appendix presents results from the analysis of vibration impacts for other Project alignment and design options evaluated.

Table F-1 through Table F-9 include a tabulation of location information for each sensitive receptor group, Project vibration levels, the impact criteria, and whether there will be vibration impacts. The tables also show the total number of dwelling units with vibration impacts for each location.

Table F-1 Summary of Vibration Impacts by Project Cities and Option

City and Option	# of Vibration Impacts**
Brooklyn Park	0
Robbinsdale*	0
Crystal	0
Minneapolis by Option	NA
Minneapolis <i>21st St N to East of I-94 (One Station)</i>	21
Minneapolis <i>21st St N to East of I-94 (Two Stations)</i>	20
Minneapolis <i>21st St N to Lyndale Ave (One Station)</i>	21
Minneapolis <i>21st St N to Lyndale Ave (Two Stations)</i>	20
Minneapolis <i>W Broadway Ave to East of I-94 (One Station)</i>	0
Minneapolis <i>W Broadway Ave to East of I-94 (Two Stations)</i>	0
Minneapolis <i>W Broadway Ave to Lyndale Ave (One Station)</i>	0
Minneapolis <i>W Broadway Ave to Lyndale Ave (Two Stations)</i>	0
Minneapolis <i>21st St N to East of I-94 along Washington Ave (Build Alternative)</i>	28

Source: CSA, 2023

*All station options in Robbinsdale have the same vibration impacts.

** The impact numbers represent the total number DUs (including apartments and other multi-family buildings), not the number of buildings impacted.



Table F-2 Summary of Vibration Impacts for Residential Land Use in the City of Minneapolis (21st Ave N to East of I-94)

Option	Location	City	Side of Track	Near Track Dist. (ft)	Speed (mph)	Max Project Vibration Level (VdB)	FTA Vibration Criteria (VdB)	Number of Impacts
	N 26th Ave to N Lowry Ave	Minneapolis	NB	43	45	60	72	0
	N 26th Ave to N Lowry Ave	Minneapolis	SB	54	45	66	72	0
	N Knox Ave to N 26th Ave	Minneapolis	NB	41	20	60	72	0
	N Knox Ave to N 26th Ave	Minneapolis	SB	36	20	62	72	0
One Station	N Emerson Ave to N Knox Ave	Minneapolis	NB	48	35	57	72	0
	N Emerson Ave to N Knox Ave	Minneapolis	SB	18	30	74	72	2
	Lyndale Ave to N Emerson Ave	Minneapolis	NB	34	30	61	72	0
	Lyndale Ave to N Emerson Ave	Minneapolis	SB	18	30	74	72	18
Two Stations	N Emerson Ave to N Knox Ave	Minneapolis	NB	48	30	56	72	0
	N Emerson Ave to N Knox Ave	Minneapolis	SB	18	30	74	72	2
	Lyndale Ave to N Emerson Ave	Minneapolis	NB	55	25	54	72	0
	Lyndale Ave to N Emerson Ave	Minneapolis	SB	17	20	73	72	18
	I-94 to Lyndale Ave	Minneapolis	NB	60	35	53	72	0
	I-94 to Lyndale Ave	Minneapolis	SB	*	*	*	*	*
	Plymouth Ave N to N 18th Ave	Minneapolis	NB	32	20	0	72	0



Option	Location	City	Side of Track	Near Track Dist. (ft)	Speed (mph)	Max Project Vibration Level (VdB)	FTA Vibration Criteria (VdB)	Number of Impacts
	Plymouth Ave N to N 18th Ave	Minneapolis	SB	*	*	*	*	*
	N 8th Ave to Plymouth Ave N	Minneapolis	NB	341	15	49	72	0
	N 8th Ave to Plymouth Ave N	Minneapolis	SB	*	*	*	*	*
	Target Field Station to N 8th Ave	Minneapolis	NB	43	20	47	72	0
	Target Field Station to N 8th Ave	Minneapolis	SB	*	*	*	*	*

Source: CSA, 2023

Note: The vibration levels shown for each location are the highest levels projected for that location. Vibration projections at other receptors within each location will be lower.

*There are no vibration sensitive receivers at this location.

- **N Emerson Ave to N Knox Ave (SB):** There are two single-family residences along the southbound side of the Project Alignment between N Emerson Ave and N Knox Ave predicted to have a vibration impact. These impacts are due to the proximity of the tracks. The impacts are the same for both the one station and two station design options.
- **Lyndale Ave to N Emerson Ave (SB):** There are 18 multi-family residences, representing one building, along the southbound side of the Project Alignment between Lyndale Ave and N Emerson Ave predicted to have a vibration impact. These impacts are due to the proximity of the tracks. The impacts are the same for both the one station and two station design options.

Table F-3 Summary of Vibration Impacts for Institutional Land Use in the City of Minneapolis (21st Ave N to East of I-94)

Option	Location	City	Side of Track	Near Track Dist. (ft)	Speed (mph)	Max Project Vibration Level (VdB)	FTA Vibration Criteria (VdB)	Impact
	Parkway United Church of Christ	Minneapolis	NB	338	25	27	75	--
	Good News Minneapolis Church	Minneapolis	NB	139	25	35	75	--
	True Vine Missionary Baptist Church	Minneapolis	SB	111	45	52	75	--
	KIPP Legacy	Minneapolis	NB	200	35	42	75	--
	St Anne-St Joseph Hien Church	Minneapolis	NB	323	35	39	75	--
	All Nations Seventh-day Adventist Church	Minneapolis	SB	182	20	40	75	--
	PYC Arts & Technology Alternative High School	Minneapolis	SB	53	20	54	75	--
	Capri Theater*	Minneapolis	SB	40	20	60	75	--
	Star Child Development Center llc	Minneapolis	SB	40	20	59	75	--
	Real Believers Faith Center Church	Minneapolis	SB	233	30	38	75	--
One Station	Liberty Community Church	Minneapolis	NB	43	25	57	75	--
	United Deliverance Temple Inc	Minneapolis	NB	259	15	34	75	--
	Sanctuary Covenant Church	Minneapolis	SB	16	30	76	75	Impact
Two Stations	Liberty Community Church	Minneapolis	NB	43	30	57	75	--
	United Deliverance Temple Inc	Minneapolis	NB	259	20	35	75	--
	Sanctuary Covenant Church	Minneapolis	SB	16	20	75	75	--
	Faith Tabernacle Gospel Fellowship International	Minneapolis	SB	14	40	67	75	--



Option	Location	City	Side of Track	Near Track Dist. (ft)	Speed (mph)	Max Project Vibration Level (VdB)	FTA Vibration Criteria (VdB)	Impact
	Metro Schools College Prep	Minneapolis	SB	166	25	54	75	--
	Minnesota International Middle Charter School	Minneapolis	NB	99	30	55	75	--

Source: CSA, 2023

Note: The vibration levels shown for each location are the highest levels projected for that location. Vibration projections at other receptors within each location will be lower.

*This level represents the non-special use spaces in the Capri Theater.

- **Sanctuary Covenant Church:** Sanctuary Covenant Church is predicted to have a vibration impact with the one station design option along 21st Street. This impact is due to the speed of the LRV and proximity of the track. This impact is only for the one station design option.

The location of the vibration impacts for the City of Minneapolis along the 21st Ave N and East of I-94 alignment options are shown in figures below for the one station and two station design options, respectively.

Figure E-8 Project Vibration Impacts in the City of Minneapolis along the 21st Ave N and East of I-94 One Station Option

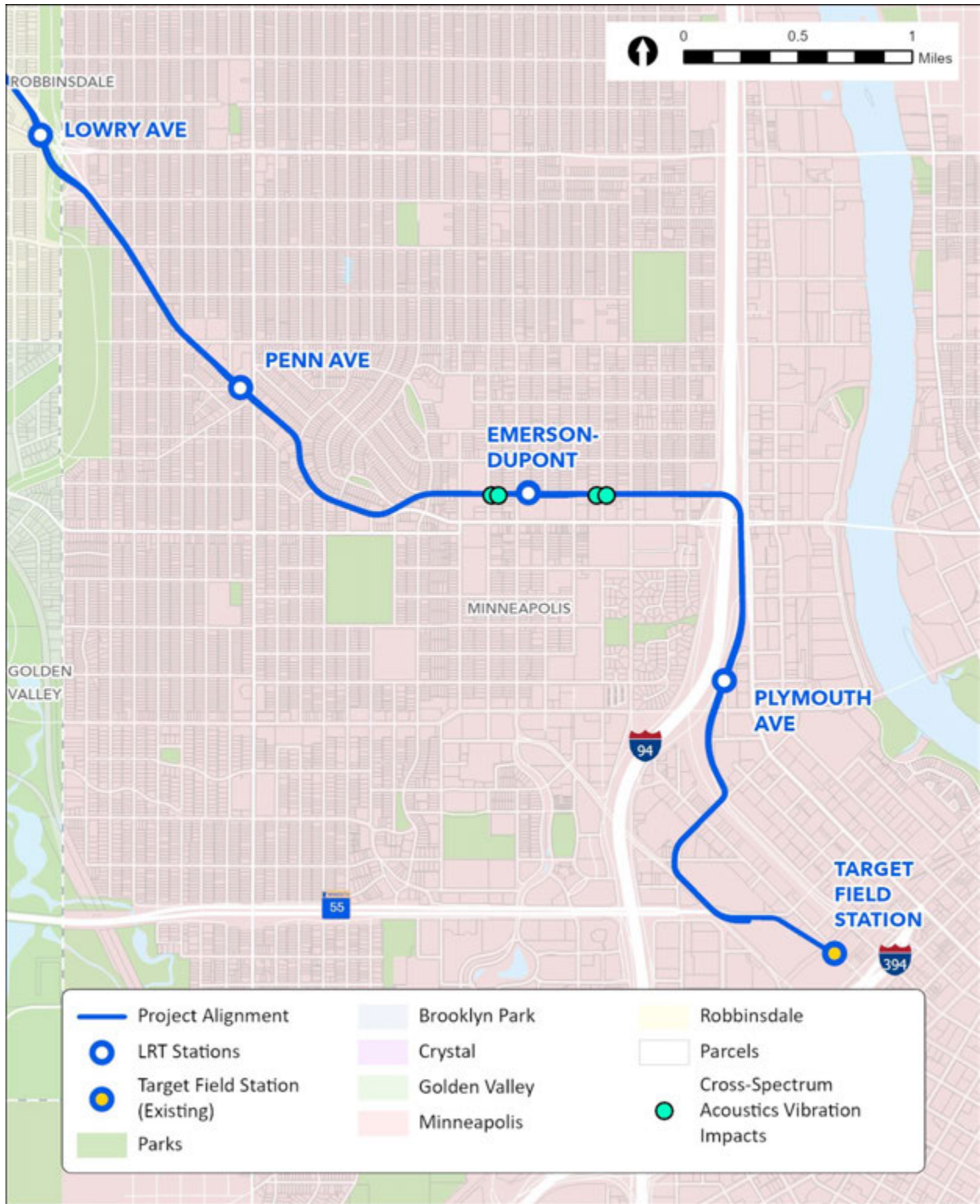


Figure E-9 Project Vibration Impacts in the City of Minneapolis along the 21st Ave N and East of I-94 Two Stations Option

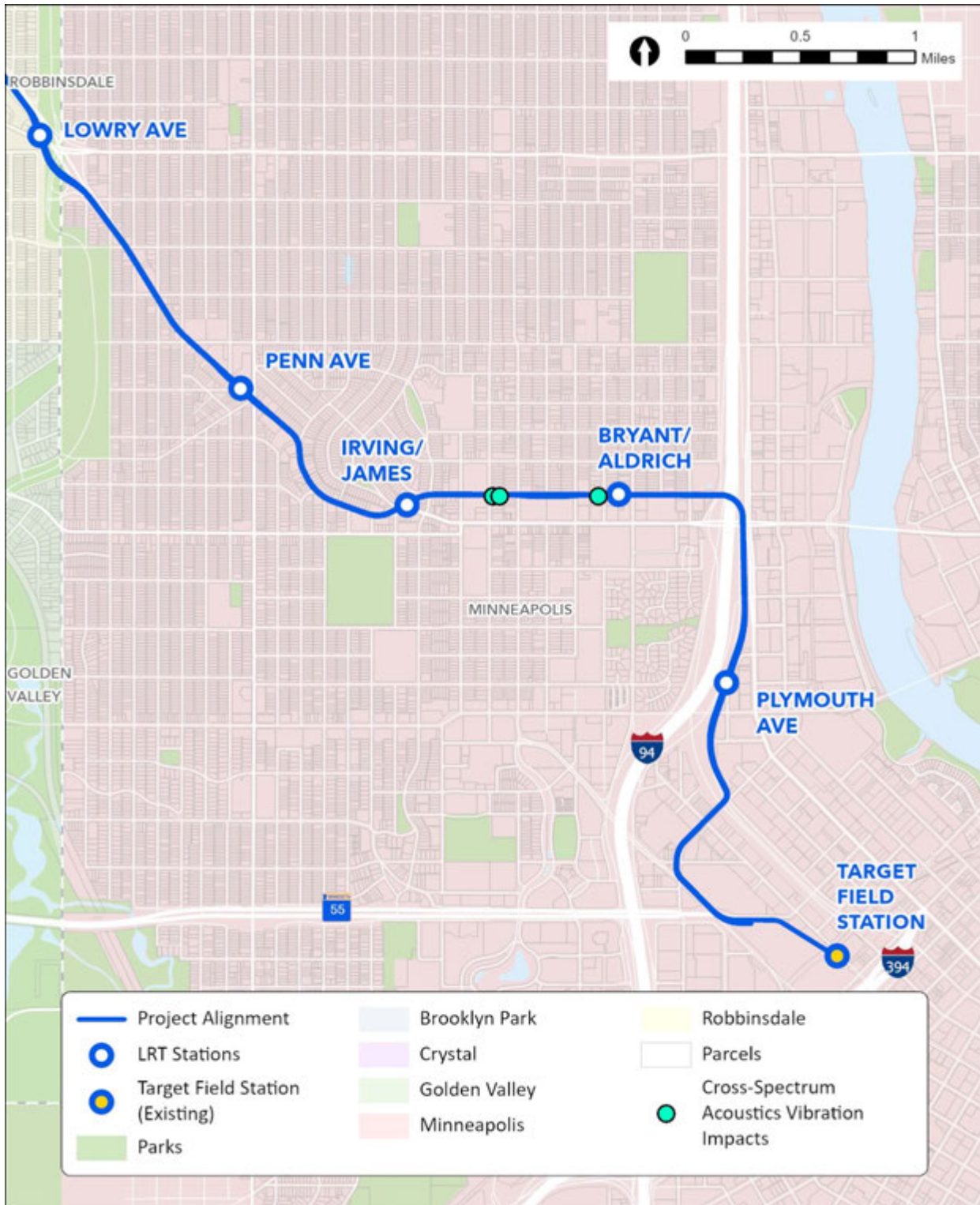




Table F-4 Summary of Vibration Impacts for Residential Land Use in the City of Minneapolis (21st Ave N to Lyndale Ave)

Option	Location	City	Side of Track	Near Track Dist. (ft)	Speed (mph)	Max Project Vibration Level (VdB)	FTA Vibration Criteria (VdB)	Number of Impacts
	N 26th Ave to N Lowry Ave	Minneapolis	NB	43	45	60	72	0
	N 26th Ave to N Lowry Ave	Minneapolis	SB	54	45	66	72	0
	N Knox Ave to N 26th Ave	Minneapolis	NB	41	20	60	72	0
	N Knox Ave to N 26th Ave	Minneapolis	SB	36	20	62	72	0
One Station	N Emerson Ave to N Knox Ave	Minneapolis	NB	48	35	57	72	0
	N Emerson Ave to N Knox Ave	Minneapolis	SB	18	30	74	72	2
	Lyndale Ave to N Emerson Ave	Minneapolis	NB	34	30	61	72	0
	Lyndale Ave to N Emerson Ave	Minneapolis	SB	18	30	74	72	18
Two Stations	N Emerson Ave to N Knox Ave	Minneapolis	NB	48	30	56	72	0
	N Emerson Ave to N Knox Ave	Minneapolis	SB	18	30	74	72	2
	Lyndale Ave to N Emerson Ave	Minneapolis	NB	55	25	54	72	0
	Lyndale Ave to N Emerson Ave	Minneapolis	SB	17	20	73	72	18
	Plymouth Ave N to N 18th Ave	Minneapolis	NB	71	35	70	72	0
	Plymouth Ave N to N 18th Ave	Minneapolis	SB	63	55	62	72	0



Option	Location	City	Side of Track	Near Track Dist. (ft)	Speed (mph)	Max Project Vibration Level (VdB)	FTA Vibration Criteria (VdB)	Number of Impacts
	N 8th Ave to Plymouth Ave N	Minneapolis	NB	*	*	*	*	*
	N 8th Ave to Plymouth Ave N	Minneapolis	SB	127	15	51	72	0
	Target Field Station to N 8th Ave	Minneapolis	NB	284	25	43	72	0
	Target Field Station to N 8th Ave	Minneapolis	SB	*	*	*	*	*

Source: CSA, 2023

Note: The vibration levels shown for each location are the highest levels projected for that location. Vibration projections at other receptors within each location will be lower.

*There are no vibration sensitive receivers at this location.

- **N Emerson Ave to N Knox Ave (SB):** There are two single-family residences along the southbound side of the Project Alignment between N Emerson Ave and N Knox Ave predicted to have a vibration impact. These impacts are due to the proximity of the tracks. These impacts are the same for both design options.
- **Lyndale Ave to N Emerson Ave (SB):** There are 18 multi-family residences, representing one building, along the southbound side of the Project Alignment between Lyndale Ave and N Emerson Ave predicted to have a vibration impact. These impacts are due to the proximity of the tracks. These impacts are the same for both design options.

Table F-5 Summary of Vibration Impacts for Institutional Land Use in the City of Minneapolis (21st Ave N to Lyndale Ave)

Option	Location	City	Side of Track	Near Track Dist. (ft)	Speed (mph)	Max Project Vibration Level (VdB)	FTA Vibration Criteria (VdB)	Impact
	Parkway United Church of Christ	Minneapolis	NB	338	25	27	75	--
	Good News Minneapolis Church	Minneapolis	NB	139	25	35	75	--
	True Vine Missionary Baptist Church	Minneapolis	SB	111	45	52	75	--



Option	Location	City	Side of Track	Near Track Dist. (ft)	Speed (mph)	Max Project Vibration Level (VdB)	FTA Vibration Criteria (VdB)	Impact
	KIPP Legacy	Minneapolis	NB	200	35	42	75	--
	St Anne-St Joseph Hien Church	Minneapolis	NB	323	35	39	75	--
	All Nations Seventh-day Adventist Church	Minneapolis	SB	182	20	40	75	--
	PYC Arts & Technology Alternative High School	Minneapolis	SB	53	20	54	75	--
	Capri Theater*	Minneapolis	SB	40	20	60	75	--
	Star Child Development Center llc	Minneapolis	SB	40	20	59	75	--
	Real Believers Faith Center Church	Minneapolis	SB	233	30	38	75	--
One Station	Liberty Community Church	Minneapolis	NB	43	25	57	75	--
	United Deliverance Temple Inc	Minneapolis	NB	259	15	34	75	--
	Sanctuary Covenant Church	Minneapolis	SB	16	30	76	75	Impact
Two Stations	Liberty Community Church	Minneapolis	NB	43	30	57	75	--
	United Deliverance Temple Inc	Minneapolis	NB	259	20	35	75	--
	Sanctuary Covenant Church	Minneapolis	SB	16	20	75	75	--
	Masjid An-Nur	Minneapolis	SB	30	40	71	75	--
	United Faith Pentecostal Church	Minneapolis	SB	50	10	63	75	--
	Metro Schools College Prep	Minneapolis	SB	166	35	56	75	--

Source: CSA, 2023

Note: The vibration levels shown for each location are the highest levels projected for that location. Vibration projections at other receptors within each location will be lower.

*This level represents the non-special use spaces in the Capri Theater.

- **Sanctuary Covenant Church:** Sanctuary Covenant Church is predicted to have a vibration impact with the one station design option along 21st Street. This impact is due to the speed of the LRV and proximity of the tracks. This impact is only for the one station design option.

The location of the vibration impacts for the City of Minneapolis along the 21st Ave N and Lyndale Ave alignment option are shown in figures below for one station and two station design options, respectively.

Figure E-10 Project Vibration Impacts in the City of Minneapolis along the 21st Ave N and Lyndale Ave One Station Option

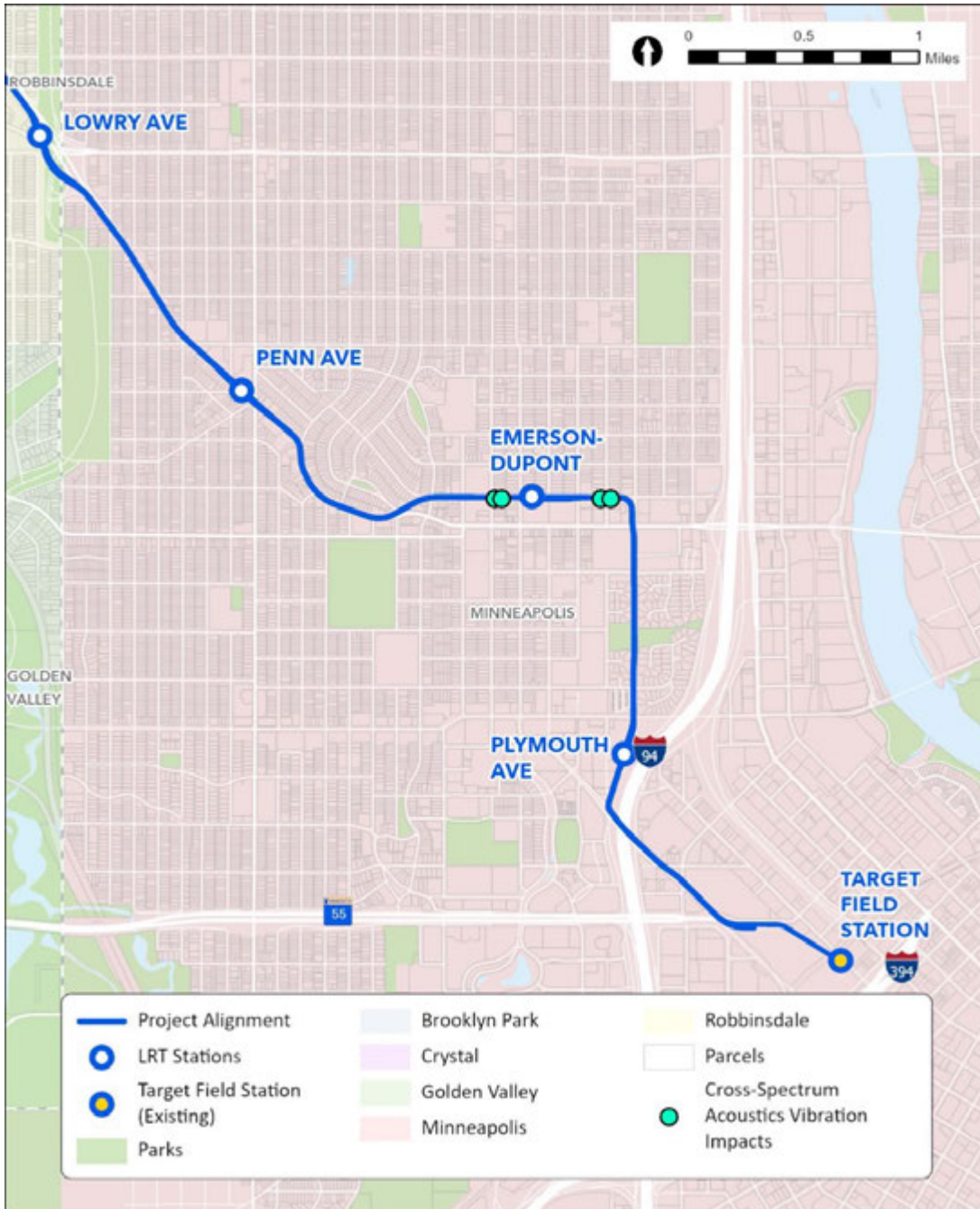


Figure E-11 Project Vibration Impacts in the City of Minneapolis along the 21st Ave N and Lyndale Ave Two Stations Option

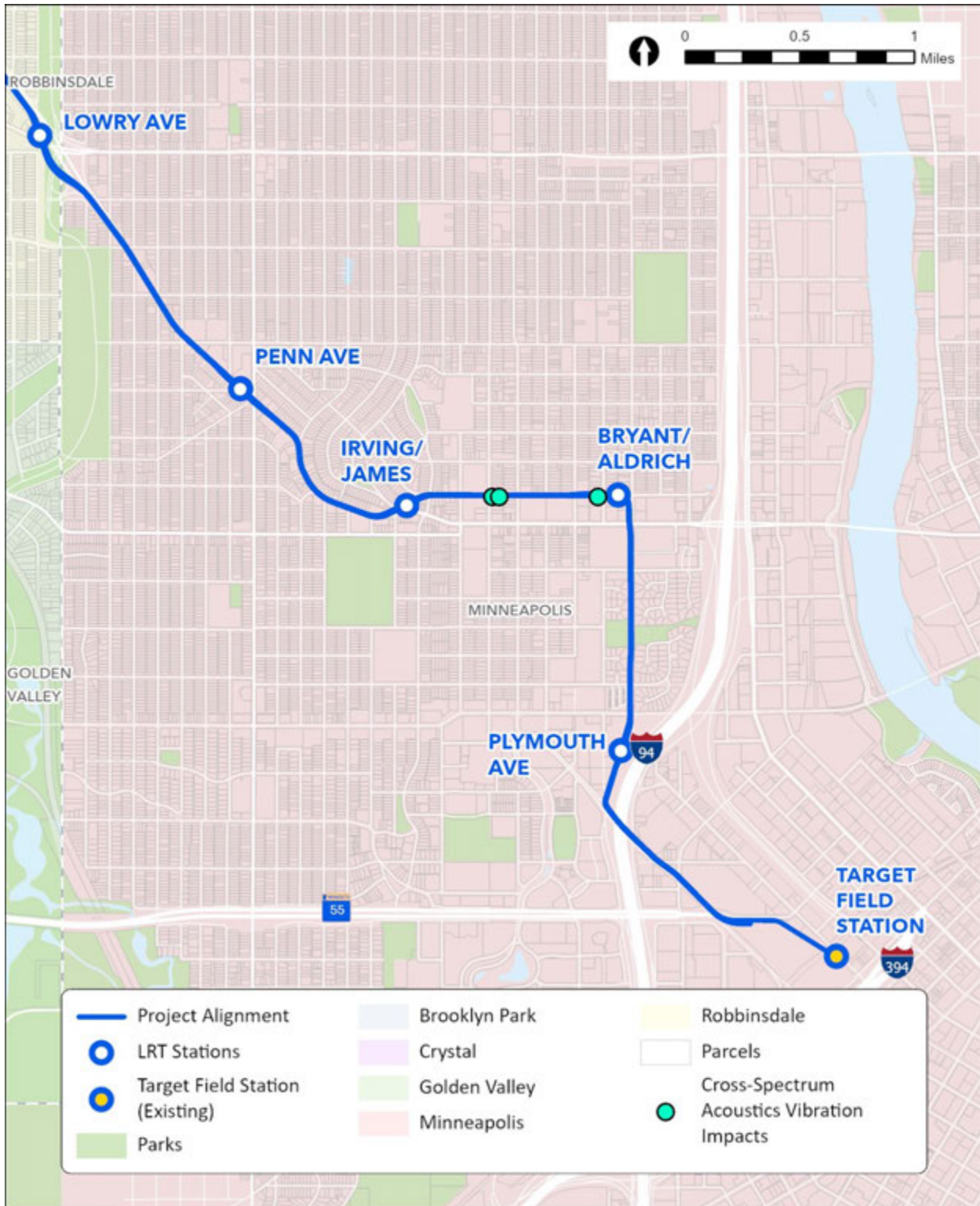




Table F-6 Summary of Vibration Impacts for Residential Land Use in the City of Minneapolis (W Broadway Ave to East of I-94)

Option	Location	City	Side of Track	Near Track Dist. (ft)	Speed (mph)	Max Project Vibration Level (VdB)	FTA Vibration Criteria (VdB)	Number of Impacts
	N 26th Ave to N Lowry Ave	Minneapolis	NB	43	45	60	72	0
	N 26th Ave to N Lowry Ave	Minneapolis	SB	54	45	66	72	0
	N Knox Ave to N 26th Ave	Minneapolis	NB	41	20	60	72	0
	N Knox Ave to N 26th Ave	Minneapolis	SB	36	20	62	72	0
One Station	N Emerson Ave to N Knox Ave	Minneapolis	NB	157	23	38	72	0
	N Emerson Ave to N Knox Ave	Minneapolis	SB	128	27	40	72	0
	Lyndale Ave to N Emerson Ave	Minneapolis	NB	*	*	*	*	*
	Lyndale Ave to N Emerson Ave	Minneapolis	SB	215	20	36	72	0
Two Stations	N Emerson Ave to N Knox Ave	Minneapolis	NB	131	20	39	72	0
	N Emerson Ave to N Knox Ave	Minneapolis	SB	99	23	43	72	0
	Lyndale Ave to N Emerson Ave	Minneapolis	NB	*	*	*	*	*
	Lyndale Ave to N Emerson Ave	Minneapolis	SB	215	20	36	72	0
	Plymouth Ave N to N 18th Ave	Minneapolis	NB	89	50	59	72	0
	Plymouth Ave N to N 18th Ave	Minneapolis	SB	63	50	62	72	0



Option	Location	City	Side of Track	Near Track Dist. (ft)	Speed (mph)	Max Project Vibration Level (VdB)	FTA Vibration Criteria (VdB)	Number of Impacts
	N 8th Ave to Plymouth Ave N	Minneapolis	NB	*	*	*	*	*
	N 8th Ave to Plymouth Ave N	Minneapolis	SB	127	10	51	72	0
	Target Field Station to N 8th Ave	Minneapolis	NB	284	25	43	72	0
	Target Field Station to N 8th Ave	Minneapolis	SB	*	*	*	*	*

Source: CSA, 2023

Note: The vibration levels shown for each location are the highest levels projected for that location. Vibration projections at other receptors within each location will be lower.

*There are no vibration sensitive receivers at this location.

Table F-7 Summary of Vibration Impacts for Institutional Land Use in the City of Minneapolis (W Broadway Ave to East of I-94)

Option	Location	City	Side of Track	Near Track Dist. (ft)	Speed (mph)	Max Project Vibration Level (VdB)	FTA Vibration Criteria (VdB)	Impacts
	Parkway United Church of Christ	Minneapolis	NB	338	25	27	75	--
	Good News Minneapolis Church	Minneapolis	NB	139	25	35	75	--
	True Vine Missionary Baptist Church	Minneapolis	SB	111	45	52	75	--
	KIPP Legacy	Minneapolis	NB	200	35	42	75	--
	St Anne-St Joseph Hien Church	Minneapolis	NB	323	35	39	75	--
	All Nations Seventh-day Adventist Church	Minneapolis	SB	182	20	40	75	--



Option	Location	City	Side of Track	Near Track Dist. (ft)	Speed (mph)	Max Project Vibration Level (VdB)	FTA Vibration Criteria (VdB)	Impacts
	PYC Arts & Technology Alternative High School	Minneapolis	SB	53	20	54	75	--
	Capri Theater*	Minneapolis	SB	40	20	60	75	--
	Star Child Development Center IIc	Minneapolis	SB	40	20	59	75	--
	St. Andrews Episcopal Church	Minneapolis	SB	326	23	34	75	--
One Station	Shiloh Temple International Ministries	Minneapolis	SB	53	30	54	75	--
	Real Believers Faith Center Church	Minneapolis	NB	129	26	40	75	--
Two Stations	Shiloh Temple International Ministries	Minneapolis	SB	44	30	57	75	--
	Real Believers Faith Center Church	Minneapolis	NB	138	26	39	75	--
	Episcopal Church in Minnesota	Minneapolis	SB	48	20	56	75	--
	Full Proof Ministry COGIC	Minneapolis	SB	343	20	33	75	--
	Sanctuary Covenant Church	Minneapolis	NB	197	30	38	75	--
	Masjid An-Nur	Minneapolis	SB	34	50	70	75	--
	United Faith Pentecostal Church	Minneapolis	SB	50	20	63	75	--
	Metro Schools College Prep	Minneapolis	SB	166	25	54	75	--

Source: CSA, 2023

Note: The vibration levels shown for each location are the highest levels projected for that location. Vibration projections at other receptors within each location will be lower.

*This level represents the non-special use spaces in the Capri Theater.

Table F-8 Summary of Vibration Impacts for Residential Land Use in the City of Minneapolis (21st Ave N to East of I-94)

Location	City	Side of Track	Near Track Dist. (ft)	Speed (mph)	Max Project Vibration Level (VdB)	FTA Vibration Criteria (VdB)	Number of Impacts
N 26th Ave to N Lowry Ave	Minneapolis	NB	43	45	60	72	0
N 26th Ave to N Lowry Ave	Minneapolis	SB	54	45	66	72	0
N Knox Ave to N 26th Ave	Minneapolis	NB	41	20	60	72	0
N Knox Ave to N 26th Ave	Minneapolis	SB	36	20	62	72	0
N Emerson Ave to N Knox Ave	Minneapolis	NB	34	15	61	72	0
N Emerson Ave to N Knox Ave	Minneapolis	SB	21	35	71	72	0
Lyndale Ave to N Emerson Ave	Minneapolis	NB	33	35	63	72	0
Lyndale Ave to N Emerson Ave	Minneapolis	SB	18	15	73	72	18
I-94 to Lyndale Ave	Minneapolis	NB	51	25	54	72	0
I-94 to Lyndale Ave	Minneapolis	SB	*	*	*	*	*
N 8th Ave to Plymouth Ave N	Minneapolis	NB	29	40	71	72	0
N 8th Ave to Plymouth Ave N	Minneapolis	SB	26	40	73	72	10
Target Field Station to N 8th Ave	Minneapolis	NB	50	15	63	72	0
Target Field Station to N 8th Ave	Minneapolis	SB	*	*	*	*	*

Source: CSA, 2023

Note: The vibration levels shown for each location are the highest levels projected for that location. Vibration projections at other receptors within each location will be lower.

*There are no vibration sensitive receivers at this location.



- **Lyndale Ave to N Emerson Ave (SB):** There are 18 multi-family residences, representing one building, along the southbound side of the Project Alignment between Lyndale Ave and N Emerson Ave predicted to have a vibration impact. These impacts are due to the proximity of the tracks.
- **N 8th Ave to Plymouth Ave (SB):** There are 10 multi-family residences, representing one building, along the southbound side of the Project Alignment between N 8th Ave and Plymouth Ave predicted to have a vibration impact. These impacts are due to the proximity of the tracks.

Table F-9 Summary of Vibration Impacts for Institutional Land Use in the City of Minneapolis (21st Ave N to East of I-94)

Location	City	Side of Track	Near Track Dist. (ft)	Speed (mph)	Max Project Vibration Level (VdB)	FTA Vibration Criteria (VdB)	Impact
Parkway United Church of Christ	Minneapolis	NB	338	25	27	75	--
Good News Minneapolis Church	Minneapolis	NB	139	25	35	75	--
True Vine Missionary Baptist Church	Minneapolis	SB	111	45	52	75	--
KIPP Legacy	Minneapolis	NB	200	35	42	75	--
St Anne-St Joseph Hien Church	Minneapolis	NB	323	35	39	75	--
All Nations Seventh-day Adventist Church	Minneapolis	SB	182	20	40	75	--
PYC Arts & Technology Alternative High School	Minneapolis	SB	53	20	54	75	--
Capri Theater*	Minneapolis	SB	40	20	60	75	--
Star Child Development Center llc	Minneapolis	SB	40	20	59	75	--
Real Believers Faith Center Church	Minneapolis	SB	236	15	33	75	--
Liberty Community Church	Minneapolis	NB	41	35	60	75	--
United Deliverance Temple Inc	Minneapolis	NB	250	15	35	75	--
Sanctuary Covenant Church	Minneapolis	SB	16	15	74	75	--
Faith Tabernacle Gospel Fellowship International	Minneapolis	SB	17	25	74	75	--



Location	City	Side of Track	Near Track Dist. (ft)	Speed (mph)	Max Project Vibration Level (VdB)	FTA Vibration Criteria (VdB)	Impact
Metro Schools College Prep	Minneapolis	SB	166	10	50	75	--
Minnesota International Middle Charter School	Minneapolis	NB	358	40	56	75	--
Lundstrum Performing Arts	Minneapolis	NB	279	40	56	75	--

Source: CSA, 2023

Note: The vibration levels shown for each location are the highest levels projected for that location. Vibration projections at other receptors within each location will be lower.

*This level represents the non-special use spaces in the Capri Theater.

The location of the vibration impacts for the City of Minneapolis along the 21st Ave N and East of I-94 to Washington Ave alignment options are shown below.

Figure E-12 Project Vibration Impacts in the City of Minneapolis along the 21st Ave N and Washington Ave Option

