NASHUA-MANCHESTER 40818 (CAPITOL CORRIDOR)

APPENDIX C
Noise and Vibration Technical Report

Prepared for:

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1. Noise and Vibration

The noise and vibration limits chosen for construction and operation of the Build Alternative satisfy the federal guidelines of the FTA[1] for train and rail facility operations.

1.1 Methods for Evaluation of Impacts

The analysis of noise and vibration impacts used design information for the proposed alignment of the Build Alternative. The FTA Guidance Manual provides guidelines for establishing the extent of the study area to be used for the noise and vibration impact analyses. It also provides guidance for identifying noise-sensitive locations where increased annoyance can occur from train pass-bys. The methodology followed by the noise and vibration analysis is described below.

1.1.1 Noise- and Vibration-Sensitive Receptors

The noise-sensitive receptors for the analysis of the Build Alternative include relevant receptors that are defined by FTA criteria. The number of receptors potentially impacted have been determined using FTA's general assessment guidelines, including comparing existing with future noise levels and rating impacts, along with GIS mapping and aerial photography. The vibration impact assessment uses the FTA general assessment procedure of determining if absolute vibration limits will exceed specified thresholds at vibration-sensitive receptors.

1.1.2 Operations Noise

The descriptors and criteria for assessing noise impacts vary according to land use categories adjacent to the track. For land uses where people live and sleep (e.g., residential neighborhoods, hospitals, and hotels), L_{dn} is the assessment parameter. L_{dn} is the day-night average level, which is the energy-averaged sound level for a continuous 24-hour period with 10 dBA added to all levels occurring between 10:00 pm and 7:00 am (to account for the added sensitivity to sounds during normal sleeping hours). For other land use types where there are noise-sensitive uses (e.g., outdoor concert areas, schools, and libraries), the equivalent (energy-averaged) noise level for an hour of noise sensitivity ($L_{eq(h)}$) that coincides with train activity is the assessment parameter. Table 1 summarizes the three land use categories.

The noise impact criteria used by the FTA are ambient-based; the increase in future noise (future noise levels with the Build Alternative added to existing noise levels) is assessed rather than the noise caused by each passing train. The criteria specify a consideration of future project noise with existing levels because this analysis with an existing condition considers annoyance due to the change in the noise environment caused by the Build Alternative. Figure 1 shows the FTA noise impact criteria for human annoyance. Depending on the magnitude of the cumulative noise increases, FTA categorizes impacts as (1) no impact; (2) moderate impact; or (3) severe impact. Severe impact is where a significant percentage of people would be highly annoyed by the project's noise. Moderate impact is where the change in cumulative noise levels would be noticeable to most people, but may not be sufficient to generate strong, adverse reactions.

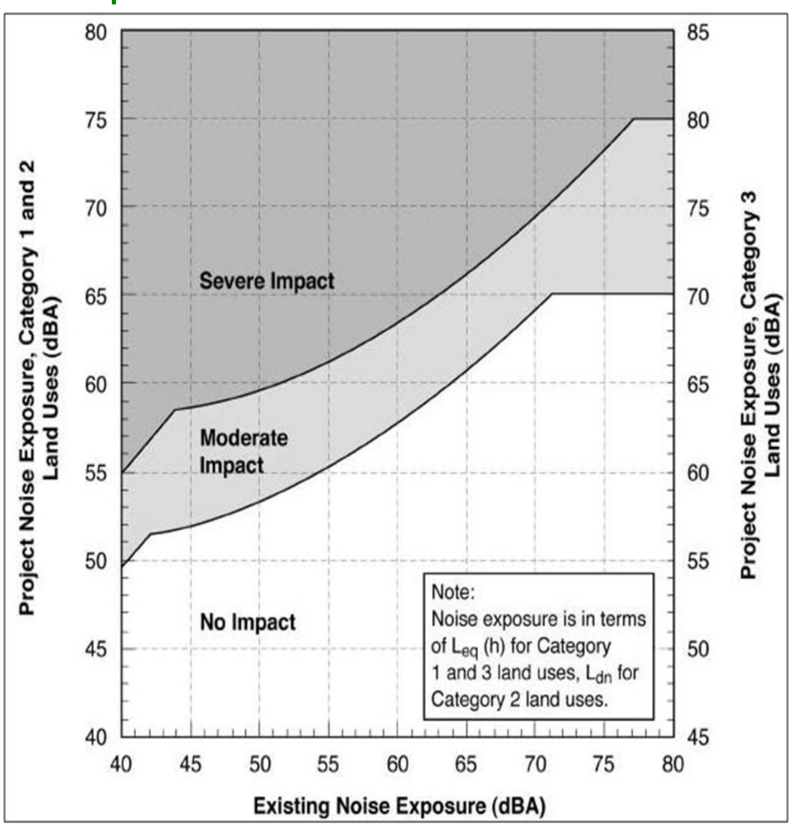
[1] FTA. *Transit Noise and Vibration Impact Assessment Manual*. FTA Report Number 0123, September 2018.

Table 1. FTA Noise-Sensitive Land Uses

Land Use Category	Noise Metric, dBA	Land Use Category
1	Outdoor $L_{eq(h)}$[(a)]	Tracts of land where quiet is an essential element in their intended purpose. This category includes lands set aside for serenity and quiet, such as outdoor amphitheaters, concert pavilions, and National Historic Landmarks with significant outdoor use.
2	Outdoor L_{dn}	Residences and buildings where people normally sleep. This category includes homes and hospitals, where nighttime sensitivity to noise is of utmost importance.
3	Outdoor $L_{eq(h)}$[(a)]	Institutional land uses with primarily daytime and evening use. This category includes schools, libraries, and churches, where it is important to avoid interference with such activities as speech, meditation, and concentration. Buildings with interior spaces where quiet is important, such as medical offices, conference rooms, recording studios, and concert halls fall into this category, as well as places for meditation or study associated with cemeteries, monuments, and museums. Certain historical sites, parks, and recreational facilities are also included.

Source: FTA 2018
(a)L_{eq} for the noisiest hour of transit-related activity during hours of noise sensitivity.

Figure 1: FTA Noise Impact Criteria



Source: FTA 2018

In addition to monitored existing background noise levels, the following assumptions and methodologies were used to establish existing noise levels at the alignment of the Build Alternative:

- Freight Train Noise – Calculations based on the FTA Guidance Manual for train operations including warning horns, and the following assumptions, with the freight operation condition based on current year (2021) operations:
  - Operations – 3 through-freight trains per day (2 trains during daytime hours [7:00 am to 10:00 pm] and 1 train during nighttime hours [10:00 pm to 7:00 am]).
  - Speeds – 25 to 40 mph, depending on segment.
  - Length – a maximum (depending on segment) of 2 locomotives and 130 freight cars per train (1 train each during daytime and nighttime hours) and 1 locomotive and 30 freight cars per train (1 train during daytime hours); length of each locomotive of 89 feet; length of each freight car of 79 feet; total train set length of approximately 10,448 feet for 2 locomotives and 130 freight cars and 2,460 feet for 1 locomotive and 30 freight cars.
  - Horns – ¼-mile from each crossing affected by warning horns.
- Freight Train Crossing Signal Noise – The crossing signal noise would be more than 10 dBA less than the warning horn noise at the same receiver. According to the FTA guidelines, horns generate sound exposure levels of 110 dBA at 50 feet while a 2-minute crossing signal generates a sound exposure level of 94 dBA at 50 feet. Therefore, the crossing signal noise was considered negligible and it was not included in the existing noise calculation.

In addition to the foregoing, the following assumptions were used for the operational noise assessment for the inclusion of passenger train service, based on the design characteristics of the Build Alternative:

- Passenger Train Noise – Calculations based on the FTA Guidance Manual for train operations including warning horns, and the following assumptions:
  - Operations –16 roundtrips per day between Lowell, MA and Manchester, NH.
  - Speeds – 79 mph maximum (worst-case assumption; this should be reanalyzed during the final design process since curves in the alignment will cause these speeds to be reduced in some areas).
  - Length – 1 locomotive per train; length of each locomotive of 89 feet; 9 passenger cars per train; length of each passenger car of 85 feet; total train set length of approximately 854 feet.
  - Horns – ¼-mile from each grade-crossing affected by warning horns, with 22 grade-crossings along the corridor.
- Crossing Signal Noise – For the reasons referenced above, the crossing signal noise would be negligible when compared to warning horn noise. Therefore, it was excluded from the noise calculations.
- Crossover Noise – The noise level would be greater with a train passing by at full speed compared with that for a train slowing down and traversing crossovers. Also, crossovers will be used infrequently by the passenger trains. Therefore, the worst-case scenario was taken into account and crossover noise was excluded from the noise calculations.

Further, it was assumed that the rail track will be a combination of ballast and ties with continuous welded rail, consistent with the assumptions in the FTA Guidance Manual, and that there will be no change to the location of any of the existing at-grade-crossings and, therefore, no change to locations where the freight and passenger trains will sound their horns.

These assumptions result in maximum predicted levels of 67 dBA L_{dn} at 50 feet between Lowell and Manchester for the passenger trains without horns.

1.1.3 Operations Vibration

Ground-borne vibration impacts from new rail operations inside vibration-sensitive buildings are defined by the vibration velocity level, expressed in terms of VdB, and the number of vibration events per day of the same kind of source. Table 2 summarizes vibration sensitivity in terms of the three land use categories and the criteria for acceptable ground-borne vibrations and acceptable ground-borne noise. Ground-borne noise is a low-frequency rumbling sound inside buildings, caused by vibrations of floors, walls, and ceilings. Ground-borne noise is generally not a problem for buildings near railroad tracks at- or above-grade, because the airborne noise from trains typically overshadows the effects of ground-borne noise. Ground-borne noise becomes an issue in cases where airborne noise cannot be heard, such as for buildings near tunnels.

The FTA provides guidelines to assess the human response to different levels of ground-borne vibration, as shown in Table 2. These levels represent the maximum vibration level of an individual train pass-by. A vibration event occurs each time a train passes the building or property and causes discernible vibration. "Frequent Events" are more than 70 vibration events per day, and "Infrequent Events" are fewer than 30 vibration events per day.

Table 2 includes separate FTA criteria for ground-borne noise (the "rumble" that radiates from the motion of room surfaces in buildings from ground-borne vibration). Although the criteria are expressed in dBA, which emphasizes the more audible middle and high frequencies, the criteria are significantly lower than airborne noise criteria to account for the annoying low-frequency character of ground-borne noise.

Table 2. FTA Ground-Borne Vibration and Ground-Borne Noise Operations Impact Criteria

Land Use Category	Ground-Borne Vibration Impact Criteria (VdB relative to 1 µin/sec)			Ground-Borne Noise Impact Criteria (dB re 20 µPa)		
	Frequent Events[a]	Occasional Events	Infrequent Events[b]	Frequent Events[a]	Occasional Events	Infrequent Events[b]
Category 1: Buildings where vibration would interfere with interior operations	65 VdB[c]	65 VdB[c]	65 VdB[c]	NA[d]	NA[d]	NA[d]
Category 2: Residences and buildings where people normally sleep	72 VdB	75 VdB	80 VdB	35 dBA	38 dBA	43 dBA
Category 3: Institutional land uses with primarily daytime use	75 VdB	78 VdB	83 VdB	40 dBA	43 dBA	48 dBA

Source: FTA 2018

(a) Frequent Events is defined as more than 70 vibration events per day.

(b) Infrequent Events is defined as fewer than 30 vibration events per day.

(c) 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 heating, ventilating and air conditioning systems, and stiffened floors.
(d) Vibration-sensitive equipment is not sensitive to ground-borne noise.
NA = Not Applicable

Because airborne noise often masks ground-borne noise for above-ground (i.e., at-grade or viaduct) trains, ground-borne noise criteria apply primarily to operations in a tunnel, where airborne noise is not a factor. The Project is planned to be at-grade only. As a result, ground-borne noise criteria are not expected to be issues for the Build Alternative. Further, for the Build Alternative, the impact criteria are based on “Occasional Events” since they would exceed 30 train events per day but not exceed 70.

Rail operation noise and vibration levels were projected using current and planned operations on the line, expected growth, and the prediction models provided in the FTA Guidance Manual. Potential noise and vibration impacts were also evaluated in accordance with the FTA Guidance Manual. The assumptions for train operations are listed above.

Predicted Project noise and existing ambient noise levels were compiled for the identified receptors and clusters of receptors. The levels of impact (no impact, moderate impact, or severe impact) were then determined by comparing the existing and projected noise exposure based on the impact criteria shown in Figure 1.

1.1.4 Station and layover facility Noise

A total of four new stations along the Project alignment are planned in the cities of Manchester, Bedford (west of the Manchester airport), and Nashua (Crown Street and South Nashua), plus a layover facility in Manchester. Noise from each station would include train idling, warning horns, and auxiliary equipment. The primary noise concern for the layover facility is train idling in the late evening and early each morning. In addition, the speed of each train would be reduced around the layover facility and each station when compared with that of a train pass-by.

When a train slows down near a station, train pass-by noise levels will be reduced. However, the use of warning horns needs to be considered when trains approach (within ¼-mile of) each grade-crossing or station regardless of the train speed. Other station noise sources are considered negligible in the locations of the proposed stations for Manchester and Nashua, each of which being situated in highly-developed, urban areas with elevated ambient sound levels already existing, as well as in Bedford, NH, since that station is near the Manchester-Boston Regional Airport. Such other noise sources are less than horn noise at all locations by more than 10 dBA, in accordance with reference source noise levels in the FTA manual.

1.1.5 Traffic Noise

The criteria for highway noise impacts (relevant to the extent the Build Alternative causes changes in traffic patterns) are from the FHWA Procedures for Abatement of Highway Traffic Noise and Construction Noise, as provided in 23 CFR Part 772. A Type 1 project is defined in 23 CFR Part 772 as a proposed federal or federal-aid highway project for the construction of a highway at a new location or the physical alteration of an existing highway that significantly changes either the horizontal or vertical alignment or increases the number of through-traffic lanes. FHWA requires identifying highway traffic noise impacts and examining potential abatement measures for all Type 1 projects receiving federal funds.

The Project is expected to divert many trips from automobile to commuter rail in the I-93 and Route 3 corridors. Access to the commuter rail stations will involve traffic increases to some local roads, mainly around the new stations, without any major changes to the existing roadway designs anticipated, so this would not be classified as a Type 1 project. Therefore, the traffic noise criteria for this Build Alternative would be the same as the FTA criteria presented in Figure 1.

1.1.6 Construction Noise

Table 3 shows the FTA general assessment criteria for construction noise. The general assessment criteria for construction noise prescribe different levels for daytime and nighttime construction. Daytime is defined as 7:00 am to 10:00 pm and nighttime is defined as 10:00 pm to 7:00 am. For the purpose of this analysis, construction noise impacts and distances to the 90 dBA and 80 dBA 1-hour L_{eq} noise contours were calculated for construction activities, including train corridors and stations. The construction noise limits are normally assessed at the noise-sensitive receiver property line.

Table 3. General Assessment Criteria for Construction Noise

Land Use	One-Hour L_{eq} (dBA)	
	Daytime	Nighttime
Residential	90	80
Commercial	100	100
Industrial	100	100

The construction noise impact assessment used the general assessment methodology described in the FTA Guidance Manual. For this analysis, construction equipment for the rail corridor and stations are based on general assumptions for railroad construction. The construction noise methodology includes the following:

- Noise emissions from equipment expected to be used by contractors for corridor and station construction.
- Typical railroad construction equipment expected to be used by contractors.
- Two noisiest pieces of construction equipment per construction phase for corridor and station construction.
- Relationship of the construction operations to nearby noise-sensitive receptors.

Table 3 above lists FTA criteria for the maximum acceptable 1-hour noise levels (L_{eq}) for daytime and nighttime.

1.1.7 Construction Vibration

The FTA Guidance Manual provides the basis for the construction vibration assessment.

FTA provides construction vibration criteria designed primarily to prevent building damage, and to assess whether vibration might interfere with vibration-sensitive building activities or temporarily annoy building occupants during the construction period. The FTA criteria include two ways to express vibration levels – (1) root-mean-square (RMS) VdB (L_v) for annoyance and activity interference; and (2) peak particle velocity (PPV), which is the maximum instantaneous peak of a vibration signal used for assessments of damage potential.

Table 4 shows the FTA building damage criteria for construction activity; the table lists PPV limits for four building categories. These limits are used to estimate potential problems that should be addressed during final design.

The FTA Guidance Manual provides the methodology for the assessment of construction vibration impact. Typical construction equipment included in the FTA Guidance Manual was used to conduct a quantitative construction vibration assessment where vibration-sensitive receptors were within the study area. Criteria for annoyance (see Table 2) and damage (see Table 4) were applied to determine construction vibration impacts.

Table 4. Construction Vibration Damage Criteria

Building Category	PPV (in/sec)	Approximate L_v (VdB)
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

1.2 Affected Environment

The affected environment follows the Manchester Commuter Rail Alternative from Lowell, MA to Manchester, NH within the existing freight rail corridor, as well as the proposed stations in South Nashua, Bedford-MHT, and Manchester, and the layover facility in Manchester. This region includes areas and communities within Middlesex County in Massachusetts and Hillsborough and Merrimack Counties in New Hampshire. These areas are mixed in terms of rural, residential, commercial, and industrial land use with isolated residential clusters considered to be suburban in nature, except for the downtown urban areas of Lowell, Nashua, and Manchester.

Each proposed station location falls within the urban areas of the cities of Nashua and Manchester. There are no applicable plans or policies for the region as a whole pertaining to noise and vibration within the rail corridor.

1.2.1 Existing Noise Levels

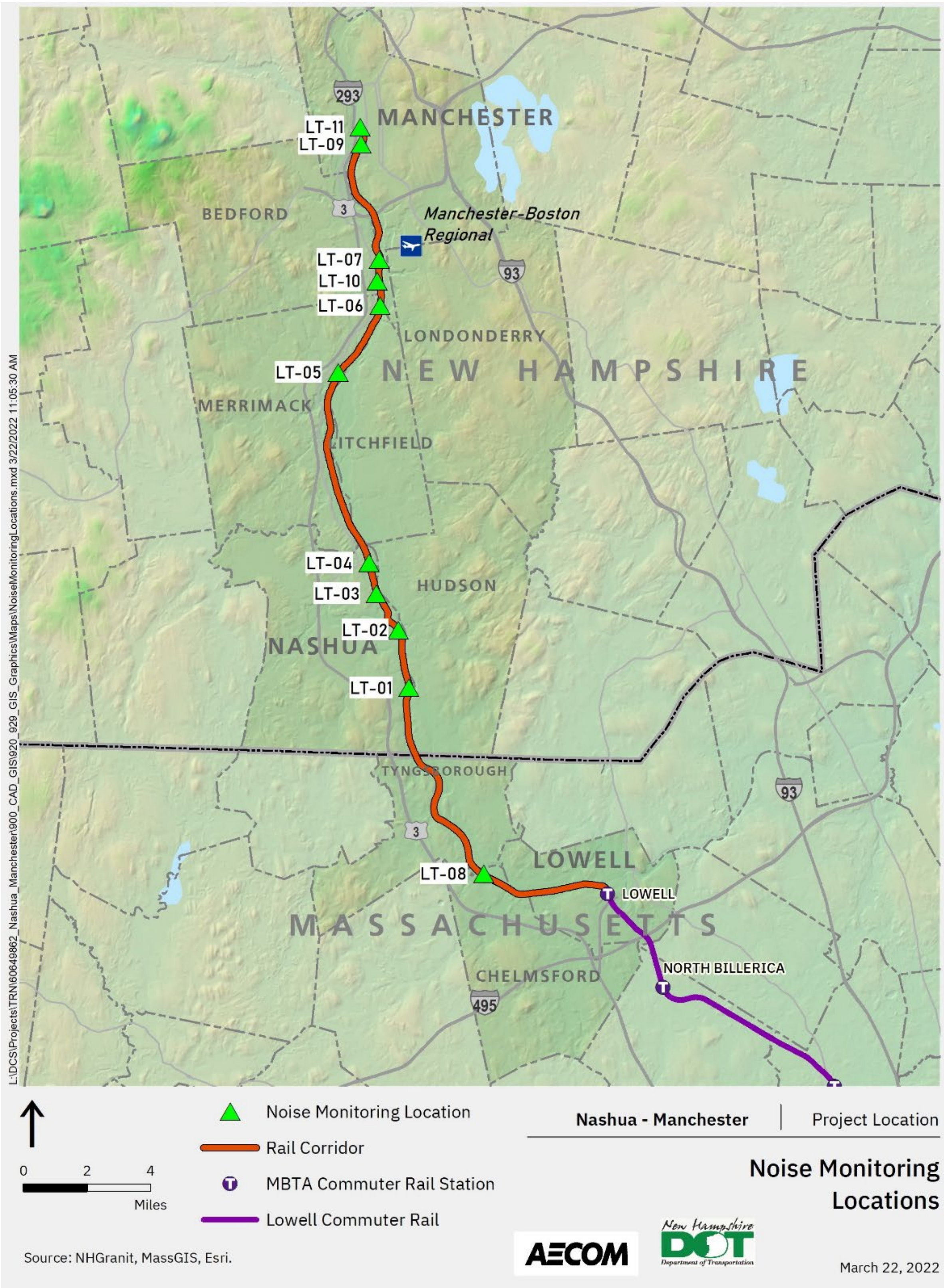
Background noise monitoring was performed at eleven (11) representative residential locations closest to the proposed Nashua-Manchester Rail Line between Lowell, MA and Manchester, NH. Each of the monitoring locations was in a concentrated residential community adjacent to the existing tracks. Roughly 24 hours of continuous data were recorded at each monitoring location.

Monitoring was performed between November 15 and 18, 2021 at the eleven representative locations. Figure 2 shows these locations on a map of the entire study area. Each of these locations provides background sound levels representative of the closest residential communities to the project alignment. These locations were on residential properties adjacent to the rail line, all with a line-of-site to the rail line. These locations are:

1. 44 Elgin Street, Nashua, NH
2. 76 Gillis Street, Nashua, NH
3. 101 Atherton Avenue, Nashua, NH
4. 21 Cassandra Lane, Nashua, NH
5. 23 Caldwell Lane, Merrimack, NH
6. 13 Monadnock Lane, Merrimack, NH
7. 45 Bourne Drive, Bedford, NH
8. Williamsburg II development off Wellman Avenue, behind Unit 897, Chelmsford, MA
9. 124 Riverwalk Way, Manchester, NH
10. 15 Iron Horse Drive, Bedford, NH
11. 6 Payson Street, Manchester, NH

The weather conditions during the entire monitoring period were favorable for the sound level measurements with no precipitation, light winds (less than 10 miles per hour), and temperatures in the mid-20s at night to the mid- to upper-40s during daylight hours, all in degrees Fahrenheit. Four (4) sound monitors were used for these sessions – all Larson Davis Model LxT Class 1 (re ANSI S1.4-2014) sound level meters (serial numbers 6200, 6201, 4926, and 4486). All meters were field-calibrated before and after the sessions with a Larson Davis Model CAL200 calibrator (serial number 1238). All instruments had been factory-calibrated within 12 months of their use and copies of their calibration certificates are in the project files. All measurement procedures were in accordance with standard industry-accepted practices. Photographs of the noise monitoring equipment were taken at each monitoring location. These photographs, showing the sound level meters with respect to the project site and nearby residential properties, along with copies of monitoring data sheets completed by the field technicians, will be included in Appendices to the final noise report for this project.

Figure 2: Project Study Area with Noise Monitoring Locations



Day-night average noise levels (L_{dn}) measured at each of these sites are listed in Table 5.

Table 5. Monitored L_{dn} at Noise Monitoring Locations

Noise Monitoring Location	Monitored L_{dn} (dBA)
1 – Elgin Street, Nashua	57
2 – Gillis Street, Nashua	49
3 – Atherton Avenue, Nashua	47
4 – Cassandra Lane, Nashua	47
5 – Caldwell Lane, Merrimack	63
6 – Monadnock Lane, Merrimack	52
7 – Bourne Drive, Bedford	64
8 – Williamsburg II, Chelmsford	64
9 – Riverwalk Way, Manchester	64
10 – Iron Horse Drive, Bedford	62
11 – Payson Street, Manchester	68

In general, freight trains would generate 67 dBA L_{dn} at 50 feet from the rail tracks without horns. The noise level would drop off at a rate of 4.5 dBA per doubling of distance, per the FTA Guidance Manual. The warning horn noise level would be 74 dBA L_{dn} at 50 feet from the rail centerline within ¼-mile of each grade-crossing.

Warning horns would be the dominant noise sources when receptors are near grade-crossings. When receptors are not near grade-crossings, the dominant noise sources would be passing freight trains, passenger trains, or vehicular traffic.

1.2.2 Existing Vibration Levels

Unlike the FTA noise impact assessment method, train-related vibration impact thresholds are not dependent upon existing ground-borne vibration levels, so the documentation of existing ground-borne vibration levels is not an issue as it is for noise levels.

As a reference, the existing freight trains generate 82 VdB at 50 feet when they operate at their maximum speed of 40 mph, but this is only relevant between Lowell and North Chelmsford, MA. This reference is based on the methodology described in the FTA Guidance Manual. The existing maximum speed for freight trains is 40 mph for a short section only between Lowell and North Chelmsford. North of Lowell, freight trains operate at a maximum speed of 25 mph along the entire existing line.

1.3 Environmental Consequences

1.3.1 Operations Noise Impacts

No noise impacts would result from the No-Build Alternative in that this scenario maintains freight operations within the corridor with no projected and planned annual growth.

Noise impacts were assessed for noise-sensitive land uses based on a consideration of existing (2021) noise levels as measured at representative locations along the corridor, together with calculated future levels per the FTA Guidance Manual, which requires that impacts are considered based on the future project-generated levels resulting from the implementation of the Build Alternative. For this analysis, the preferred alternative being considered is the Manchester Regional Commuter Rail Service (with passenger service between Lowell and Manchester).

Table 6 summarizes potential noise impacts related to the Manchester Regional Rail Service Alternative by county, without mitigation, during the build-out year (2040).

Table 6. Summary of Unmitigated Noise Impact Results Manchester Regional Commuter Rail Service Alternative

County	Number of Severe Impact Parcels				Number of Moderate Impact Parcels			
	Residential Single Family	Residential Multi Family	Institutional	Recreational	Residential Single Family	Residential Multi Family	Institutional	Recreational
Middlesex (MA)	192	259	5	13	570	204	5	12
Hillsborough (NH)	928	139	5	32	3894	1076	24	20

Source: AECOM 2022

Most of the predicted impacts under the Build Alternative take into account the effects of horn soundings from the trains within ¼-mile of each grade-crossing approach. As explained in the Mitigation Section below, however, most of the impacts of such horns could be eliminated through the introduction of stationary wayside horns at affected grade-crossings as a committed mitigation measure for severe and unmitigated impacts under the Build Alternative. Table 7 shows the number of impacts if wayside horns are used.

Table 7. Summary of Noise Impact Results with Wayside Horns Manchester Regional Rail Service Alternative

County	Number of Severe Impact Parcels				Number of Moderate Impact Parcels			
	Residential Single Family	Residential Multi Family	Institutional	Recreational	Residential Single Family	Residential Multi Family	Institutional	Recreational
Middlesex (MA)	6	1	1	10	20	16	0	0
Hillsborough (NH)	47	12	1	18	282	69	3	6

Source: AECOM 2022

1.3.2 Operations Vibration Impacts

A vibration impact general assessment was conducted based on information in the FTA Guidance Manual. The factors considered in a general assessment include train speed, trainset composition, track system/support, track structure, propagation characteristics, coupling-to-building foundation, and type of building/receiver location in a building. Because any impacts would be relatively close to the tracks, a general soil type assumption was used and is appropriate for the level of detail of this analysis.

Since there are planned to be more than 30 (but less than 70) operations in the study area, the impact limits would be 75 VdB for ground-borne vibration and 38 dBA for ground-borne noise for residential buildings (see Table 2). For the operation of the Build Alternative, Table 8 shows the number of predicted vibration impacts without mitigation. As the analysis indicates, the alternative considered within this EA would be expected to result in operational vibration impacts without mitigation measures.

Table 8. Summary of Unmitigated Vibration Impact Results

County	Potential Daytime Impacts		
	Residential Single Family	Residential Multi Family	Institutional
Middlesex (MA)	21	18	1
Hillsborough (NH)	105	8	0

Source: AECOM 2022

1.3.3 Station Noise Impacts

A total of four proposed stations along the Project alignment are planned in the cities of Nashua, Bedford (at the MHT airport), and Manchester, NH as part of the Build Alternative. Each proposed station location is in a highly developed urban area with predicted existing noise levels in the 65 to 70 dBA L_{dn} range at the closest residences. Noise from each station would include train idling, warning horns, and auxiliary equipment. In addition, the speed of each train would be reduced around the stations when compared to that for a train pass-by.

The dominant noise source near each station will be the warning horn. When a train slows down near a station, train pass-by noise will be reduced. However, the warning horn will be used when a train approaches each station regardless of the train speed. There are no noise- or vibration-sensitive parcels within 350 feet of any of the proposed station sites to be impacted by the station noise, except for the Crown Street Station in Nashua, for which there are 13 single-family residential properties and 5 multifamily residential properties under the severe impact category. Therefore, station noise impacts are expected for only the Crown Street Station.

1.3.4 Layover Facility Noise Impacts

Up to two locomotives may be idling simultaneously between roughly 4:00 and 7:00 am at the layover facility in Manchester. Depending on which track the idling trains will be using, the associated noise levels could exceed the impact threshold at the closest residential townhouse buildings along Riverwalk Way to the west of the layover tracks. The severe impact threshold distance is 143 feet, which is situated near the central tracks of the proposed layover facility.

1.3.5 Traffic Noise Impacts

While traffic conditions will change for the roadways around the proposed stations, there are no new major roadways or roadway expansions anticipated for the proposed Build Alternative. Because the proposed Build Alternative is located in busy downtown areas of Nashua, Bedford (at the MHT airport), and Manchester, the existing traffic volumes around the station sites are already high. No traffic noise impacts are expected to be caused by traffic increases around the proposed stations.

1.3.6 Construction Noise Impacts

Based on the construction noise impact criteria described in Table 3, the threshold noise levels would be 90 dBA L_{eq} for daytime hours (7:00 am to 10:00 pm) and 80 dBA L_{eq} for nighttime hours (10:00 pm to 7:00 am) for residential communities. Noise-sensitive receptors within 45 feet of construction activities would be potentially impacted during daytime hours and those within 145 feet would be potentially impacted during nighttime hours. Since construction activities are planned to occur only during daytime hours, nighttime impacts are not being considered. Table 9 summarizes these impacts.

Table 9. Summary of Unmitigated Construction Noise Impact Results

County	Potential Daytime Impacts		
	Residential Single Family	Residential Multi Family	Institutional
Middlesex (MA)	0	0	1
Hillsborough (NH)	0	0	0

Source: AECOM 2022

No noise impacts will result from the implementation of the Build Alternative. Only 1 potential daytime impact has been identified as a result of the analysis conducted pursuant to the FTA guidelines. As explained in the Mitigation Section below, however, any such impact will be addressed through the introduction of committed mitigation measures under the Build Alternative such that no significant impact would result.

1.3.7 Construction Vibration Impacts

During construction, some equipment may cause perceptible ground-borne vibrations, most notably pile driving equipment. If pile driving is used for the Build Alternative, it would only be for certain elements of the Bedford-Manchester Station construction or a small number of culvert replacements. Construction equipment can produce vibration levels at 25 feet that range from 58 VdB for a small bulldozer to 112 VdB for a pile driver. Because there are receptors within the screening distances identified for construction vibration impact criteria in the FTA guidelines, the potential for vibration impacts during construction exists. These potential impacts would mostly depend on the locations of pile driving equipment (if used) associated with station construction. As explained in the Mitigation Section below, such an impact (if any) would be addressed through the introduction of committed mitigation measures under the Build Alternative such that no significant impact would result.

1.4 Mitigation Measures

FTA guidance requires the consideration of mitigation measures for all severe impacts. The FTA 2018 impact assessment guide has guidelines that will be followed during construction. The following mitigation measures will be followed to address impacts that cannot be minimized or avoided by other means.

1.4.1 Operations Noise Mitigation Measures

Warning horns and wheel/rail noise on the trains have been calculated to generate impacts resulting from the Build Alternative, as summarized in Table 6. If these impacts are not mitigated by separate action (such as efforts that may be undertaken independently by others), NHDOT is committed to mitigating these impacts with the installation of stationary wayside horns at the required grade-crossings where severe, unmitigated impacts exist and is coordinating with the MBTA on the proposed mitigation. This measure would not eliminate all severe noise impacts from occurring for the Build Alternative, and therefore there will be other measures taken to eliminate the remaining severe impacts, mainly in the form of providing upgraded exterior windows to provide added soundproofing for the affected residences, at most locations, with the few remaining impacts eliminated with sound walls.

1.4.2 Operations Vibration Mitigation Measures

Vibration impacts have been predicted for a total of 3.6 miles of the proposed alignment. Approximately 1.1 miles of that total would be associated with new track in areas where the former second track is being reinstalled and 2.5 miles would be associated with renewal of the existing single track. Ballast mats installed with new track sections and resilient ties added to existing track sections would eliminate these impacts.

1.4.3 Construction Noise Mitigation Measures

As shown on Table 9, 1 potential daytime impact has been identified as a result of the analysis conducted pursuant to the FTA guidelines. Construction noise will be monitored to verify compliance with the relevant noise limits and appropriate noise restrictions will be incorporated into the plans and specifications of the construction bid documents for the Project to meet the FTA construction noise limits in the most efficient and cost-effective manner.

To meet required noise limits, the following noise control mitigation measures will be implemented, as necessary, for nighttime and daytime:

- Install a temporary construction site sound barrier near a noise source.
- Avoid nighttime construction in residential neighborhoods.
- Locate stationary construction equipment as far as possible from noise-sensitive sites.
- Re-route construction-related truck traffic along roadways that will cause the least disturbance to residents.
- Monitor and maintain equipment to meet noise limits.
- Minimize the use of generators to power equipment.
- Limit the use of public address systems.
- Limit or avoid certain noisy activities during nighttime hours such as above-ground jackhammering and impact pile driving.

To mitigate noise related to pile driving (if needed), the use of an auger to install the piles instead of a pile driver would reduce noise levels substantially. Further, if pile driving is necessary for station construction, the time of day that the activity can occur will be limited.

Through the foregoing proposed measures, the limited and temporary construction noise impacts from the Build Alternative would be significantly reduced, and largely eliminated.

1.4.4 Construction Vibration Mitigation Measures

Because there are receptors within the screening distances identified for construction vibration impact criteria in the FTA guidelines, the potential for vibration impacts during construction exists. However, building damage from construction vibration is only anticipated from impact pile driving at very close distances to buildings. If piling occurs more than 25 to 50 feet from buildings, or if alternative methods such as push piling or auger piling can be used, impacts or damage from construction vibration is not expected to occur. Other sources of construction vibration do not generate high enough vibration levels for impacts or damage to occur. In any event, once a construction scenario has been established, preconstruction surveys will be conducted at locations within 50 feet of piling to document the existing condition of buildings in case damage is reported during or after construction.

In light of the foregoing proposal to engage in alternative methods such as push piling or auger piling if and to the extent that piling must occur within 25 to 50 feet from existing buildings, impacts or damage from construction vibration are not expected to occur from the Build Alternative.

1.4.5 Additional Noise and Vibration Analysis Following Final Design

If final design or final specifications result in changes to the assumptions underlying the noise or vibration analyses, the Project team will reassess noise and/or vibration impacts and consider recommendations for mitigation, and provide supplemental environmental documentation, as required by FTA.

1.5 Summary of Potential Project Impacts and Mitigation

Figure 3 depicts the location of noise and vibration impacts and the proposed mitigation along the corridor, as described in the preceding narrative and further summarized below.

1.5.1 Operations Noise

With the proposed Build Alternative, noise impacts are identified in this EA pursuant to the FTA guidelines. Most of the predicted unmitigated noise impacts are due to the warning horns from the additional number of trains operating in the corridor under the Build Alternative. There are also severe noise impacts predicted from wheel/rail noise at residences close to the tracks. A planned combination of wayside horns and window upgrades would eliminate these impacts at most locations, with the few remaining impacts eliminated with sound walls.

1.5.2 Operations Vibration

Ballast mats are planned for the new track sections identified for impacts and resilient ties would be added to the existing track sections identified for impacts. These measures will eliminate these impacts.

1.5.3 Station Noise

As the above analysis indicates, the Build Alternative would only be expected to result in noise impacts at residences near the platform of the Crown Street Station in Nashua. These impacts would be eliminated by providing upgraded windows to those buildings.

1.5.4 Layover Facility Noise

Severe noise impacts would be eliminated by providing upgraded exterior windows for houses within 143 feet of the layover facility tracks.

1.5.5 Traffic Noise Impacts

As outlined above, traffic noise produced by the Build Alternative is not anticipated to cause significant impacts due to the already existing high ambient noise environment and lack of sensitive receptors in the impact range in the study area of the Build Alternative. There are, therefore, no significant traffic noise impacts anticipated under the Build Alternative.

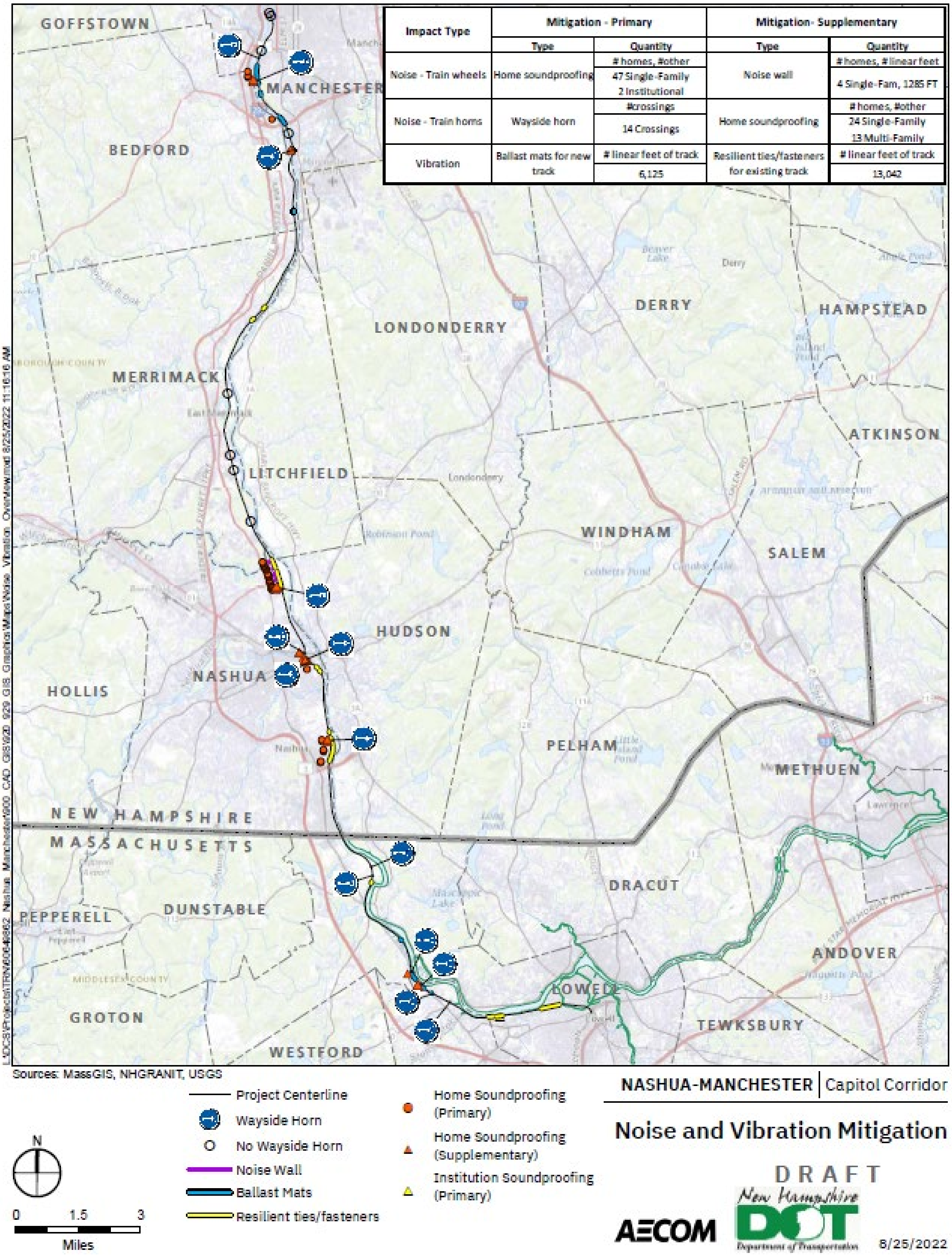
1.5.6 Construction Noise

Because the construction noise mitigation measures found above will be followed for the construction of the Build Alternative, no noise impacts will result from the implementation of the Build Alternative.

1.5.7 Construction Vibration

In light of the foregoing analysis showing that the construction of the Build Alternative is not expected to result in impacts exceeding FTA limits for residential buildings in the study area or for institutional buildings in the Project Area, there are no significant vibration impacts expected from construction of the Build Alternative.

Figure 3: Noise and Vibration Mitigation



Impact Type	Mitigation - Primary		Mitigation- Supplementary	
	Type	Quantity	Type	Quantity
Noise - Train wheels	Home soundproofing	# homes, #other 47 Single-Family 2 Institutional	Noise wall	# homes, # linear feet 4 Single-Fam, 1285 FT
Noise - Train horns	Wayside horn	#crossings 14 Crossings	Home soundproofing	# homes, #other 24 Single-Family 13 Multi-Family
Vibration	Ballast mats for new track	# linear feet of track 6,125	Resilient ties/fasteners for existing track	# linear feet of track 13,042