Appendix G6. Noise and Vibration Technical Report

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Noise and Vibration Technical Report

West Lake Corridor Project

Federal Transit Administration
and
Northern Indiana Commuter
Transportation District

March 2018

NORTHERN INDIANA COMMUTER
TRANSPORTATION DISTRICT

33 East U.S. Highway 12

Chesterton, Indiana 46304

T 219.926.5744 / F 219.929.4438

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Acronyms and Abbreviations

CN	Canadian National Railway
dB	decibel
dBA	A-weighted decibel
DEIS	Draft Environmental Impact Statement
FEIS	Final Environmental Impact Statement
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
GBN	ground-borne noise
GBV	ground-borne vibration
Hz	hertz
I-80	Interstate 80
I-94	Interstate 94
INDOT	Indiana Department of Transportation
KW	kilowatt
Ldn	day-night average sound level
Leq	equivalent average sound level
Leq(h)	1-hour equivalent average sound level
MED	Metra Electric District (system)
Metra	Metra Electric District (district and line)
MP	milepost
mph	miles per hour
MSF	maintenance and storage facility
NICTD	Northern Indiana Commuter Transportation District
Project	West Lake Corridor Project
qty.	quantity
RMS	root mean square
ROW	right-of-way
SEL	single event level
SPL	sound pressure level
SSL	South Shore Line
SWL	sound power level
VdB	vibration decibel

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Executive Summary

The Federal Transit Administration (FTA) and the Northern Indiana Commuter Transportation District (NICTD) are conducting the environmental review process for the West Lake Corridor Project (Project) in Lake County, Indiana, in accordance with the National Environmental Policy Act (NEPA) and other regulatory requirements. The Project would expand commuter rail service through an approximate 9-mile southern extension, creating a new passenger rail service to the municipalities of Dyer, Munster, and Hammond in Lake County, Indiana. This new service would provide rail access to downtown Chicago. The Project would also expand service coverage, improve mobility and accessibility, and stimulate local job creation and economic development opportunities for Lake County.

This *Noise and Vibration Technical Report* has been prepared in support of the Final Environmental Impact Statement (FEIS) for the Project. The objective of this technical report is to evaluate the Project's anticipated effects on noise- and vibration-sensitive land use within the Project Area.

Noise analysis results indicate that the Project, as modeled, would cause severe noise impacts at 8 receptors, all of which are Category 2 (residential) land uses. The severely affected receptors include both single-family and multiple-family residences that represent 107 affected dwelling units. Analysis results also indicate that the Project would cause moderate noise impacts at 125 receptors. These moderate noise impacts would occur at Category 2 (residential) land uses including both single-family and multiple-family residences that represent 376 total affected dwelling units. Of the moderate impacts, 9 would fall in the upper range of moderate noise impact. Proposed noise mitigation would reduce these impacts to lower-range moderate impacts or would eliminate the impacts.

Vibration analysis results indicate that the Project, as modeled, would cause vibration impacts at 3 Category 2 (residential) structures that represent 13 dwelling units at both single-family and multiple-family buildings. Proposed mitigation would eliminate these impacts but must be engineered during final design.

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1 Introduction

This report presents the technical assessment of noise and vibration effects of the West Lake Corridor Project (Project). This noise and vibration impact assessment has been prepared in support of the Final Environmental Impact Statement (FEIS) and in accordance with the National Environmental Policy Act.

This report introduces the Project and summarizes the noise and vibration resources, impacts of the Project, and potential mitigation measures.

1.1 Project Background

The Northern Indiana Commuter Transportation District (NICTD) operates the electrically powered interurban commuter South Shore Line (SSL) between Millennium Station in downtown Chicago, Illinois, and the South Bend International Airport in South Bend, Indiana (a distance of about 90 miles). NICTD operates in concert with the freight carrier Chicago South Shore & South Bend Railroad.

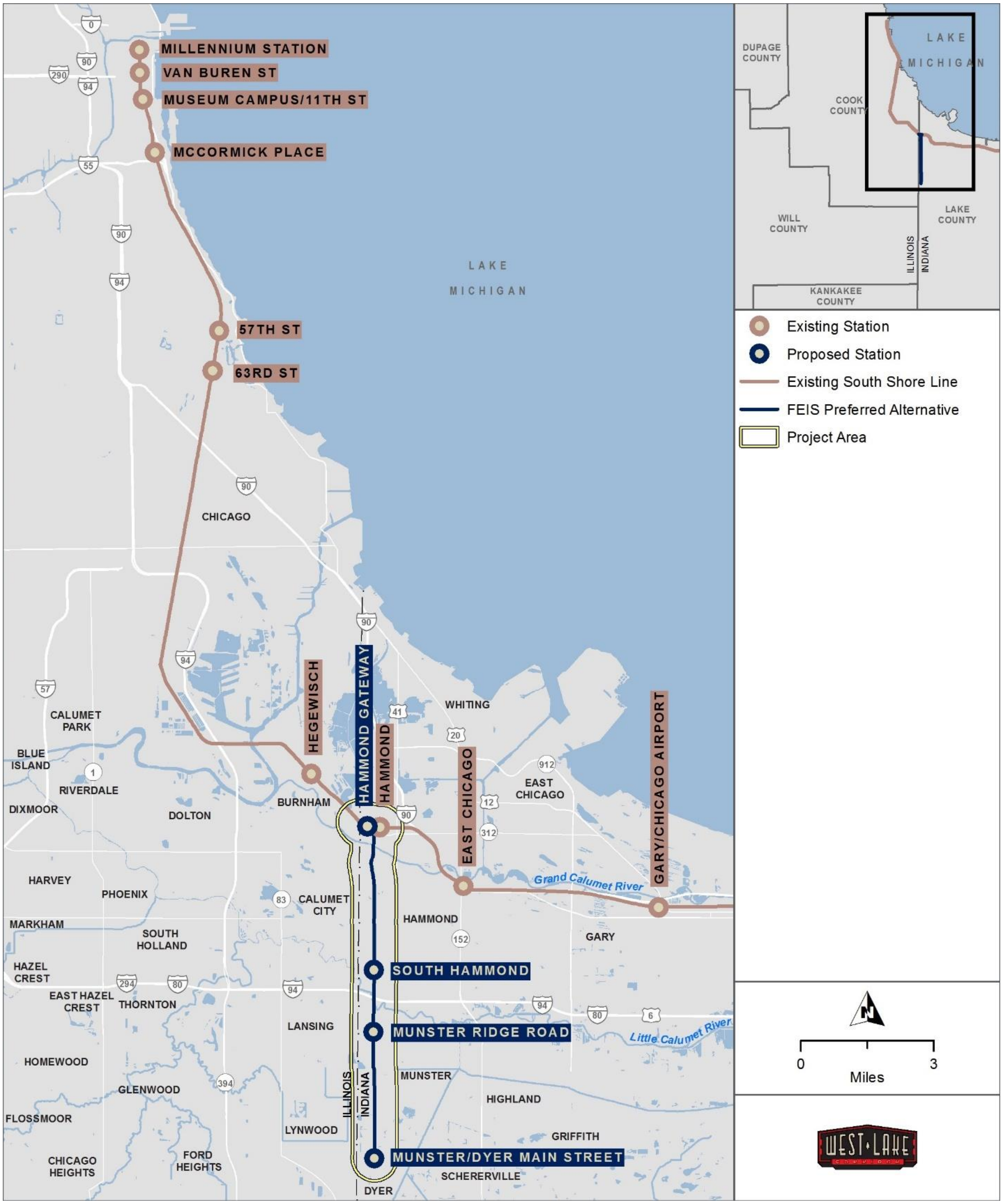
The purpose of the Project is to provide preliminary engineering services to support a New Starts grant administered by the Federal Transit Administration's (FTA) Capital Investment Grant program for a new service from the town of Dyer, Indiana, to the city of Hammond, Indiana. The Project is a proposed 9-mile southern extension tying the existing SSL in Hammond to Dyer.

The new route is proposed to reach high-growth areas in central and western Lake County, Indiana. The Project would expand NICTD's service coverage, improve mobility and accessibility, and stimulate local job creation. Numerous transit-oriented development and economic development opportunities would be created in Lake County by this Project. This Project includes the design of a mainline track, railroad bridge structures, elevated rail structures, drainage culverts, at-grade roadway and pedestrian crossings, contact power and signal design, and construction of four commuter stations.

1.2 Project Description

The environmental review process builds upon NICTD's prior West Lake Corridor studies that examined a broad range of alignments, technologies, and transit modes. The studies concluded that a rail-based service between the Munster/Dyer area and Metra's Millennium Station in downtown Chicago, shown in **Figure 1.2-1**, would best meet the transportation needs of the northwest Indiana area. Thus, NICTD advanced a Preferred Build Alternative (referred to as the FEIS Preferred Alternative) for detailed analysis in the FEIS. The National Environmental Policy Act also requires consideration of a No Build Alternative to provide a basis for comparison to the Build Alternative.

Figure 1.2-1: Regional Setting of West Lake Corridor Project



Source: HDR 2017.

1.2.1 No Build Alternative

The No Build Alternative is defined as the existing transportation system, plus any committed transportation improvements included in the Northwestern Indiana Regional Planning Commission's (NIRPC) *2040 Comprehensive Regional Plan* (NIRPC 2011) and the Chicago Metropolitan Agency for Planning's (CMAP) *GO TO 2040 Comprehensive Regional Plan* (CMAP 2014) through the planning horizon year 2040. It also includes capacity improvements to the existing Metra Electric District's (MED) line and Millennium Station, documented in NICTD's *20-Year Strategic Business Plan* (NICTD and RDA 2014).

1.2.2 Build Alternative

The Project is an approximate 9-mile southern extension of the existing NICTD SSL between the town of Dyer and city of Hammond, Indiana. Traveling north from the southern terminus near Main Street at the Munster–Dyer municipal boundary, the Project would include new track operating at grade on a separate right-of-way (ROW) to be acquired adjacent to the CSX Transportation Monon Subdivision rail line in Dyer and Munster. The Project alignment would be elevated from 45th Street to the Canadian National Railway (CN) Elsdon Subdivision rail line at Maynard Junction. North of the CN line, the Project alignment would return to grade and join with the publicly owned former Monon Railroad corridor in Munster and Hammond, Indiana, and continue north. The Project would relocate the existing Monon Trail pedestrian bridge crossing over the Little Calumet River and build a new rail bridge at the location of the former Monon Railroad Bridge. The Project alignment would cross under Interstate 80/94 (I-80/94) and continue north on the former Monon Railroad corridor to Sibley Street. From Douglas Street north, the Project would be elevated over all streets and rail lines using a combination of retaining walls, elevated structures, and bridges. The Project would terminate just east of the Indiana Harbor Belt at the state line, where it would connect with the SSL. Project trains would operate on the existing MED line for the final 14 miles, terminating at Millennium Station in downtown Chicago.

Four new stations would be constructed along the alignment; Munster/Dyer Main Street, Munster Ridge Road, South Hammond, and Hammond Gateway Stations. Each station would include station platforms, parking facilities, benches, trash receptacles, bicycle racks, and other site furnishings. Shelter buildings would only be located at the Munster/Dyer Main Street and Hammond Gateway Stations.

The Project would include a vehicle maintenance and storage facility (MSF) with a layover yard and traction power substation (TPSS) to power the overhead contact system, located just south of the Hammond Gateway Station, west of Sheffield Avenue. Additional TPSSs would be located at the South Hammond Station parking lot and Munster/Dyer Main Street Station. The TPSS would be enclosed to secure the electrical equipment and controls, with a footprint of about 20 feet by 40 feet.

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2 Regulatory Context

The noise and vibration analyses for the Project were prepared in accordance with FTA's noise and vibration guidance manual, *Transit Noise and Vibration Impact Assessment* (FTA 2006). The manual includes noise and vibration assessment methods and impact thresholds. Operation of the Project would not be subject to state or local noise regulations.

2.1 Noise

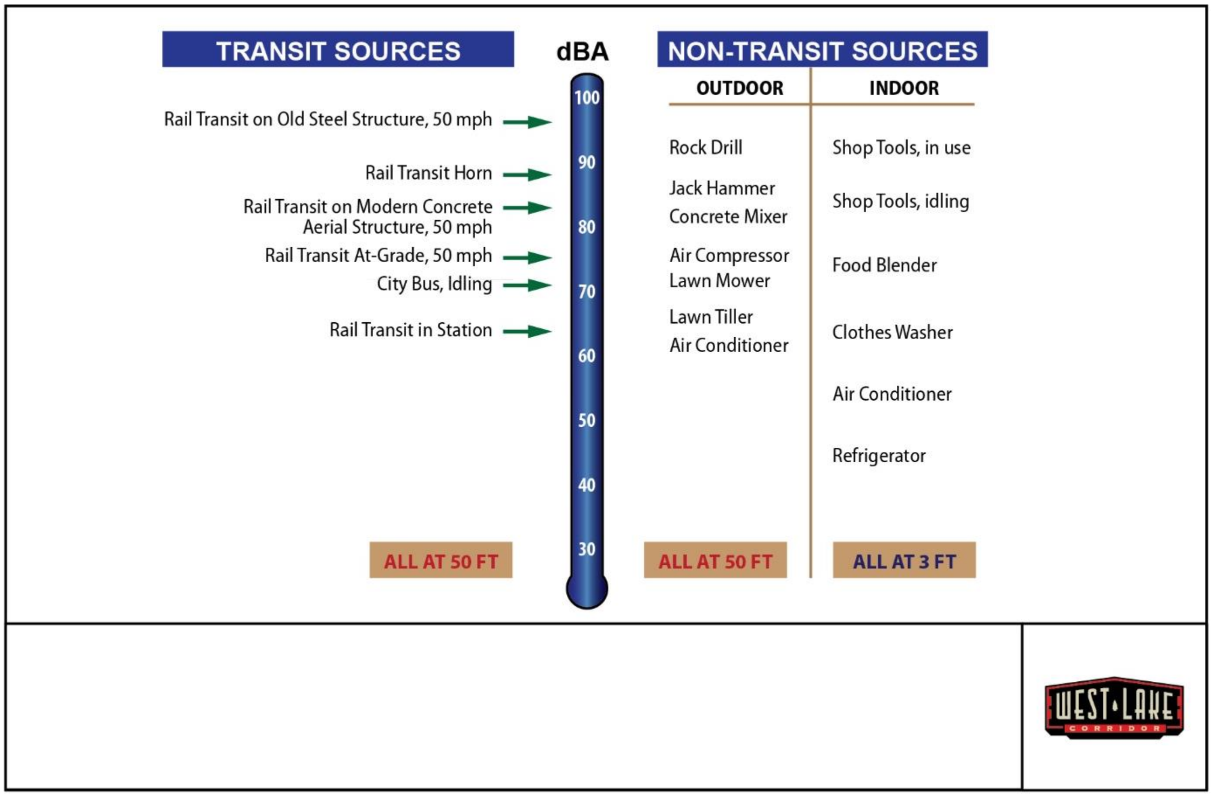
Sound is what we hear when fluctuations in air pressure occur above and below the standard atmospheric pressure, and noise is generally defined as unwanted or undesirable sound. Three variables define characteristics of noise: level (or amplitude), frequency, and time pattern.

Sound pressure level is expressed in decibels (dB). Typical sound levels generally fall between 20 and 120 dB, similar to the range of human hearing. A 3-dB change in sound level is widely considered to be barely noticeable in outdoor environments, and a 10-dB change in sound level is perceived as a doubling (or halving) of the loudness.

The frequency of sound is the rate at which fluctuations in air pressure occur and is expressed in cycles per second, or hertz (Hz). Most sounds consist of a broad range of sound frequencies. The average human ear does not perceive all frequencies equally. Therefore, the A-weighted decibel (dBA) scale was developed to approximate the way the human ear responds to sound levels; it mathematically applies less “weight” to frequencies we do not hear well and applies more weight to frequencies we do hear well. Typical A-weighted noise levels for various types of sound sources are summarized in **Figure 2.1-1**.

The equivalent average sound level (Leq) is often used to describe sound levels that vary over time, typically for a 1-hour period. Using 24 consecutive 1-hour Leq values, it is possible to calculate daily cumulative noise exposure. The day-night average sound level (Ldn) is a 24-hour cumulative A-weighted noise level that includes all noise that occurs throughout a 24-hour period, with a 10-dBA penalty on noise that occurs during nighttime hours (between 10 PM and 7 AM) where sleep interference might be an issue. The 10-dBA penalty makes the Ldn useful when assessing noise in residential areas or other land uses where overnight sleep occurs.

Figure 2.1-1: A-weighted Noise Levels



Source: FTA 2006.

2.1.1 FTA Transit Noise Criteria

The noise impact criteria used for transit projects are presented in Chapter 3 of FTA's guidance manual. The FTA noise impact criteria are based on well-documented studies regarding community response to noise. These thresholds are based on the land use of the noise-sensitive receptor and existing noise level. The 24-hour Ldn is used to assess transit-related noise for residential areas and land uses where overnight sleep occurs (Land Use Category 2), and the 1-hour Leq [Leq(h)] is used to assess impact at locations with daytime and/or evening use (Land Use Category 1 or 3), as shown in **Table 2.1-1**.

Table 2.1-1: Noise Land Use Categories

Land Use Category	Noise Metric (dBA)	Description of Land Use Category
1	Outdoor Leq(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, and such land uses as outdoor amphitheaters and concert pavilions, as well as National Historic Landmarks with significant outdoor use. Also included are recording studios and concert halls.
2	Outdoor Ldn	Residences and buildings where people normally sleep. This category includes homes, hospitals, and hotels where a nighttime sensitivity to noise is assumed to be of utmost importance.
3	Outdoor Leq(h)	Institutional land uses with primarily daytime and evening use. This category includes 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 can also be considered to be in this category. Certain historical sites and parks are also included.

Source: FTA 2006.

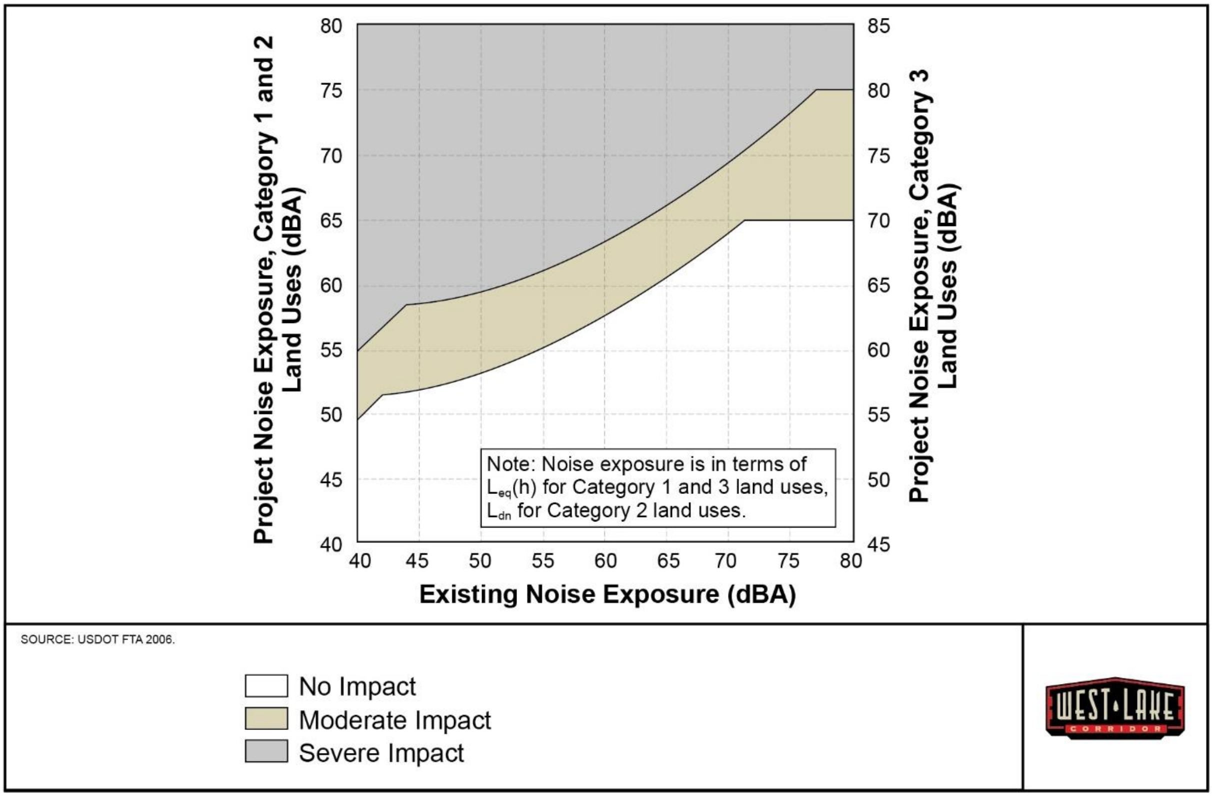
Notes: Outdoor Leq(h) uses the noisiest hour of transit-related activity during hours of noise sensitivity

[a] 1-hour Leq

The FTA noise impact criteria are defined by two curves that allow a varying amount of project noise based on the existing noise level, as shown in **Figure 2.1-2**. Below the lower curve, a project is considered to have no impact because the introduction of the project noise would result in an insignificant increase in noise level and number of people highly annoyed. The two degrees of noise impact defined by the FTA criteria are defined as follows:

- **Severe Impact**: In the severe impact range, a significant percentage of people would be highly annoyed by the project noise. Noise mitigation will normally be specified for severe impact areas unless it is not feasible or reasonable (meaning there is no practical method of mitigating the impact or mitigation measures are cost-prohibitive).
- **Moderate Impact**: In the moderate impact range, changes in the cumulative noise level are noticeable, but may not be sufficient to cause strong, adverse reactions from the community. In this range, other project-specific factors are considered to determine the magnitude of the impact and the need for mitigation. Other factors include the predicted increase over existing noise levels, the types and number of noise-sensitive land uses affected, existing outdoor-indoor sound insulation, and the cost-effectiveness of mitigating noise to more acceptable levels.

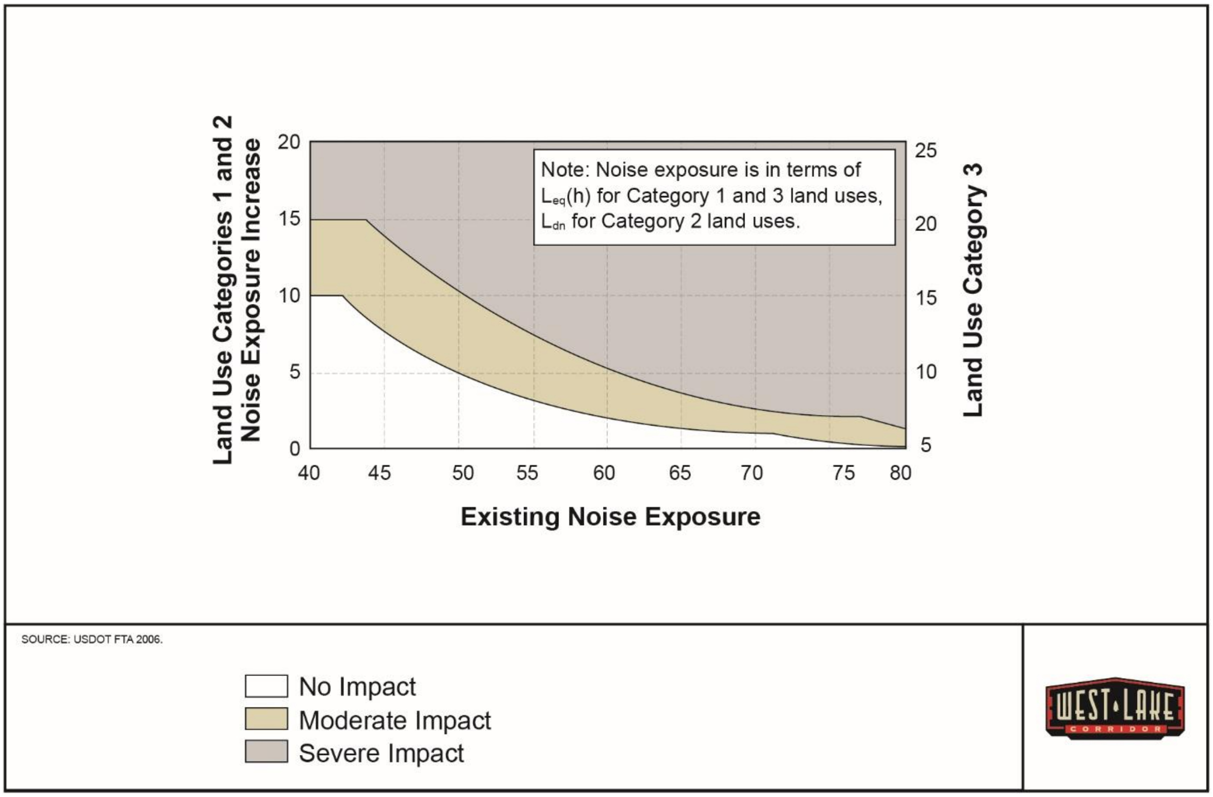
Figure 2.1-2: Noise Impact Criteria



Source: FTA 2006.

Along the existing MED/SSL rail corridor, the existing noise sources would also change as a result of the Project, so the Project noise cannot be defined separately from the existing noise. In this case, the existing noise was calculated and combined with the additional Project noise to assess the increase in cumulative noise exposure. Section 5.2.4 of the Draft Environmental Impact Statement (DEIS) provides the results of this analysis, and the calculated future noise level was assessed for impacts using the cumulative form of the noise criteria shown in **Figure 2.1-3**.

Figure 2.1-3: Cumulative Form of the Noise Criteria



Source: FTA 2006.

2.1.2 FTA Construction Noise Criteria

FTA's guidance manual does not provide standardized criteria for construction noise impacts. However, the manual suggests that the guidelines in **Table 2.1-2** are reasonable criteria for assessment. These construction noise criteria are intended to be compared with the combined 1-hour Leq [Leq(h)] of the two noisiest pieces of construction equipment during 1 hour.

Table 2.1-2: Criteria for Construction Noise Assessment

Land Use	Daytime Noise Limit (dBA)	Nighttime Noise Limit (dBA)
Residential	90	80
Commercial and industrial	100	100

Source: FTA 2006.

Note: Noise limit is the combined Leq(h) of the two noisiest pieces of construction equipment during 1 hour.

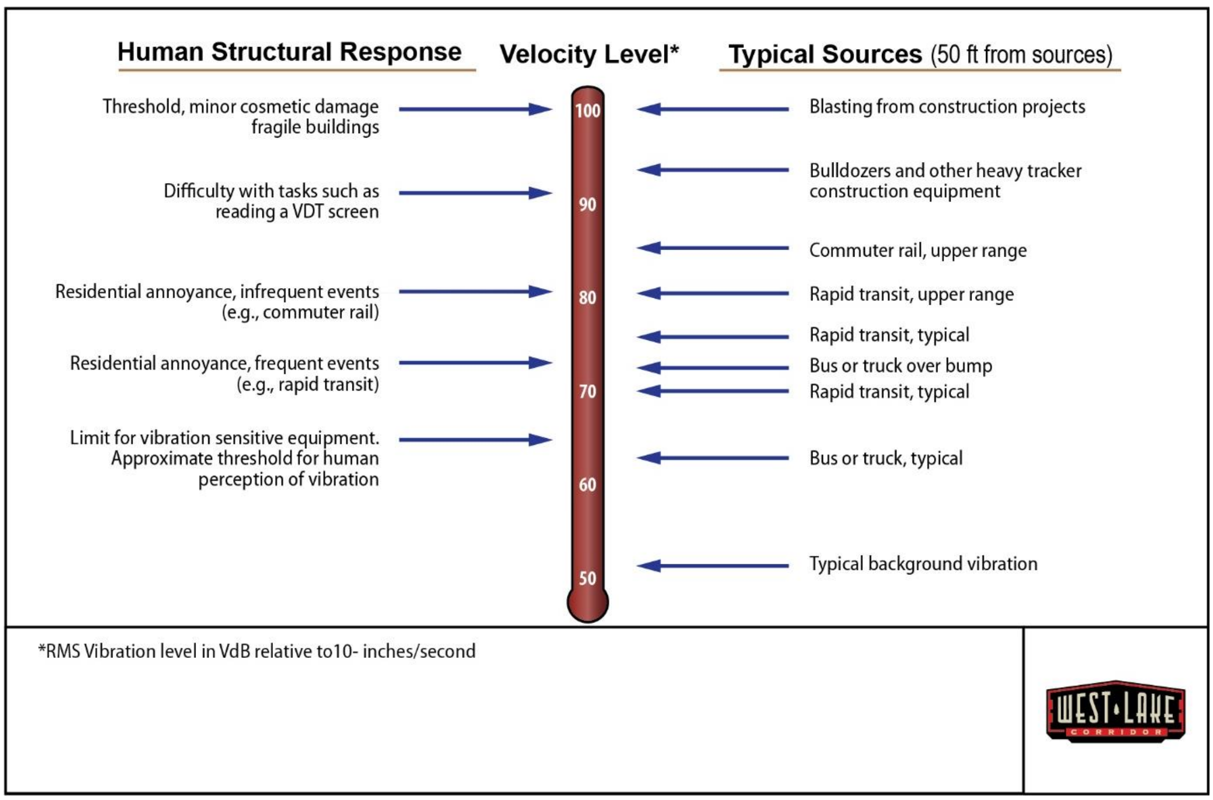
2.2 Vibration

Ground-borne vibration (GBV) consists of rapidly fluctuating motions of the ground transmitted into a receptor (building) from a vibration source, such as transit trains. Vibration velocity level is used to describe vibration levels for transit projects and can also be defined by three variables: level, frequency, and time pattern.

The root mean square (RMS) amplitude of a motion over a 1-second period is commonly used to predict human response to vibration. The vibration velocity level is expressed in terms of vibration decibels (VdB), which is decibels relative to a reference quantity of 1 micro-inch per second. The level of vibration represents how much the ground is moving. The background vibration level in residential areas is usually 50 VdB or lower—well below the threshold of perception for humans, which is around 65 VdB. Annoyance begins to occur for frequent transit events at vibration levels over 70 VdB.

Vibration frequency is also expressed in Hz, and the human response to vibration generally falls between 6 and 200 Hz. Human response to vibration is a function of the average motion over a period of time, such as 1 second. Human response to vibration also roughly correlates to the number of vibration events during the day. The more events that occur, the more sensitive humans are to vibration. **Figure 2.2-1** illustrates common vibration sources and associated human and structural responses to GBV.

Figure 2.2-1: Common Vibration Sources



Source: FTA 2006.

2.2.1 FTA Transit Vibration Criteria

The vibration impact criteria used for transit projects are presented in Chapter 8 of FTA's guidance manual. FTA identifies separate criteria for both GBV and ground-borne noise (GBN). GBN is often masked by airborne noise; therefore, GBN criteria are primarily applied to subway operations in which airborne noise is negligible. FTA differentiates vibration-sensitive land uses into three distinct categories—similar but not identical to the noise-sensitive land use categories, as shown in **Table 2.2-1**. The vibration thresholds vary based on the land use and the frequency of the vibration events, as shown in **Table 2.2-2**.

Table 2.2-1: Vibration Land Use Categories

Land Use Category	Description of Land Use Category
1	**High Vibration Sensitivity**. Buildings where ambient vibration well below levels associated with human annoyance is essential for equipment or operations within the building. Typically includes vibration-sensitive research and manufacturing facilities, hospitals, and university research operations.
2	**Residential**. Includes all residential land uses and any building where people sleep, such as hotels and hospitals.
3	**Institutional**. Schools, churches, other institutions, and quiet offices that do not have vibration-sensitive equipment, but still have the potential for activity interference. Includes certain office buildings, but not all buildings that have office space.

Source: FTA 2006.

Note: Special buildings—such as concert halls, television and recording studios, and theaters—have separate vibration impact thresholds because of the unique sensitivity of such buildings.

Table 2.2-2: Vibration Thresholds, by Land Use and Frequency of Event

Land Use Category	Frequent Events[a]	Occasional Events[b]	Infrequent Events[c]
GBV impact level (VdB re 1 micro-inch/second)			
Category 1[d] (highly sensitive, where vibration would interfere with operations)	65	65	65
Category 2 (where overnight sleep occurs)	72	75	80
Category 3 (institutional with primarily daytime use)	75	78	83
GBN impact level (dBA re 20 micropascals)			
Category 2 (where overnight sleep occurs)	35	38	43
Category 3 (institutional with primarily daytime use)	40	43	48

Source: FTA 2006.

[a] *Frequent events* is defined as more than 70 vibration events of the same source per day. Most rapid transit projects fall in this category.

[b] *Occasional events* is defined as between 30 and 70 vibration events of the same source per day. Most commuter rail 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] The Category 1 criteria limits are based on levels that are acceptable for most moderately sensitive equipment, such as optical microscopes. Vibration-sensitive manufacturing or research would require detailed evaluation to define the acceptable vibration levels. Vibration-sensitive equipment is generally not sensitive to GBN.

The GBV impact criteria are related to causing human annoyance or interfering with use of vibration-sensitive equipment. The basis for evaluating FTA vibration impact thresholds is the highest expected RMS vibration levels for repeated vibration events from the same source. Some buildings, such as concerts halls, television and recording studios, and theaters, can have higher sensitivity to GBV or GBN but do not fit into the categories in **Table 2.2-1**. The land uses with special buildings such as these have separate vibration impact thresholds for both GBV and GBN. Two theaters are in the Project Area, but neither is directly adjacent to the proposed track. **Table 2.2-3** lists the vibration criteria for theater buildings.

Table 2.2-3: Vibration Criteria for Theater Buildings

Type of Building or Room	GBV Impact Criteria (VdB re: 1 micro-inch per second) for Frequent Events	GBV Impact Criteria (VdB re: 1 micro-inch per second) for Occasional or Infrequent Events	GBN Impact Criteria (dBA re: 20 micropascals) for Frequent Events	GBN Impact Criteria (dBA re: 20 micropascals) for Occasional or Infrequent Events
Concert hall	65	65	25	25
TV studio	65	65	25	25
Recording studio	65	65	25	25
Auditorium	72	80	30	38
Theater	72	80	35	43

Source: FTA 2006.

2.2.2 FTA Construction Vibration Criteria

Vibration attributable to construction activities is usually temporary. Thus, the principal concern for construction vibration is potential damage to structures. **Table 2.2-4** lists damage criteria that can be applied to protect sensitive or fragile structures. These criteria can be used to identify locations that should be considered more carefully during the Project's final design phases.

Table 2.2-4: Damage Criteria for Sensitive or Fragile Structures

Building Category	Peak Particle Velocity (inch/second)	RMS Velocity (VdB)
I. Reinforced-concrete, steel, or timber (no plaster)	0.50	102
II. Engineered concrete and masonry (no plaster)	0.30	98
III. Non-engineered timber and masonry buildings	0.20	94
IV. Buildings extremely susceptible to vibration damage	0.12	90

Source: FTA 2006.

Note: RMS velocity is provided as a reference to the general magnitude of vibration, compared with the operational vibration impact thresholds; assumes a crest factor of 4 (12 VdB).

3 Methodology

3.1 Noise

3.1.1 Operation Noise Evaluation Methods

This section describes the methodology used to assess potential noise impacts from operation of the Project. The methodology and modeling assumptions used in this noise analysis were based on the methods and default data presented in FTA's guidance manual, except where measurements were noted. Operational information was provided by NICTD. The various noise modeling assumptions, including noise levels for proposed noise sources and operating characteristics, are described below.

- The Project train would consist of electric multiple unit vehicles consisting of eight rail cars during hours of operation. The noise analysis used the single event level (SEL) for railcars of 82 dBA in FTA's guidance manual.
- The schedule is based on the future Project train schedule, with 4 additional non-service trains added before 7 AM headed southbound before the start of service. This would result in 27 trains during the daytime (7 AM to 10 PM), 8 trains during the nighttime (10 PM to 7 AM), and 2 trains during the peak hour.
- Locations of elevated structures, turnouts, and station platforms were identified based on conceptual engineering drawings provided by the engineering team.
- Turnouts would increase noise levels by up to 6 dB for nearby receptors because of the gap in the track, according to FTA's guidance manual.
- Elevated structures would increase noise levels by up to 4 dB for nearby receptors because of structure-borne noise, according to FTA's guidance manual.
- Train speeds were based on operating speed by track segment and on a speed profile developed for the Project. Operating speeds would range from 25 to 60 miles per hour (mph). The noise from trains was adjusted for speed according to FTA's guidance manual.
- Train horns were not included in this assessment because Quiet Zones are being implemented at all railroad-highway grade crossings along the new alignment.[1] Quiet Zones are segments of a train corridor where the routine sounding of horns can be eliminated because of safety improvements at railroad-highway grade crossings. Safety improvements can vary but often include raised median barriers and four-quadrant gates; these and other improvements consistent with Quiet Zone readiness were included in the design of the Project. Each municipality must apply to the Federal Railroad Administration (FRA) for approval of Quiet Zones; if any of the municipalities fail to apply for a Quiet Zone or FRA declines to approve the Quiet Zone, the Project would have additional noise impacts. Horns are still sounded in Quiet Zones for emergencies.
- Stationary crossing bells were assumed to sound for a duration of 30 seconds at railroad-highway grade crossings. The noise analysis used the SEL given by FTA's guidance manual for crossing bells of 109 dBA at 50 feet and a height of 12 feet.

[1] The requirements for implementing Quiet Zones have been met by the project.

- Onboard warning bells were assumed to sound within 500 feet of Project station platforms for a duration of 23 seconds. The noise analysis used the SEL given by the FTA’s guidance manual for onboard warning bells of 83 dBA at 50 feet and a height of 5 feet.
- Track curves were assumed to have radii large enough to not cause wheel squeal.
- Operations from the Project MSF at Hammond Gateway Station were modeled using the SEL given by FTA’s guidance manual of 118 dBA at 50 feet. The following estimated operations were used:
  - 22 railcar movements during the daytime (7 AM to 10 PM)
  - 18 railcar movements during the nighttime (10 PM to 7 AM)
- Traction power substations were modeled using the SEL given by FTA’s guidance manual of 99 dBA at 50 feet.
- “Park-and-Ride” lots were modeled using the SEL given by FTA’s guidance manual of 101 dBA at 50 feet. Daytime and nighttime volumes were based on morning and evening peak-hour ridership projections.
- Propagation from Project-related noise sources was calculated according to FTA’s guidance manual. This considers the receptor distance from the track, intervening structures and other obstructions, and acoustically “soft” ground to represent the yards and lawns at receptors.

Noise impacts were evaluated along the Project alignment following FTA’s guidance manual and the assumptions listed above.

Refer to the DEIS Section 5.2 for an evaluation of Project noise along the existing MED/SSL.

3.1.2 Construction Noise Evaluation Methods

The construction noise assessment was based on the methodology described in FTA’s guidance manual. The construction noise analysis identified construction equipment commonly used for this type of project. Data from similar projects were used to estimate for internal combustion engines, numbers of equipment to be used during each phase of construction, the rated horsepower for each piece of equipment, and the duration that each piece of equipment is anticipated to operate during construction activities.

To estimate construction noise levels, a sound power level (SWL) was calculated by converting horsepower to kilowatts, then to SWL. A utilization factor representing the percentage of time items would be in use during an hour was developed using FTA’s guidance manual. An adjusted SWL was determined by accounting for the number of pieces of equipment and their utilization factor. The adjusted SWL was then converted to sound pressure level (SPL) at distances of 100, 200, 500, and 1,000 feet. The SPL is expressed as Leq(h) in dBA. The Leq(h) is an energy-based average noise level over a 1-hour period. The resulting noise level from all noise sources during construction (construction equipment) was calculated at fixed distances from the noise source (i.e., bridge or retaining wall locations).

3.1.2.1 Construction Noise Prediction

FTA’s guidance manual provides guidance for construction noise assessment, as explained below.

Construction of the Project would likely result in a temporary increase in noise levels. Pieces of equipment used to move soil and other earthen materials are often the loudest construction noise sources. **Table 3.1-1** presents typical noise levels, by construction phase. This is based on considering the typical equipment used for different phases of railroad construction with typical noise levels, quantities, and estimated uses for each type of equipment. **Table A-1** in **Appendix A** shows the typical equipment, uses, and sound levels for construction equipment by phase. The table also shows the SWL used to determine the SPL at different distances.

Table 3.1-1: Estimated Noise Levels by Construction Phase

Construction Phase	SPL (dBA) at 100 feet	SPL (dBA) at 200 feet	SPL (dBA) at 500 feet	SPL (dBA) at 1,000 feet
Clearing	89	83	75	69
Utility relocation	89	83	75	69
Earthwork	91	85	77	71
Bridge construction for overpasses	90	84	76	70
Retaining walls	89	83	75	69
Signals	84	78	70	64
Track installation	90	84	76	70
Signal work	84	78	70	64
Track and subballast installation	91	85	77	71
Final cut-over and removal of turnouts	85	79	71	65

Source: HDR 2017.

Note: See **Appendix A** for additional information on construction equipment by phase.

The noise level estimates presented in **Table 3.1-1** conservatively overestimate actual expected construction noise levels by assuming that all of the equipment (i.e., all of the dump trucks or all of the pickup trucks) would operate at the same location simultaneously. Typically, construction equipment is spread throughout the construction work zone. Given the linear nature of the Project and the relatively confined width of the railroad ROW, it is reasonable to assume that all pieces of equipment would not operate next to each other in the same (stationary) location for the entirety of 1 hour. In all other cases, the estimates are assumed to be within 3 dBA of likely construction noise levels assuming that the equipment has been properly maintained and the mufflers are in good condition.

FTA does not have noise impact thresholds for construction noise, but suggests reasonable criteria that can be used for assessment purposes. The criteria for residential land uses are an Leq(h) of 90 dBA during the day and 80 dBA during the night; this is a recommendation, not an impact threshold. Construction noise levels shown in **Table 3.1-1** indicate the total combined noise for all equipment types, and construction phases would never exceed the 90-dBA threshold at 200 feet, even using a conservative approach to the evaluation.

3.2 Vibration

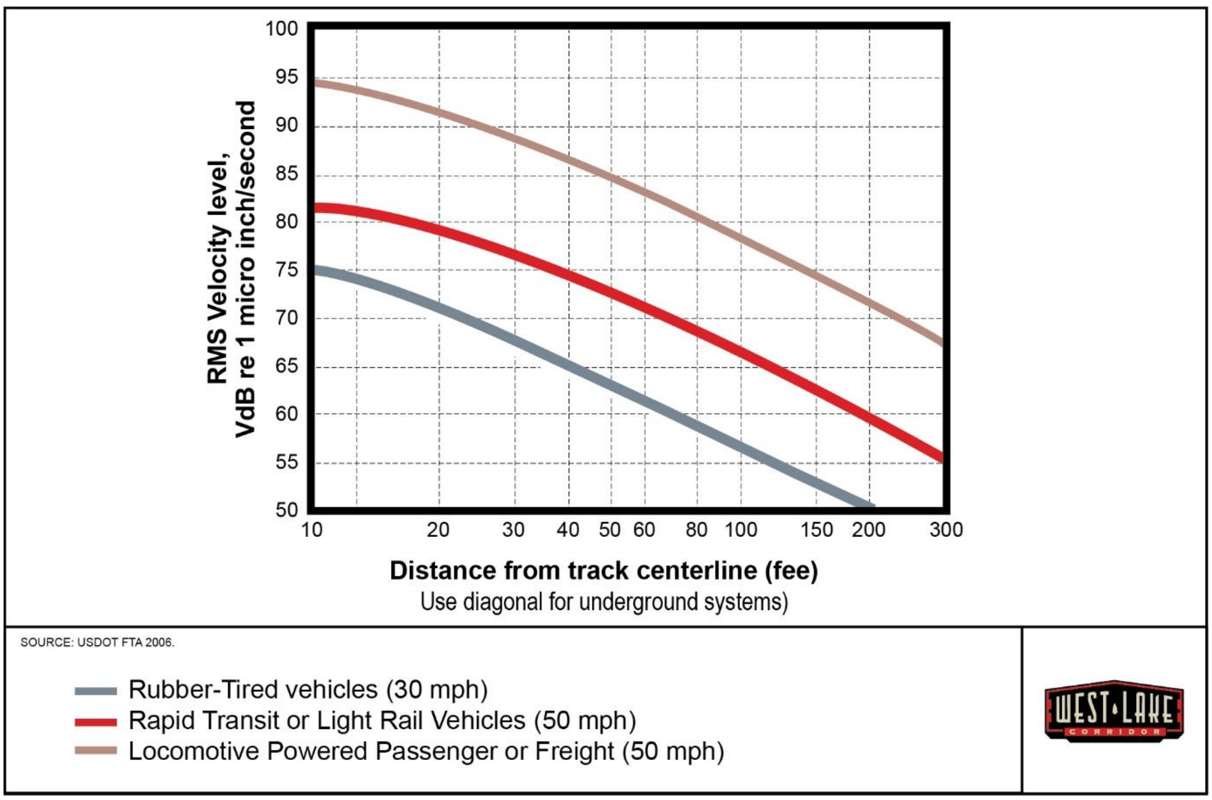
3.2.1 Operation Vibration Evaluation Methods

Projected GBV levels from commuter rail pass-by events were predicted using the default ground-surface vibration curves in FTA's guidance manual. These GBV curves are shown in **Figure 3.2-1**. The commuter rail trains would travel up to a maximum speed of 60 mph. Following FTA guidance, the surface vibration curves in **Figure 3.2-1** were adjusted to reflect local conditions (receptor distances), changes in train speed, and special trackwork such as switches. No adjustments were applied for corrugated rail, wheel flats, or other unmaintained rolling stock. NICTD maintains a rail-grinding and wheel-trueing program to maximize track life and to minimize adverse vibration in the community. Finally, no adjustments were applied for different receptor building construction types (i.e., masonry versus timber).

Vibration impacts were evaluated along the Project alignment following FTA guidance.

Refer to the DEIS Section 5.3 for an evaluation of the vibration from the Project along the existing MED/SSL.

Figure 3.2-1: Surface Vibration Curves



Source: FTA 2006.

3.2.2 Construction Vibration Evaluation Methods

A quantitative construction vibration assessment is generally necessary only when the construction activities have potential for damaging fragile buildings or interfering with equipment or activities that are highly sensitive to GBV. Examples include projects that use blasting, pile driving, pavement breaking, vibratory compaction, and drilling or excavating the ground near sensitive structures. Construction vibration was not evaluated quantitatively because the primary vibration sources or activities of concern are not currently proposed. A brief qualitative assessment is provided, as suggested by FTA's guidance manual.

3.2.2.1 Construction Vibration Prediction

FTA's guidance manual provides guidance for construction vibration assessment, as explained below.

Most construction equipment can cause ground vibration, which rapidly diminishes in strength with distance. Some construction activities have potential for producing higher vibration levels—such as pavement breaking, vibratory compaction, and drilling or excavating the ground—and the highest vibration levels typically result from blasting activities or impact pile driving. The construction activities associated with this Project would not include blasting. Other activities have potential to create temporary, perceptible vibrations when construction activities move very close to a structure, but these impacts would be temporary and would occur only while the construction equipment moves through that location.

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4 Affected Environment

4.1 Noise

This section discusses noise- and vibration-sensitive land uses in the Project Area and presents noise and vibration measurement results.

4.1.1 Noise-sensitive Land Uses

Noise-sensitive land uses in the Project Area include residences, churches, parks, schools, and other institutional land uses:

- **Dyer**: residences, St. Maria Goretti Catholic Church, and Dyer Nursing and Rehabilitation Center
- **South Munster**: residences, West Lakes Park, and Family Christian Center Church
- **North Munster**: residences and Kiwanis Park
- **South Hammond**: residences, churches, Oak Hill Cemetery, the American Conservatory of Music – Chicago Campus, and Beatniks on Conkey Theater
- **North Hammond**: residences, churches, Harrison Park, Henry W. Eggers School, Jefferson Hotel (multiple-family residence), and Towle Company Theater

4.1.2 Existing Noise Measurements

Existing noise was measured in the Project Area from June 6 to June 9, 2017. These measurements were used, along with measurements gathered during the DEIS phase of the Project, to determine existing noise levels throughout the Project Area. **Table 4.1-1** summarizes the existing noise measurements. **Figure 4.1-1** shows the noise measurement locations.

Source reference-level measurements were also conducted adjacent to the existing SSL. Measurements of train pass-by events were gathered along Brunswick Avenue at 50 feet from the existing track centerline. These measurements were used to determine the SEL of the horn on the NICTD vehicle. This measurement location is shown in **Figure 4.1-1** as SEL1.

Table 4.1-1: Existing Noise Measurements

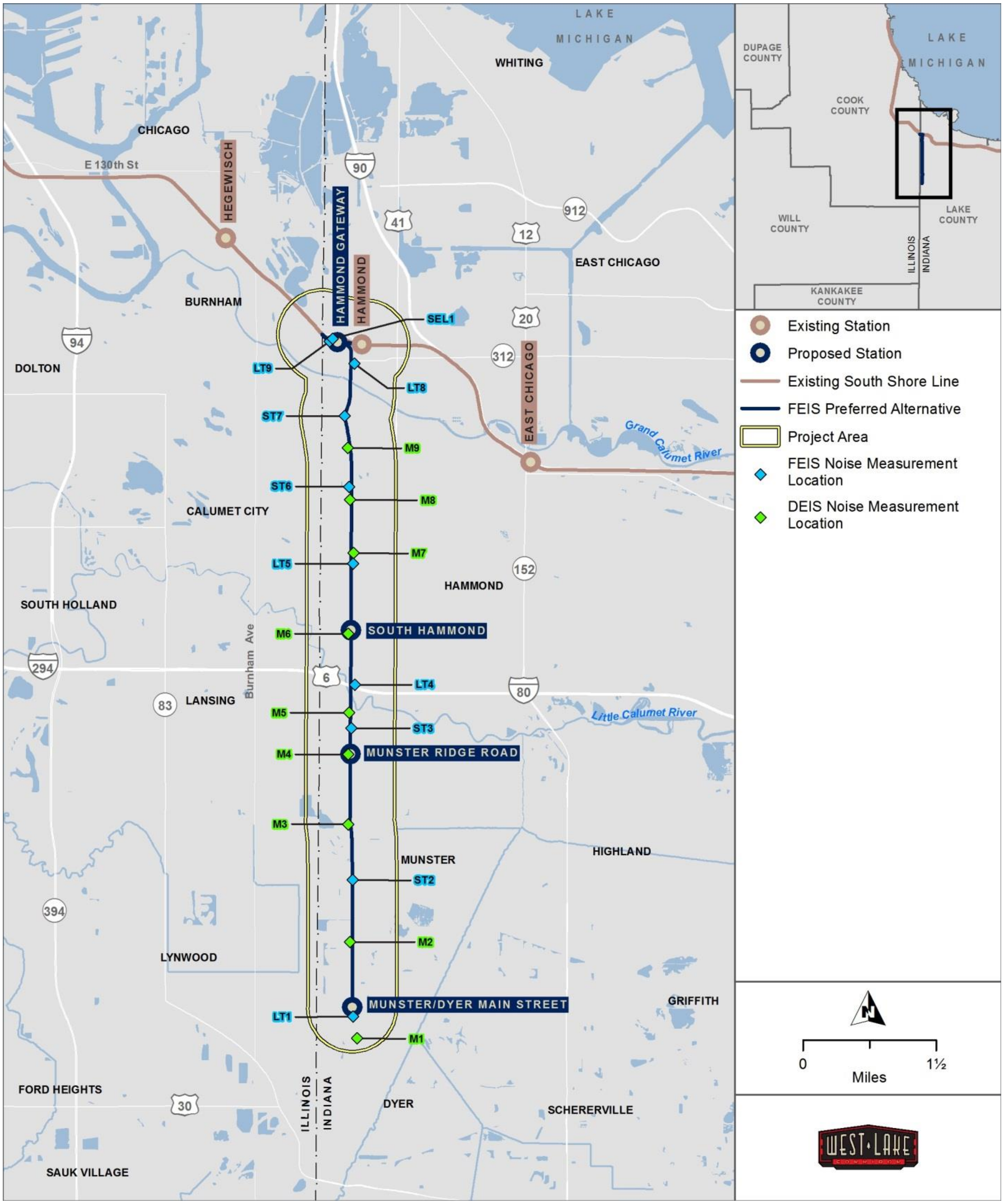
ID	Receptor Descriptor	Measurement Phase	FTA Land Use Category	Peak Hour Noise Level (Leq)	Day-Night Noise Level (Ldn)
M1	St. Maria Goretti Catholic Church, 500 Northgate Drive, Dyer	DEIS	3	56	Not available[a]
M2	Residence, 9901 Whitehall Gardens, Munster	DEIS	2	55	60
M3	Residence, 8827 Manor Avenue, Munster	DEIS	2	52	54
M4	Vacant, Manor Avenue at Ridge Road, Munster	DEIS	2	55	58
M5	Residence, 736 Sunnyside Avenue, Munster	DEIS	2	58	61
M6	Residence, 7136 Lyman Avenue, Hammond	DEIS	2	62	63
M7	Residence, 6411 Blaine Avenue, Hammond	DEIS	2	56	60
M8	Residence, 268 Waltham Street, Hammond	DEIS	2	61	61
M9	Residence, 255 Ogden Street, Hammond	DEIS	2	60	62
LT1	Residence, 542 Sheffield Avenue, Dyer	FEIS	2	50	60
ST2	421 45th Street, Calumet Area Humane Society,[b] Munster	FEIS	Not applicable	64	62
ST3	Residence, 8000 Frederick Avenue, Munster	FEIS	2	47	45
LT4	Residence, 426 176th Court, Hammond	FEIS	2	63	69
LT5	Residence, 408 165th Street, Hammond	FEIS	2	56	60
ST6	Hohman Avenue, Harrison Park, Hammond	FEIS	3	55	53
ST7	415 Sibley Street, Jefferson Hotel, Hammond	FEIS	2	61	59
LT8	Residence, 4715 Sheffield Avenue, Hammond	FEIS	2	59	66
LT9	Residence, 35 Brunswick Street, Hammond	FEIS	2	62	72

Sources: HDR 2017; NICTD 2016.

[a] This measurement was performed in the DEIS phase, and an Ldn was not calculated for this site or used in the noise analysis.

[b] This location is also representative of the Family Christian Center Church on the other side of the street.

Figure 4.1-1: Measurement Locations



Source: HDR 2017.

4.2 Vibration

4.2.1 Vibration-sensitive Land Uses

Vibration-sensitive land uses in the Project Area include residences, churches, schools, and other institutional land uses:

- **Dyer**: residences, St. Maria Goretti Catholic Church, and Dyer Nursing and Rehabilitation Center
- **South Munster**: residences and Family Christian Center Church
- **North Munster**: residences
- **South Hammond**: residences, churches, the American Conservatory of Music – Chicago Campus, and Beatniks on Conkey Theater
- **North Hammond**: residences, churches, Henry W. Eggers School, Jefferson Hotel (multiple-family residence), and Towle Company Theater

4.2.2 Existing Vibration Conditions

Existing vibration sources in the Project Area include local streets and existing freight and commuter rail lines. The SSL currently operates in North Hammond between Hudson and Gostlin Streets. Several railroads currently exist in the Project Area, including the CSX Transportation line in Dyer and Munster and several rail lines in Hammond.

Existing vibration levels were monitored from SSL trains and freight trains operating in North Hammond between Hudson and Gostlin Streets. The average vibration level at 50 feet from SSL trains was 74 VdB, while the average vibration level at 50 feet from freight trains was 81 VdB.

Along the existing MED/SSL, existing vibration sources include the existing SSL rail service, MED, Amtrak, and freight train traffic.

5 Environmental Consequences

5.1 Noise

5.1.1 Long-term Operating Effects

5.1.1.1 No Build Alternative

Projected noise levels under the No Build Alternative are anticipated to be similar to those under existing conditions. Irrespective of other projects planned and programmed in the region, ambient noise under the No Build Alternative is anticipated to be essentially the same as under existing conditions without the FEIS Preferred Alternative. For example, it takes a doubling of the traffic volumes for the noise levels to increase by 3 dBA, the threshold where most listeners detect the change. However, only marginal increases in traffic levels are predicted in the Project Area between now and 2040, resulting in slightly higher congestion and lower average travel speeds. Along the existing MED/SSL, ambient noise levels at residences adjacent to the rail corridor would be dominated by existing rail operations. The future noise under the No Build Alternative is expected to be similar to the existing conditions since operations are not expected to increase substantially.

5.1.1.2 FEIS Preferred Alternative

Severe and moderate noise impacts are predicted to occur as part of the Project. **Table 5.1-1** presents the number of affected dwelling units. The impacts are further described following the table. **Figure B-1** in **Appendix B** shows these impacts.

Table 5.1-1: Dwelling Units Affected by Noise

Municipality/Section	Category 1 Moderate	Category 1 Severe	Category 2 Moderate	Category 2 Severe	Category 3 Moderate	Category 3 Severe
Dyer (south of milepost [MP] 61.4)	0	0	0	0	0	0
Munster – Megans Way to 45th Street (MP 61.4 to 62.8)	0	0	4	1	0	0
Munster – 45th Street to Ridge Road (MP 62.8 to 64.1)	0	0	266	76	0	0
Munster – Ridge Road to I-94 (MP 64.1 to 65)	0	0	18	0	0	0
Hammond – I-94 to 165th Street (MP 65 to 66.4)	0	0	9	2	0	0
Hammond – 165th Street to Waltham Street (MP 66.4 to 67.15)	0	0	49	0	0	0
Hammond – Waltham Street to Douglas Street (MP 67.15 to 67.8)	0	0	0	0	0	0
Hammond – Douglas Street to Hoffman Street (MP 67.8 to 68.3)	0	0	23	28	0	0
Hammond – Hoffman Street to 143rd Street (MP 68.3 to 69.2)	0	0	7	0	0	0
Total Impacts	**0**	**0**	**376**	**107**	**0**	**0**

Source: HDR 2017.

Moderate impacts are further classified by “upper range” and “lower range.” The severe noise impacts and the upper-range moderate noise impacts are identified in more detail below:

- A severe noise impact is projected to occur at 1 single-family home and an upper-range moderate noise impact is projected to occur at 1 single-family home in Munster between MP 61.5 and 61.6. These impacts are attributable to the location of the turnout for the northbound siding.
- Severe noise impacts are projected to occur at 2 multiple-family buildings in Munster between MP 63.4 and 63.6, resulting in 28 dwelling units affected.
- Severe noise impacts are projected to occur at 2 multiple-family buildings in Munster between MP 63.7 and 63.9, resulting in 48 dwelling units affected.
- A severe noise impact is projected to occur at 1 single-family home, and an upper-range moderate noise impact is projected to occur at 1 single-family home in Hammond between MP 65.3 and 65.5.
- A severe noise impact is projected to occur at 1 single-family home, and upper-range moderate noise impacts are projected to occur at 2 single-family homes in Hammond between MP 66.3 and 66.4.
- Upper-range moderate noise impacts are projected to occur at 5 single-family homes in Hammond between MP 66.9 and 67.2.
- Severe noise impacts are projected to occur at Jefferson Hotel in Hammond south of milepost (MP) 68.1, resulting in 28 dwelling units affected. Jefferson Hotel is currently a multiple-family property with 51 total dwelling units, and the severe impact is predicted to occur at all three floors of the property. An estimated 28 dwelling units face the alignment. The remaining 23 dwelling units facing away from the alignment are projected to experience lower-range moderate impacts.

Mitigation for these impacts is discussed in **Chapter 6**.

5.1.2 Short-term Construction Effects

5.1.2.1 No Build Alternative

Under the No Build Alternative, no Project-related impacts on noise levels would occur.

5.1.2.2 FEIS Preferred Alternative

Construction of the Project would result in a temporary increase in noise levels. Pieces of equipment used to move soil and other earthen materials are often the loudest construction noise sources. FTA’s guidance manual suggests construction noise criteria for residential land uses are Leq(h) of 90 dBA during the day and 80 dBA during the night. These construction noise criteria are intended to be compared with the combined Leq(h) of the two noisiest pieces of construction equipment during 1 hour.

The estimated noise levels presented in **Table 3.1-1** show that numerous single pieces of equipment may exceed the FTA recommendations if running constantly for 1 hour within 100 feet of a receptor. During the final design and construction phase, NICTD would require construction contractors to develop a construction noise management plan which includes identifying and complying with any applicable local noise ordinances; therefore, construction noise impacts would not be anticipated to occur.

5.2 Vibration

5.2.1 Long-term Operating Effects

5.2.1.1 No Build Alternative

Projected vibration levels under the No Build Alternative are expected to be similar to existing conditions. Traffic, including heavy trucks and buses, rarely creates perceptible GBV unless vehicles are operating very close to buildings or there are irregularities in the road, such as potholes or expansion joints. The pneumatic tires and suspension systems of automobiles, trucks, and buses eliminate most GBV. Similarly, vibration levels from existing train service along the existing MED/SSL is expected to be the dominant source of vibration in the area, which is not expected to change from the existing condition. As a result, no vibration impacts would be associated with the No Build Alternative because nothing would be built.

5.2.1.2 FEIS Preferred Alternative

Vibration impacts are predicted to occur as part of the Project. **Table 5.2-1** presents the number of affected dwelling units. The impacts are further described following the table. **Figure B-3** in **Appendix B** shows these impacts.

Table 5.2-1: Dwelling Units Affected by Vibration

Municipality/Section	Category 1	Category 2	Category 3
Dyer (south of MP 61.4)	0	0	0
Munster – Megan Way to 45th Street (MP 61.4 to 62.8)	0	0	0
Munster – 45th Street to Ridge Road (MP 62.8 to 64.1)	0	12	0
Munster – Ridge Road to I-94 (MP 64.1 to 65)	0	0	0
Hammond – I-94 to 165th Street (MP 65 to 66.4)	0	1	0
Hammond – 165th Street to Waltham Street (MP 66.4 to 67.15)	0	0	0
Hammond – Waltham Street to Douglas Street (MP 67.15 to 67.8)	0	0	0
Hammond – Douglas Street to Hoffman Street (MP 67.8 to 68.3)	0	0	0
Hammond – Hoffman Street to 143rd Street (MP 68.3 to 69.2)	0	0	0
Total Impacts	**0**	**13**	**0**

Source: HDR 2017.

The vibration impacts are discussed in more detail below:

- GBV impacts are projected to occur at 2 multiple family buildings in Munster between MP 63.7 and 63.9 because of wayside vibration (wheels rolling on the track). The estimated dwelling units in these buildings is 24 units total, 12 units on each of the two floors. Only the ground-floor units closest to the alignment are projected to experience vibration impacts, resulting in 6 impacted dwelling units in each building, for a total of 12 impacted dwelling units. Project-related GBV levels are projected to be 75 VdB at the 6 ground-floor front-row dwelling units, which equals the vibration impact threshold of 75 VdB at these receptors. The 12 dwelling units on the second floor of each building are not anticipated to experience vibration impacts because the floor-to-floor attenuation reduces the vibration levels to below FTA vibration impact thresholds.

- One vibration impact would occur at a single-family home in Hammond between MP 66.3 and 66.4 because of wayside vibration (wheels rolling on the track). Project-related GBV levels are projected to be 76.5 VdB, which exceeds the vibration impact threshold of 75 VdB at this receptor.

Mitigation for these vibration impacts is discussed in **Chapter 6**.

5.2.2 Short-term Construction Effects

5.2.2.1 No Build Alternative

Under the No Build Alternative, no Project-related impacts on vibration levels would occur. Therefore, no mitigation would be required.

5.2.2.2 FEIS Preferred Alternative

Construction vibration would very rarely damage buildings. Construction activities that typically generate the most severe vibrations with the potential for building damage including blasting and pile-driving. No blasting activities are expected to be included on this project, and pile-driving is expected to occur in select locations. Examples of other construction activities with a potential for vibration impact include concrete pavement breaking, vibratory compaction, and drilling or excavating in the ground near sensitive structures. During the final design and construction phase, NICTD would require construction contractors to develop a construction vibration management plan and include vibration performance specifications in the construction contract documents; therefore, construction vibration impacts would not be anticipated to occur.

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6 Mitigation Measures

This chapter discusses noise and vibration mitigation recommendations. Noise and vibration impacts are projected to occur as a consequence of this Project. To mitigate the anticipated noise and vibration impacts, a combination of noise barrier walls, receiver-based treatments, and track treatments is recommended.

Noise barrier walls are generally constructed as modular precast concrete wall systems, consisting of metal panels designed to sit on footings or posts and be joined by tongue and groove joints. Earthen berms generally require a 2:1 slope to facilitate maintenance and landscaping activities, which can lead to wide footprints for tall berms. Earthen berms would be considered for noise mitigation purposes if adequate ROW is available and no drainage issues exist (a wide berm footprint has potential to interfere with drainage and utilities). Therefore, while earthen berms may be considered for noise mitigation, noise barrier walls may be preferable because they do not require as much ROW.

6.1 Noise

6.1.1 Long-term Operating Effects

For the No Build Alternative, no long-term effects on noise levels would occur, and, therefore, would not require mitigation.

Noise analysis results indicate that the Project, as modeled, would cause severe noise impacts at 8 receptors, all of which are Category 2 land uses. The severely affected receptors include both single-family and multiple-family residences that represent 107 affected dwelling units. Analysis results also indicate that the Project would cause moderate noise impacts at 125 receptors. These moderate noise impacts would occur at Category 2 land uses including both single-family and multiple-family residences that represent 376 total affected dwelling units. Of the moderate impacts, 9 would fall in the upper range of moderate impact shown in **Figure 2.1-2**. Noise mitigation options are discussed below for the severe and upper-range moderate noise impacts, as well as the lower-range moderate noise impacts where reasonable. **Figure B-2** in **Appendix B** shows locations where noise mitigation would be implemented.

- A severe noise impact is projected to occur at 1 single-family home and an upper-range moderate noise impact is projected to occur at 1 single-family home in Munster between MP 61.5 and 61.6. These impacts are attributable to the location of the turnout for the northbound siding. To mitigate these impacts, receiver-based treatments are recommended. These treatments would cost approximately $50,000 to $100,000 to mitigate the 1 severe noise impact and 1 upper-range moderate noise impact.
- Severe noise impacts are projected to occur at 2 multiple-family buildings in Munster between MP 63.4 and 63.6, resulting in 28 dwelling units affected. To mitigate these impacts, a noise barrier wall approximately 1,210 feet long ranging in height from 4 to 5 feet above the top-of-rail is recommended. This noise barrier would be on the eastern side of the Project alignment, with a height of 5 feet from MP 63.4 to 63.5 and 4 feet from MP 63.5 to 63.65. This barrier would also reduce noise levels at 46 lower-range moderate noise impacts located between MP 63.4 and 63.6. Assuming a unit cost of $30 per square foot of noise barrier (consistent with INDOT policy), the cost of this noise barrier would be approximately $165,000.

- Severe noise impacts are projected to occur at 2 multiple-family buildings in Munster between MP 63.7 and 63.9, resulting in 48 dwelling units affected. To mitigate these impacts, a noise barrier wall approximately 1,330 feet long and 5 feet above the top-of-rail is recommended. This noise barrier would be on the western side of the Project alignment. This noise barrier would also reduce noise levels at 72 lower-range moderate noise impacts located between MP 63.65 and 63.9. Assuming a unit cost of $30 per square foot of noise barrier (consistent with INDOT policy), the cost of this noise barrier would be approximately $199,500.
- A severe noise impact is projected to occur at 1 single-family home and an upper-range moderate noise impact is projected to occur at 1 single-family home in Hammond between MP 65.3 and 65.5. To mitigate these impacts, a noise barrier wall approximately 580 feet long and 5 feet above the top-of-rail is recommended. This noise barrier would be on the western side of the Project alignment and would also protect 1 lower-range moderate noise impact projected to occur at 1 single-family home between MP 65.3 and 65.5. Assuming a unit cost of $30 per square foot of noise barrier (consistent with INDOT policy), the cost of this noise barrier would be approximately $87,000. For comparison, receiver-based treatments would cost approximately $50,000 to $100,000 to mitigate the 1 severe and 1 upper-range moderate noise impact.
- A severe noise impact is projected to occur at 1 single-family home and upper-range moderate noise impacts are projected at 2 single-family homes in Hammond between MP 66.3 and 66.4. To mitigate these impacts, a noise barrier wall approximately 700 feet long and 5 feet above the top-of-rail is recommended. This noise barrier would be on the eastern side of the Project alignment and would also protect 2 lower-range moderate noise impacts projected to occur at single-family homes approximately between MP 66.3 and 66.4. Assuming a unit cost of $30 per square foot of noise barrier (consistent with Indiana Department of Transportation [INDOT] policy), the cost of this noise barrier would be approximately $105,000. For comparison, receiver-based treatments would cost approximately $75,000 to $150,000 to mitigate the 1 severe and 2 upper-range moderate noise impacts.
- Upper-range moderate noise impacts are projected to occur at 5 single-family homes in Hammond between MP 66.9 and 67.2. To mitigate these impacts, receiver-based treatments (treatment to the single-family home itself) are recommended. A noise barrier wall would not be considered feasible mitigation because the railroad-highway grade crossings would result in gaps in the noise barrier. Receiver-based treatments can range from $25,000 to $50,000 per single-family home, resulting in a cost of approximately $125,000 to $250,000 to mitigate these 5 receptors.
- Severe noise impacts are projected to occur at Jefferson Hotel in Hammond south of MP 68.1, resulting in 28 dwelling units affected. Jefferson Hotel is currently functioning as a multiple-family property with 51 total dwelling units, and the severe impact is predicted to occur at all three floors of the property. An estimated 28 dwelling units face the alignment (the remaining 23 dwelling units would experience lower-range moderate impacts). To mitigate these impacts, a noise barrier wall approximately 370 feet long and 3 feet above the top-of-rail would be constructed. This noise barrier would be on the western side of an elevated portion of the Project alignment. The noise barrier would eliminate the impact at the first and second floors and would reduce the impact at the third floor to the lower moderate

range[2]; it would additionally benefit the dwelling units on the back side of the building, reducing them to no impact.

6.1.2 Short-term Construction Effects

Under the No Build Alternative, no short-term effects on noise levels would occur. No mitigation is, therefore, proposed.

By their nature, construction activities generate some degree of noise, though usually the impacts are temporary and unavoidable. NICTD would limit noise impacts during construction by requiring the construction contractors to include noise performance specifications in the construction contract documents.

Additionally, construction contractors would be required to develop a construction noise management plan. This may be a stand-alone plan, or it may be included in a larger environmental management plan for the construction project. At a minimum, the plan would include:

- An outline of the project's noise-control objectives and potential components
- A summary of noise-related criteria and local ordinances for construction contractors to abide by
- The requirement to perform a preconstruction survey or assessment to identify receptors potentially affected by construction noise and document the pre-construction conditions of particularly susceptible receptors
- A list of potential mitigation measures, a plan to implement mitigation, and an approach for deciding the appropriateness of mitigation by construction activity and receptor
- An approach to minimize noise impacts on adjacent noise-sensitive stakeholders while maintaining construction progress
- A strategy to coordinate with affected Project stakeholders to minimize intrusive construction impacts
- A complaint-handling and -resolution procedure for any Project stakeholder

As stated above, NICTD would require the construction contractor to develop noise specifications and a construction noise management plan. There are several approaches the contractor may use at their discretion to comply with these requirements and the applicable construction noise limits. Noise monitoring of construction activities is effective to limit unanticipated adverse impacts. Additional examples of noise-control measures that could be applied during construction as needed include, but are not limited to, the following:

- Scheduling the loudest construction activities during daytime hours in residential neighborhoods, and limiting or completely avoiding their use in the evening and at nighttime
- Ensuring that all construction equipment has been properly maintained and is in good working order, with mufflers that are at least as good as the original equipment or a higher-performing replacement; in locations where noise-sensitive receptors could be adversely

[2] It is assumed that 14 dwelling units face the Project alignment on the third floor. The layout of dwelling units in the Jefferson Hotel is unknown. Based on field observation, the noise analysis assumes there are no dwelling units on the first floor.

affected by construction equipment noise, use specially quieted equipment with enclosed engines, noise-reduction packages, and high-performance mufflers

- Locating stationary construction equipment as far as possible from noise-sensitive sites
- Constructing noise barriers, such as temporary walls or piles of excavated material, between noisy activities and noise-sensitive receivers, where feasible; acoustic fencing may also be installed to mitigate short-term noise impacts due to construction
- Rerouting construction-related truck traffic along roads that would cause the least disturbance to residents
- Conducting noise monitoring during construction to verify compliance with the limits
- Coordinating with the municipalities in the Project Area

6.2 Vibration

6.2.1 Long-term Operating Effects

The No Build Alternative would not result in any long-term vibration impacts and, therefore, would not require mitigation.

Analysis results indicate that the Project, as modeled, would cause vibration impacts at 3 residential structures that represent 13 dwelling units. **Figure B-4** in **Appendix B** shows locations where vibration mitigation would be implemented.

- GBV impacts are projected to occur at 2 multiple-family buildings in Munster between MP 63.7 and 63.9. Twelve units on the ground floor are projected to experience vibration impacts. Project-related GBV levels are projected to be 75 VdB at the 12 ground-floor dwelling units, which equals the vibration impact threshold of 75 VdB at these receptors. To mitigate this impact, ballast mats, resilient ties (sleeper pads) or other track-support system modifications would be implemented. This treatment would extend the length of one full trainset on either side of the affected receptor, which would result in approximately 2,360 feet of treatment.
- One vibration impact is projected to occur at a single-family home in Hammond between MP 66.3 and 66.4 that would be attributable to wayside vibration. Project-related GBV levels are projected to be 76.5 VdB, which exceeds the vibration impact threshold of 75 VdB at this receptor. To mitigate this impact, ballast mats, resilient ties (sleeper pads) or other track-support system modifications would be implemented. This treatment would extend the length of one full trainset on either side of the affected receptor, which would result in approximately 1,360 feet of treatment. This is based on a trainset length of 680 feet, consisting of 8 cars at 85 feet.

6.2.2 Short-term Construction Effects

The No Build Alternative would not result in any construction-related vibration impacts. No mitigation is proposed.

By their nature, construction activities generate some degree of vibration, though usually the impacts are temporary and unavoidable. NICTD would limit vibration impacts during construction by requiring construction contractors to include vibration performance specifications in the construction contract documents.

Additionally, construction contractors would be required to develop a construction vibration management plan. This may be a stand-alone plan, or it may be included in a larger environmental management plan for the construction project. At a minimum, the plan would include:

- An outline of the project's vibration-control objectives and potential components
- A summary of vibration-related criteria and local ordinances for construction contractors to abide by
- The requirement to perform a preconstruction survey or assessment to identify receptors potentially affected by construction vibration and document the preconstruction conditions of particularly susceptible receptors
- A list of potential mitigation measures, a plan to implement mitigation, and an approach for deciding the appropriateness of mitigation by construction activity and receptor
- An approach to minimize vibration impacts on adjacent vibration-sensitive stakeholders while maintaining construction progress
- A strategy to coordinate with affected Project stakeholders to minimize intrusive construction impacts
- A complaint-handling and -resolution procedure for any Project stakeholder

As stated above, NICTD would require the construction contractor to develop vibration specifications and a construction vibration management plan. To limit vibration impacts from construction activities, the construction contract documents would specify vibration limits for construction activities. There are several approaches the contractor may use at their discretion to comply with these requirements and the applicable construction vibration limits. Vibration monitoring of construction activities is effective in limiting unanticipated adverse impacts. Additional examples of vibration-control measures include, but are not limited to, the following:

- Rerouting construction-related truck traffic along roads that would cause the least disturbance to residents
- Performing a preconstruction survey near sites where vibration activities would occur to document the preconstruction conditions of potentially affected structures
- Restricting the use of certain vibration-producing equipment near sensitive structures
- Conducting vibration monitoring during construction to verify compliance with the limits
- Establishing a complaint-resolution procedure to rapidly address any problems that may develop during construction
- Coordinating with municipalities in the Project Area

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7 Conclusions

Noise analysis results indicate that the Project, as modeled, would cause severe noise impacts at 8 land uses, all Category 2. The severely impacted receptors include both single-family and multiple-family residences that represent 107 affected dwelling units. Analysis results also indicate that the Project would cause moderate noise impacts at 125 land uses that are also all Category 2 and include both single-family and multiple-family residences that represent 376 total affected dwelling units. Of the moderate impacts, 9 would fall in the upper range of moderate impact shown in **Figure 2.1-2** of FTA's guidance manual. Proposed noise mitigation would reduce these impacts to lower range moderate impacts or would eliminate the impacts.

Analysis results indicate that the Project, as modeled, would cause vibration impacts at 3 residential structures that represent 13 dwelling units. Proposed mitigation would eliminate these impacts but must be engineered during final design.

All proposed mitigation measures are subject to refinement during final design, as well as possible further testing to ensure adequate performance.

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Appendix A. Construction Noise

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Table A-1: Estimated Construction Equipment Noise Levels by Construction Phase

Equipment	Qty.	Hours/Day	Utilization	Horse-power	Kilowatts (KW)	SWL/Unit	Total SWL	SPL (dBA) at Distance (feet)			
								100	200	500	1,000
Clearing											
Off-highway trucks	4	6	50%	350	261	123	126	85	79	72	65
Rubber tired dozers	3	8	67%	255	190	122	125	84	78	70	64
Rubber tired loaders	2	6	50%	199	148	121	121	80	74	66	60
Tractors/loaders/backhoes	3	5	42%	97	72	118	119	78	72	64	58
Trenchers	2	4	33%	80	60	117	115	74	68	60	54
							Combined noise level	**89**	**83**	**75**	**69**
Utility relocation											
Cranes	1	6	50%	226	169	121	118	78	72	64	58
Dumper/tender	2	4	33%	16	12	110	108	67	61	53	47
Off-highway trucks	2	6	50%	350	261	123	123	82	76	69	62
Rubber tired dozers	3	8	67%	255	190	122	125	84	78	70	64
Rubber tired loaders	2	6	50%	199	148	121	121	80	74	66	60
Tractors/loaders/backhoes	3	5	42%	97	72	118	119	78	72	64	58
Trenchers	2	6	50%	80	60	117	117	76	70	62	56
Welders	3	6	50%	46	34	114	116	75	69	61	55
							Combined noise level	**89**	**83**	**75**	**69**
Earthwork											
Excavators	2	8	67%	162	121	120	121	80	74	66	60
Graders	1	8	67%	174	130	120	118	78	72	64	58
Off-highway trucks	4	8	67%	350	261	123	127	87	81	73	67
Off-highway trucks	1	4	33%	350	261	123	118	78	72	64	58

Equipment	Qty.	Hours/Day	Utilization	Horse-power	Kilowatts (KW)	SWL/Unit	Total SWL	SPL (dBA) at Distance (feet)			
								100	**200**	**500**	**1,000**
Rollers	2	6	50%	80	60	117	117	100	200	500	1,000
Rubber tired dozers	1	8	67%	255	190	122	120	79	73	65	59
Rubber tired loaders	2	6	50%	199	148	121	121	80	74	66	60
Scrapers	2	8	67%	361	269	123	125	84	78	70	64
Signal boards	3	8	67%	6	4	106	109	68	62	54	48
Tractors/loaders/backhoes	3	6	50%	97	72	118	119	79	73	65	59
Combined noise level	**91**		**85**			**77**	**71**				
Bridge construction for overpasses											
Cranes	1	7	58%	226	169	121	119	78	72	64	58
Excavators	2	8	67%	162	121	120	121	80	74	66	60
Forklifts	3	8	67%	89	66	117	120	80	74	66	60
Generator sets	1	8	67%	84	63	117	115	75	69	61	55
Graders	1	8	67%	174	130	120	118	78	72	64	58
Pavers	2	8	67%	125	93	119	120	79	73	65	59
Paving equipment	2	8	67%	130	97	119	120	79	73	65	59
Rollers	2	8	67%	80	60	117	118	77	71	63	57
Rubber tired dozers	1	8	67%	255	190	122	120	79	73	65	59
Scrapers	2	8	67%	361	269	123	125	84	78	70	64
Tractors/loaders/backhoes	2	8	67%	97	72	118	119	78	72	64	58
Welders	1	8	67%	46	34	114	113	72	66	58	52
Combined noise level	**90**		**84**			**76**	**70**				

Equipment	Qty.	Hours/Day	Utilization	Horse-power	Kilowatts (KW)	SWL/Unit	Total SWL	SPL (dBA) at Distance (feet)			
								100	200	500	1,000
Retaining walls											
Excavators	2	8	67%	162	121	120	121	80	74	66	60
Forklifts	3	8	67%	89	66	117	120	80	74	66	60
Generator sets	1	8	67%	84	63	117	115	75	69	61	55
Graders	1	8	67%	174	130	120	118	78	72	64	58
Rubber tired dozers	1	8	67%	255	190	122	120	79	73	65	59
Rubber tired loaders	2	7	58%	199	148	121	121	81	75	67	61
Scrapers	2	8	67%	361	269	123	125	84	78	70	64
Tractors/loaders/backhoes	3	7	58%	97	72	118	120	79	73	65	59
Combined noise level	**89**		**83**			**75**	**69**				
Signals											
Cranes	1	7	58%	226	169	121	119	78	72	64	58
Forklifts	3	8	67%	89	66	117	120	80	74	66	60
Generator sets	1	8	67%	84	63	117	115	75	69	61	55
Tractors/loaders/backhoes	2	8	67%	97	72	118	119	78	72	64	58
Welders	1	8	67%	46	34	114	113	72	66	58	52
Combined noise level	**84**		**78**			**70**	**64**				
Track installation											
Air compressors	1	6	50%	78	58	117	114	73	67	59	53
Cranes	1	7	58%	226	169	121	119	78	72	64	58
Forklifts	3	8	67%	89	66	117	120	80	74	66	60
Generator sets	1	8	67%	84	63	117	115	75	69	61	55
Track laying machine	1	8	67%	1500	1119	129	128	87	81	73	67

Equipment	Qty.	Hours/Day	Utilization	Horse-power	Kilowatts (KW)	SWL/Unit	Total SWL	SPL (dBA) at Distance (feet)			
								100	200	500	1,000
Track tamper	1	8	67%	200	149	121	119	78	72	64	58
Track stabilizer	1	8	67%	700	522	126	124	84	78	70	64
Tractors/loaders/backhoes	2	8	67%	97	72	118	119	78	72	64	58
Welders	1	8	67%	46	34	114	113	72	66	58	52
Combined noise level	**90**		**84**			**76**	**70**				
Signal work											
Cranes	1	7	58%	226	169	121	119	78	72	64	58
Forklifts	3	8	67%	89	66	117	120	80	74	66	60
Generator sets	1	8	67%	84	63	117	115	75	69	61	55
Tractors/loaders/backhoes	2	8	67%	97	72	118	119	78	72	64	58
Welders	1	8	67%	46	34	114	113	72	66	58	52
Combined noise level	**84**		**78**			**70**	**64**				
Install track and subballast											
Air compressors	1	6	50%	78	58	117	114	73	67	59	53
Cranes	1	7	58%	226	169	121	119	78	72	64	58
Forklifts	3	8	67%	89	66	117	120	80	74	66	60
Generator sets	1	8	67%	84	63	117	115	75	69	61	55
Track laying machine	1	8	67%	1500	1119	129	128	87	81	73	67
Track tamper	1	8	67%	200	149	121	119	78	72	64	58
Track stabilizer	1	8	67%	700	522	126	124	84	78	70	64
Ballast regulator	1	8	67%	135	101	119	117	77	71	63	57

Equipment	Qty.	Hours/Day	Utilization	Horse-power	Kilowatts (KW)	SWL/Unit	Total SWL	SPL (dBA) at Distance (feet)			
								100	200	500	1,000
Tractors/loaders/backhoes	2	8	67%	97	72	118	119	78	72	64	58
Welders	1	8	67%	46	34	114	113	72	66	58	52
Combined noise level	**91**		**85**			**77**	**71**				
Final cut-over and removal of turnouts											
Cranes	1	7	58%	226	169	121	119	78	72	64	58
Forklifts	3	8	67%	89	66	117	120	80	74	66	60
Generator sets	1	8	67%	84	63	117	115	75	69	61	55
Tractors/loaders/backhoes	3	7	58%	97	72	118	120	79	73	65	59
Welders	1	8	67%	46	34	114	113	72	66	58	52
Combined noise level	**85**		**79**			**71**	**65**				

Source: HDR 2017.

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Appendix B. Noise and Vibration Impact and Mitigation Figures

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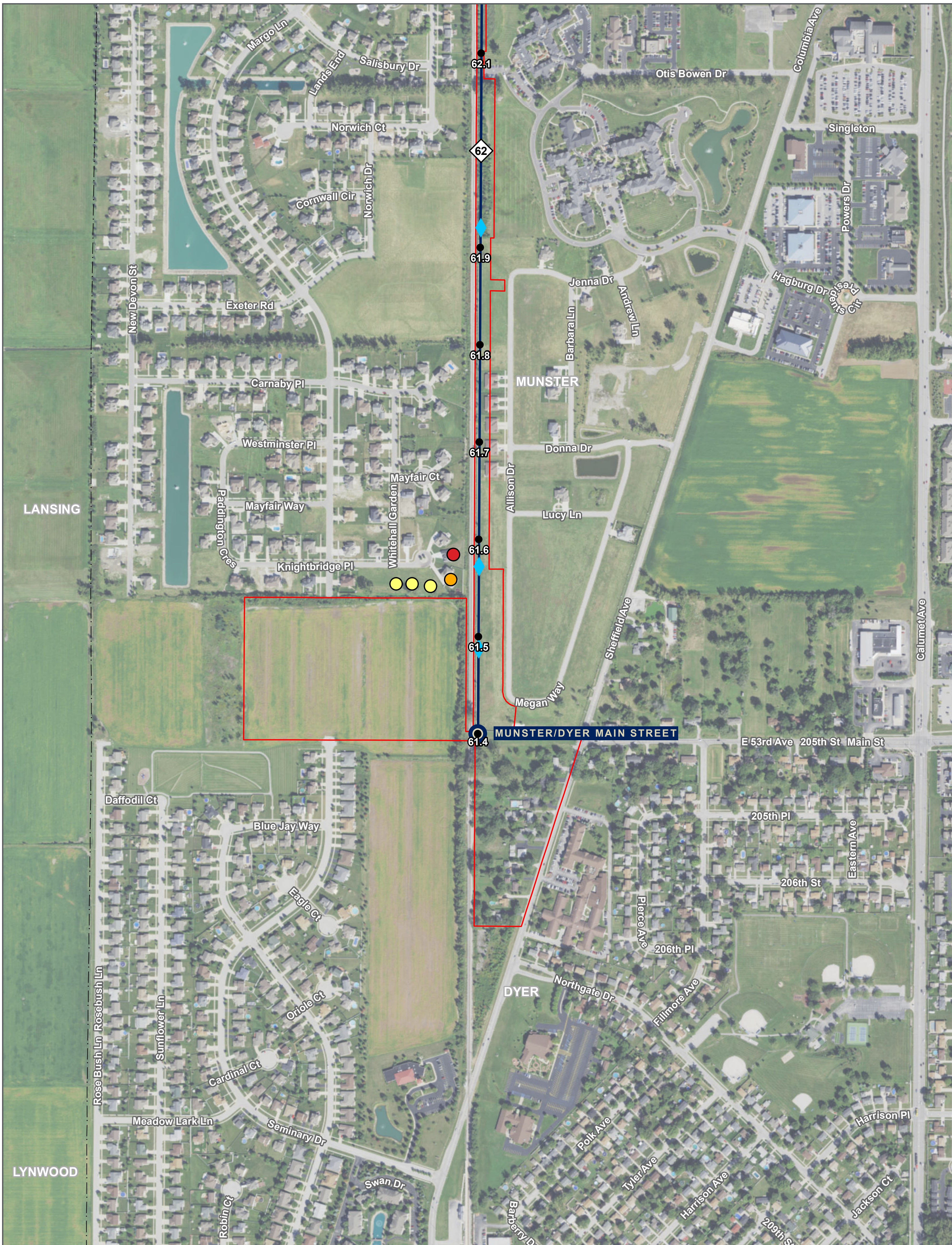
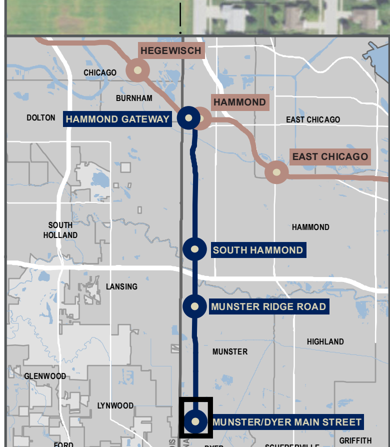




- Existing Station
- Proposed Station
- Existing South Shore Line
- FEIS Preferred Alternative
- Project Footprint
- Milepost
- Milepost Stationing
- Proposed Turnouts
- Proposed Grade Crossing

Noise Impact

- Lower Range Moderate Noise Impact
- Upper Range Moderate Noise Impact
- Severe Noise Impact

FIGURE B-1
NOISE IMPACTS

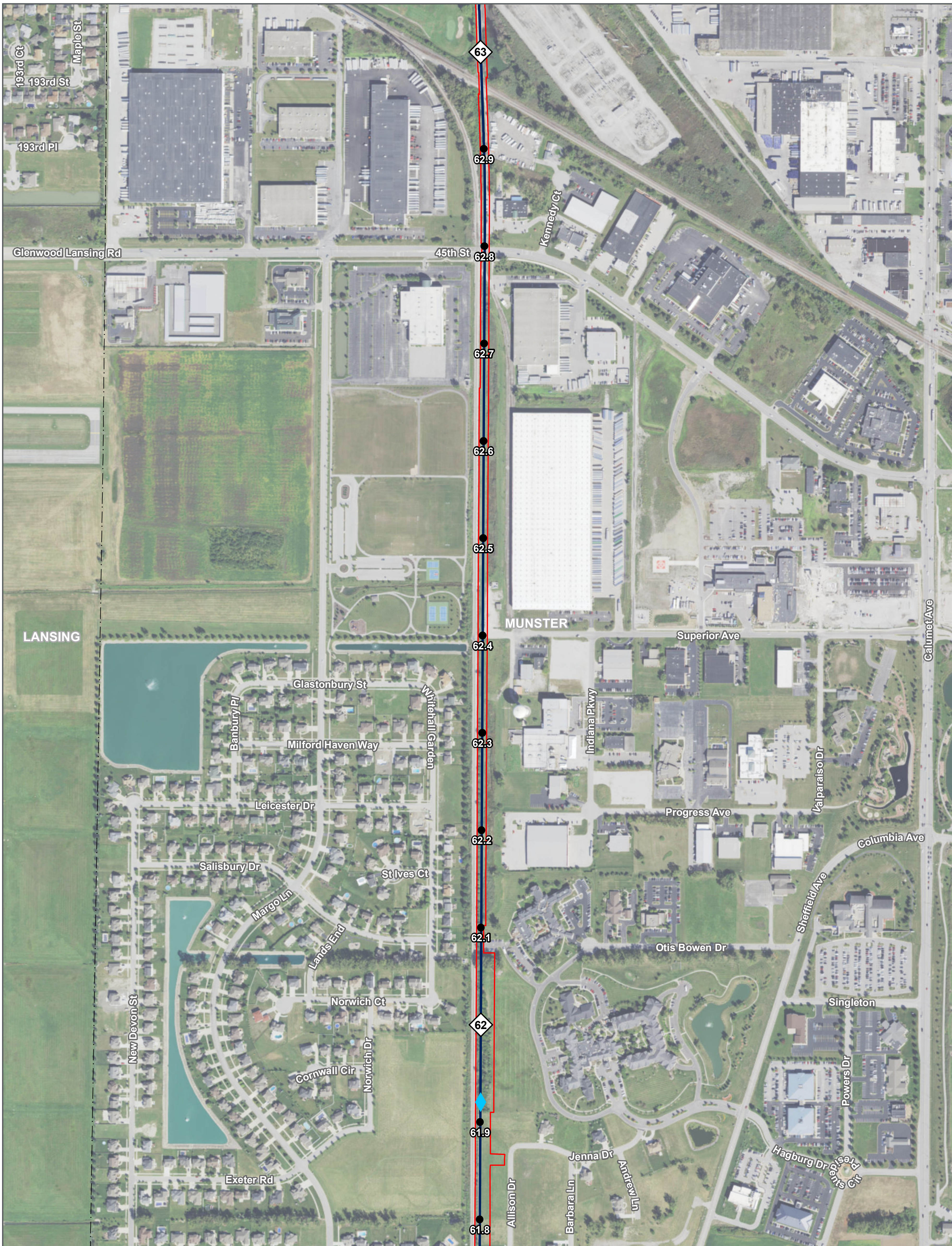
0 500
FEET

WEST LAKE CORRIDOR

SHEET 1 OF 9

Data for Reference Only

Background Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



- Existing Station
- Proposed Station
- Existing South Shore Line
- FEIS Preferred Alternative
- Project Footprint
- Milepost
- Milepost Stationing
- Proposed Turnouts
- Proposed Grade Crossing

Noise Impact

- Lower Range Moderate Noise Impact
- Upper Range Moderate Noise Impact
- Severe Noise Impact

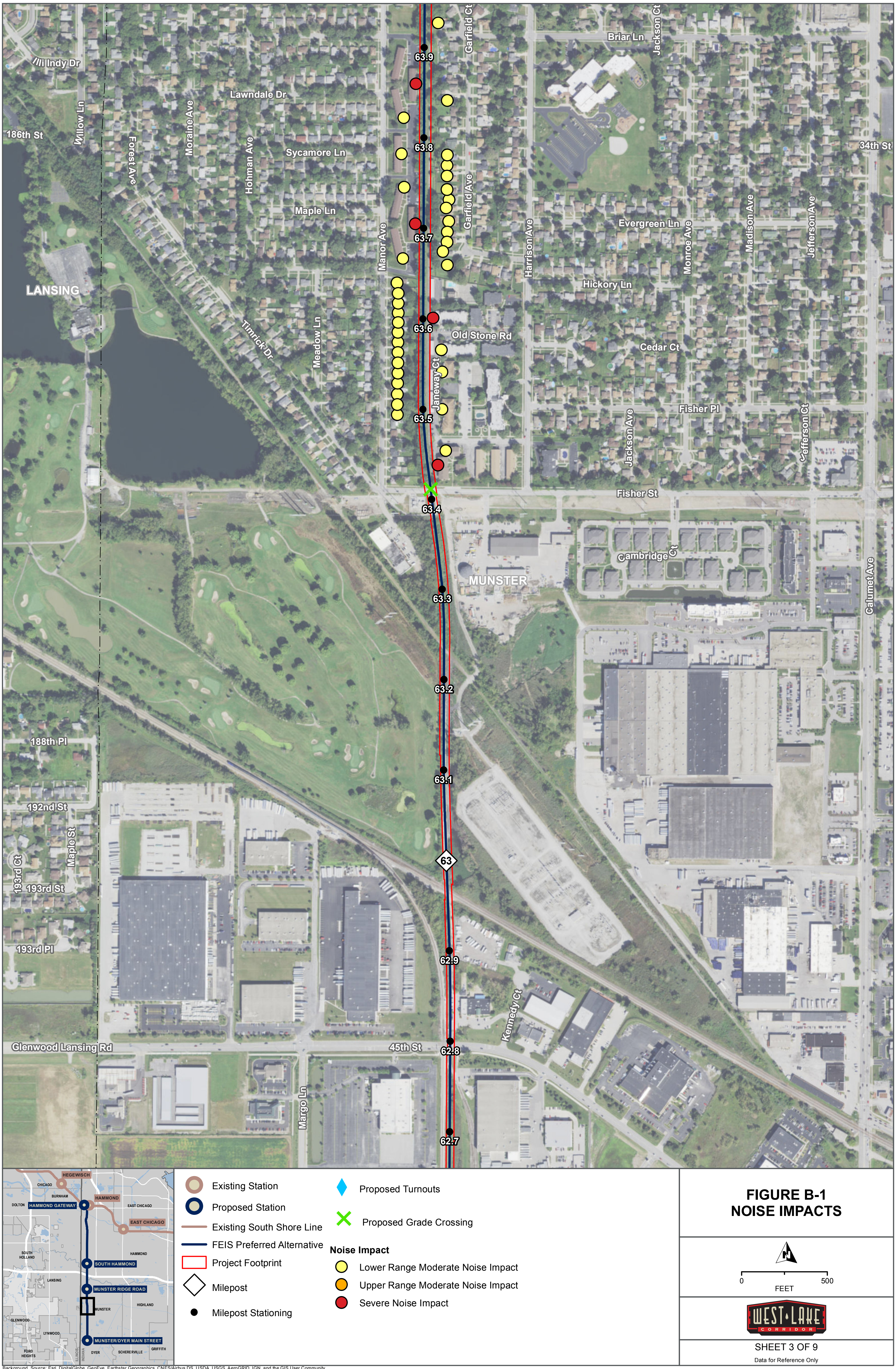
FIGURE B-1
NOISE IMPACTS

0 500
FEET

SHEET 2 OF 9

Data for Reference Only

Background Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

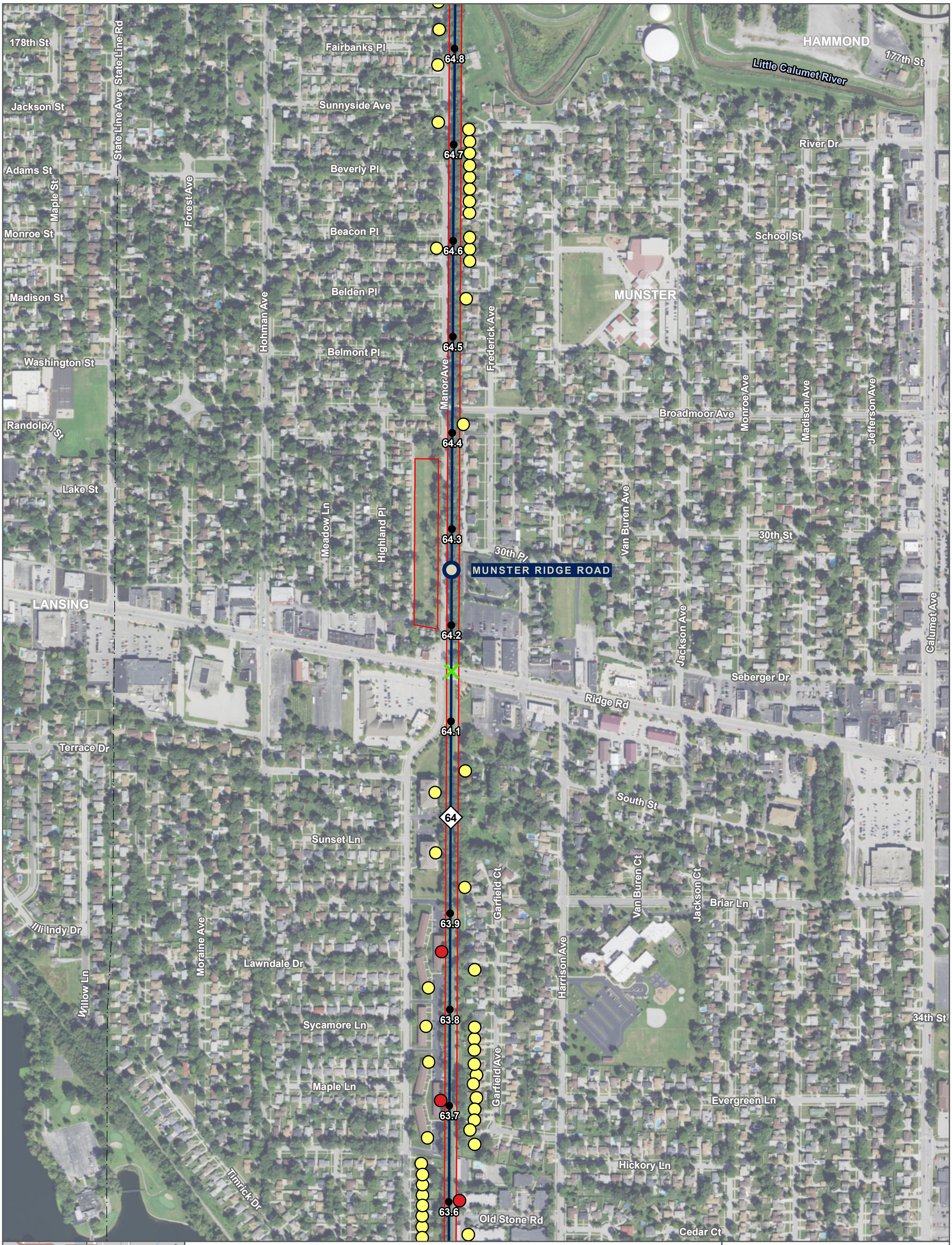


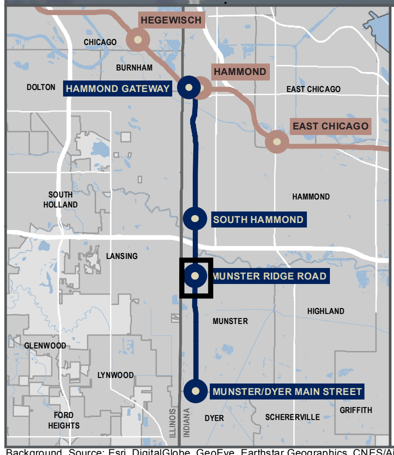
Background Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

FIGURE B-1
NOISE IMPACTS

SHEET 3 OF 9

Data for Reference Only





Existing Station
Proposed Station
Existing South Shore Line
FEIS Preferred Alternative
Project Footprint
Milepost
Milepost Stationing
Proposed Turnouts
Proposed Grade Crossing

Noise Impact
Lower Range Moderate Noise Impact
Upper Range Moderate Noise Impact
Severe Noise Impact

FIGURE B-1
NOISE IMPACTS

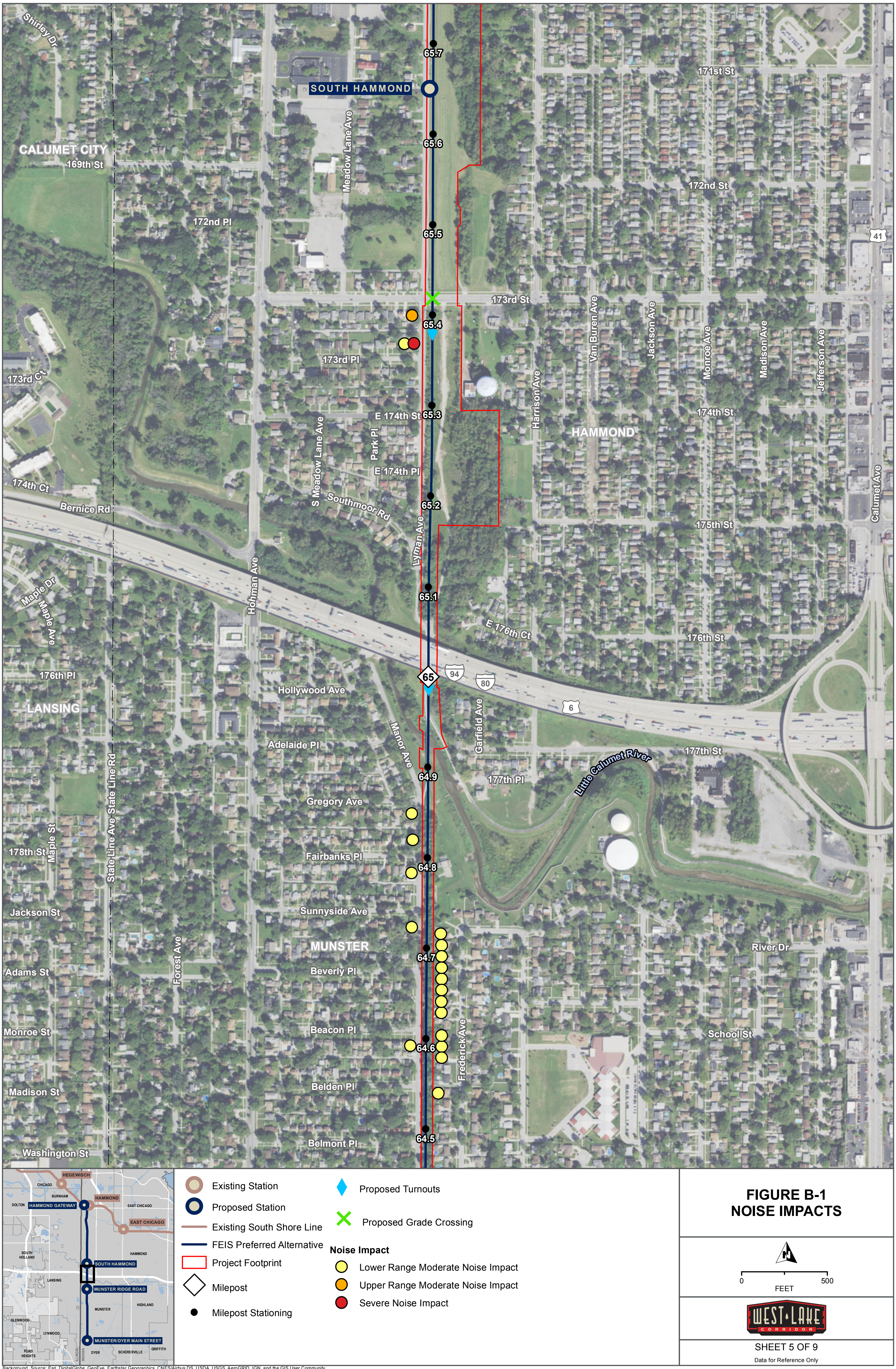
0 500
FEET

WEST LAKE CORRIDOR

SHEET 4 OF 9

Data for Reference Only

Background Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



Existing Station

Proposed Station

Existing South Shore Line

FEIS Preferred Alternative

Project Footprint

Milepost

Milepost Stationing

Proposed Turnouts

Proposed Grade Crossing

Noise Impact

Lower Range Moderate Noise Impact

Upper Range Moderate Noise Impact

Severe Noise Impact

FIGURE B-1
NOISE IMPACTS

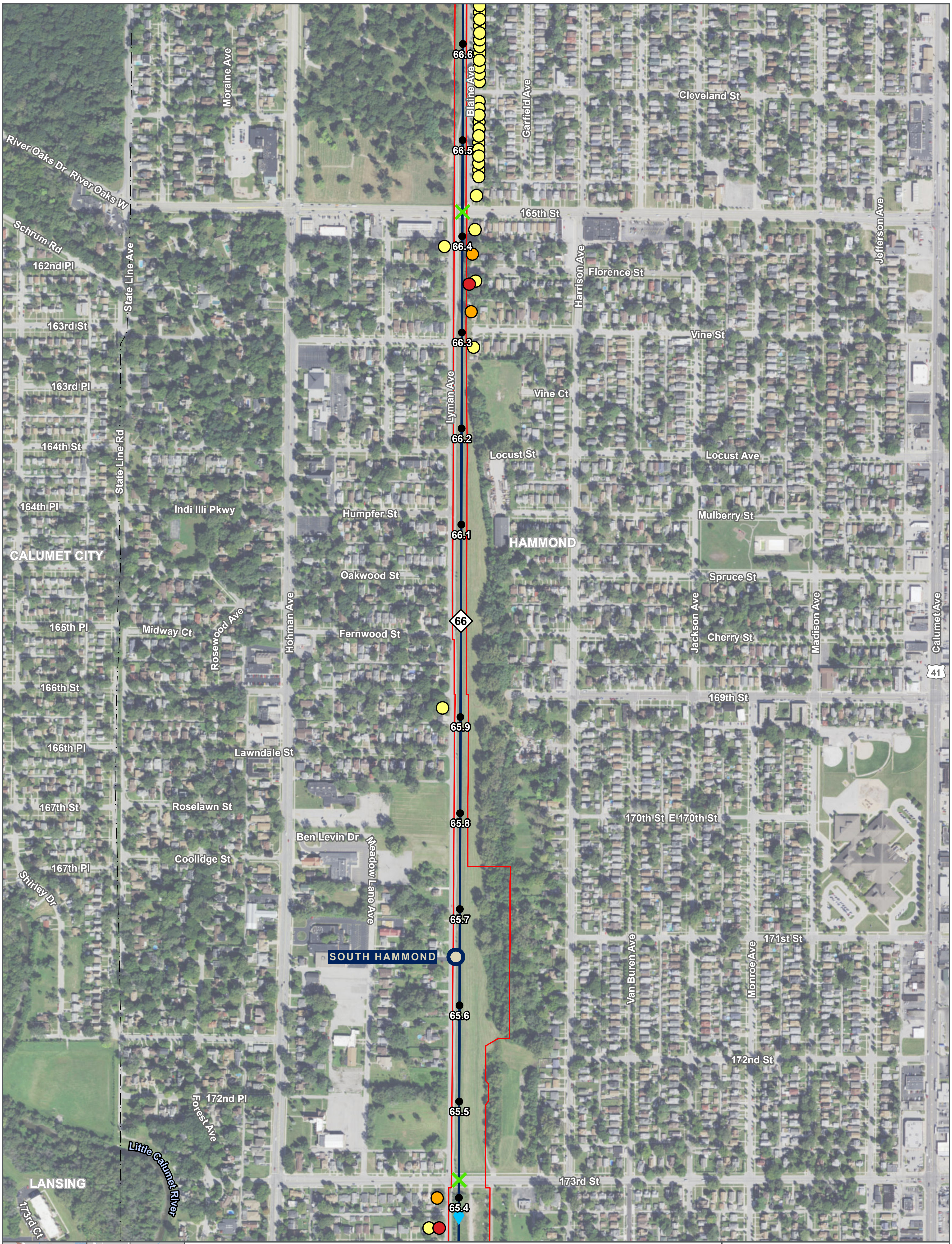
0 500
FEET

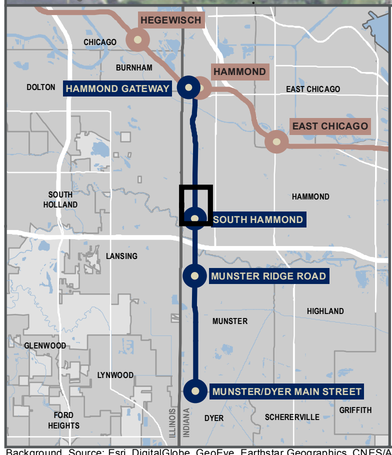
WEST LAKE CORRIDOR

SHEET 5 OF 9

Data for Reference Only

Background Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community





- Existing Station
- Proposed Station
- Existing South Shore Line
- FEIS Preferred Alternative
- Project Footprint
- Milepost
- Milepost Stationing
- Proposed Turnouts
- Proposed Grade Crossing

Noise Impact

- Lower Range Moderate Noise Impact
- Upper Range Moderate Noise Impact
- Severe Noise Impact

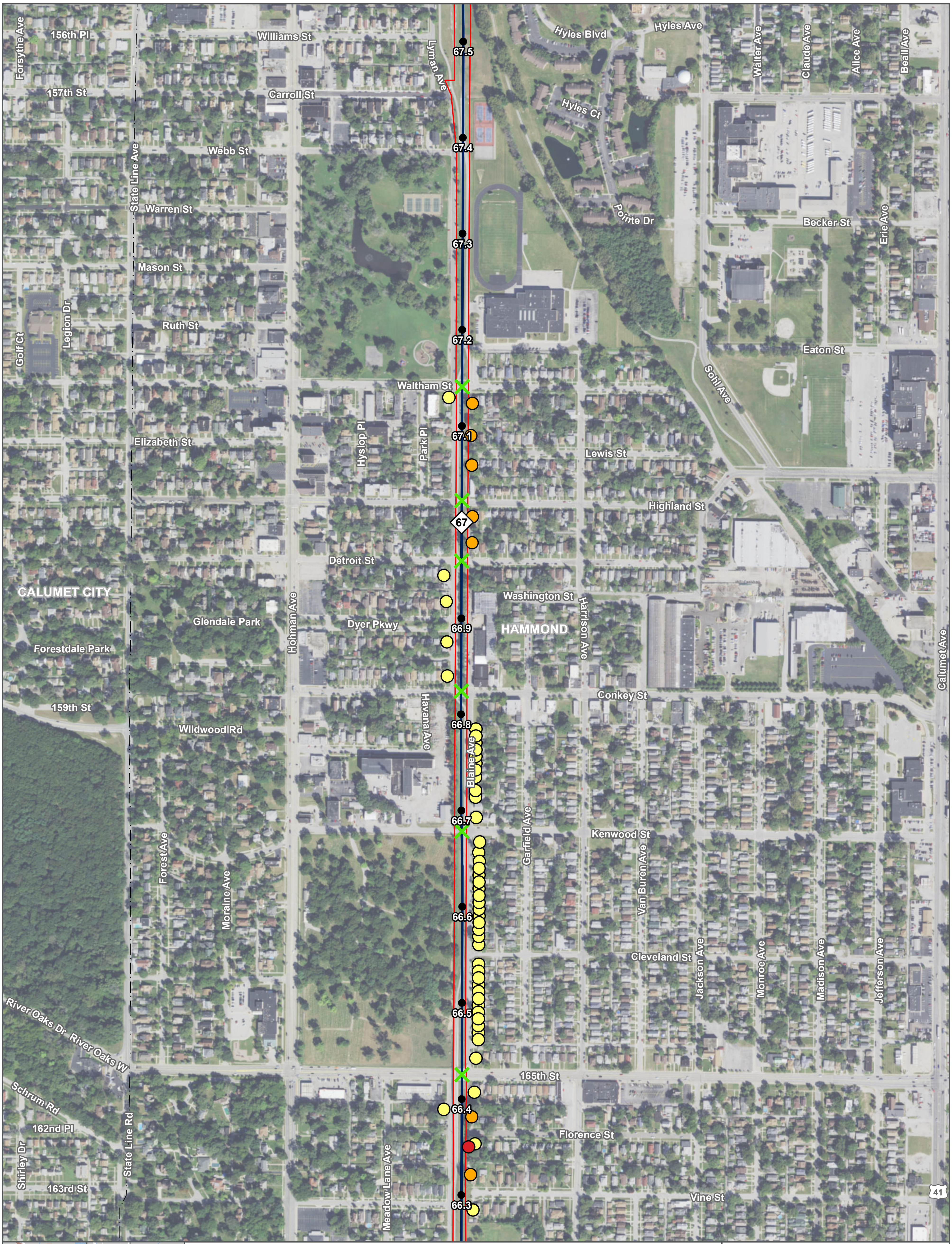
FIGURE B-1 NOISE IMPACTS

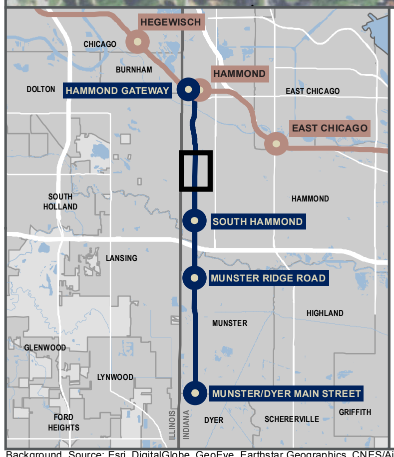
0 500
FEET

SHEET 6 OF 9

Data for Reference Only

Background Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community





- Existing Station
- Proposed Station
- Existing South Shore Line
- FEIS Preferred Alternative
- Project Footprint
- Milepost
- Milepost Stationing
- Proposed Turnouts
- Proposed Grade Crossing

Noise Impact
- Lower Range Moderate Noise Impact
- Upper Range Moderate Noise Impact
- Severe Noise Impact

FIGURE B-1
NOISE IMPACTS

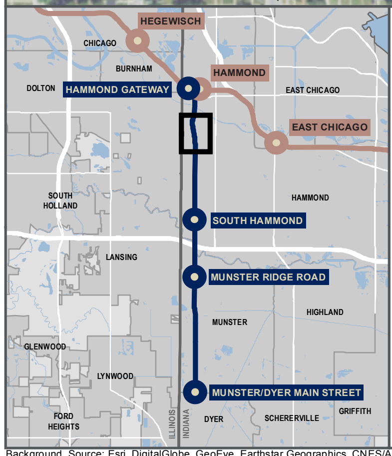
0 500
FEET

WEST LAKE CORRIDOR

SHEET 7 OF 9

Data for Reference Only

Background Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



Existing Station

Proposed Station

Existing South Shore Line

FEIS Preferred Alternative

Project Footprint

Milepost

Milepost Stationing

Proposed Turnouts

Proposed Grade Crossing

Noise Impact

Lower Range Moderate Noise Impact

Upper Range Moderate Noise Impact

Severe Noise Impact

FIGURE B-1
NOISE IMPACTS

N

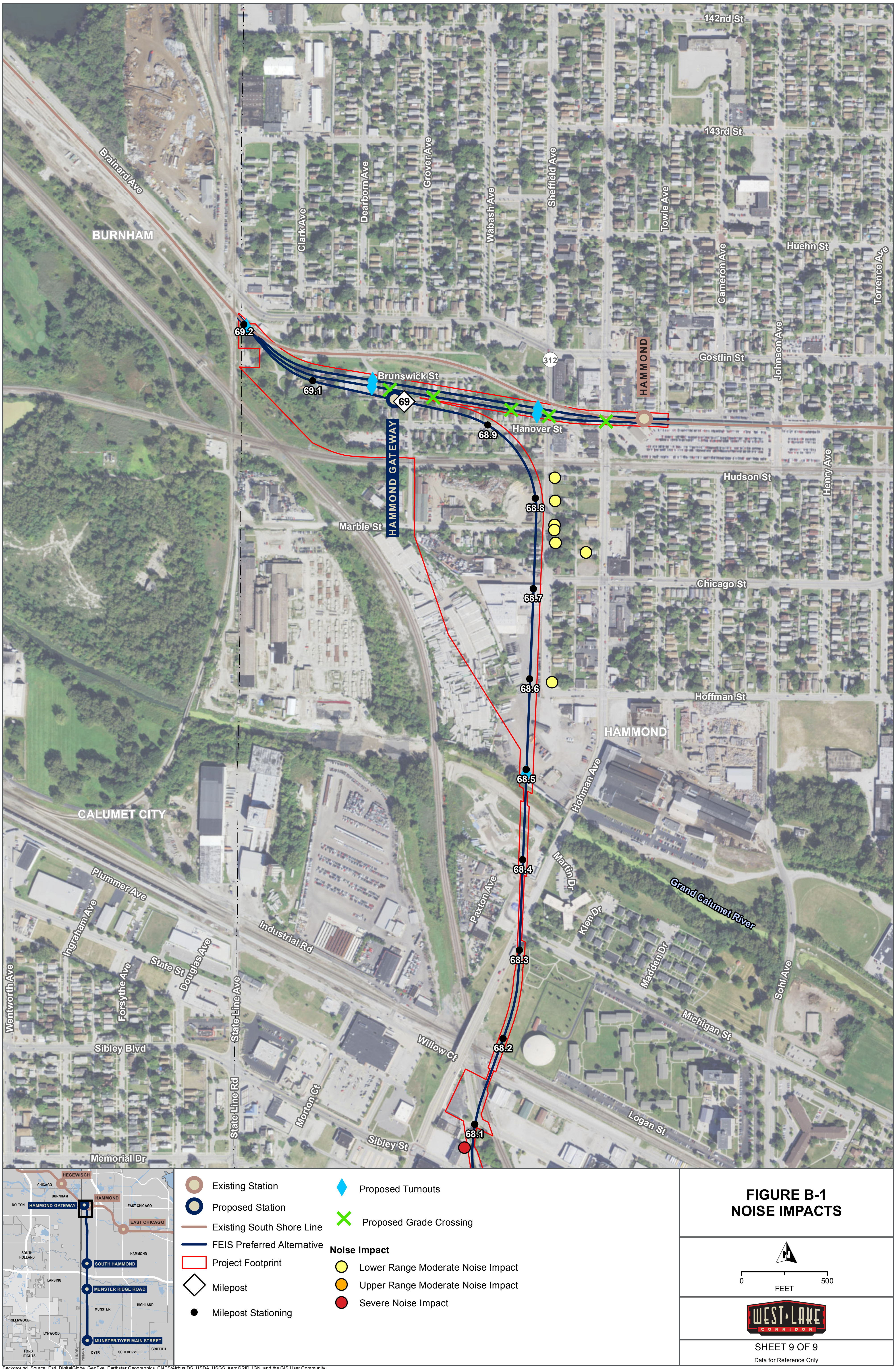
0 500
FEET

WEST LAKE CORRIDOR

SHEET 8 OF 9

Data for Reference Only

Background Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



- Existing Station
- Proposed Station
- Existing South Shore Line
- FEIS Preferred Alternative
- Project Footprint
- Milepost
- Milepost Stationing
- Proposed Turnouts
- Proposed Grade Crossing

Noise Impact

- Lower Range Moderate Noise Impact
- Upper Range Moderate Noise Impact
- Severe Noise Impact

FIGURE B-1
NOISE IMPACTS

0 — 500
FEET

WEST LAKE CORRIDOR

SHEET 9 OF 9

Data for Reference Only

Background Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

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- Existing Station
- Proposed Station
- Existing South Shore Line
- FEIS Preferred Alternative
- Project Footprint
- Milepost
- Milepost Stationing
- Proposed Turnouts
- Proposed Grade Crossing
- Vibration Impact

*Note: Sheets along the corridor are only shown where vibration impacts occur

FIGURE B-2
VIBRATION IMPACTS

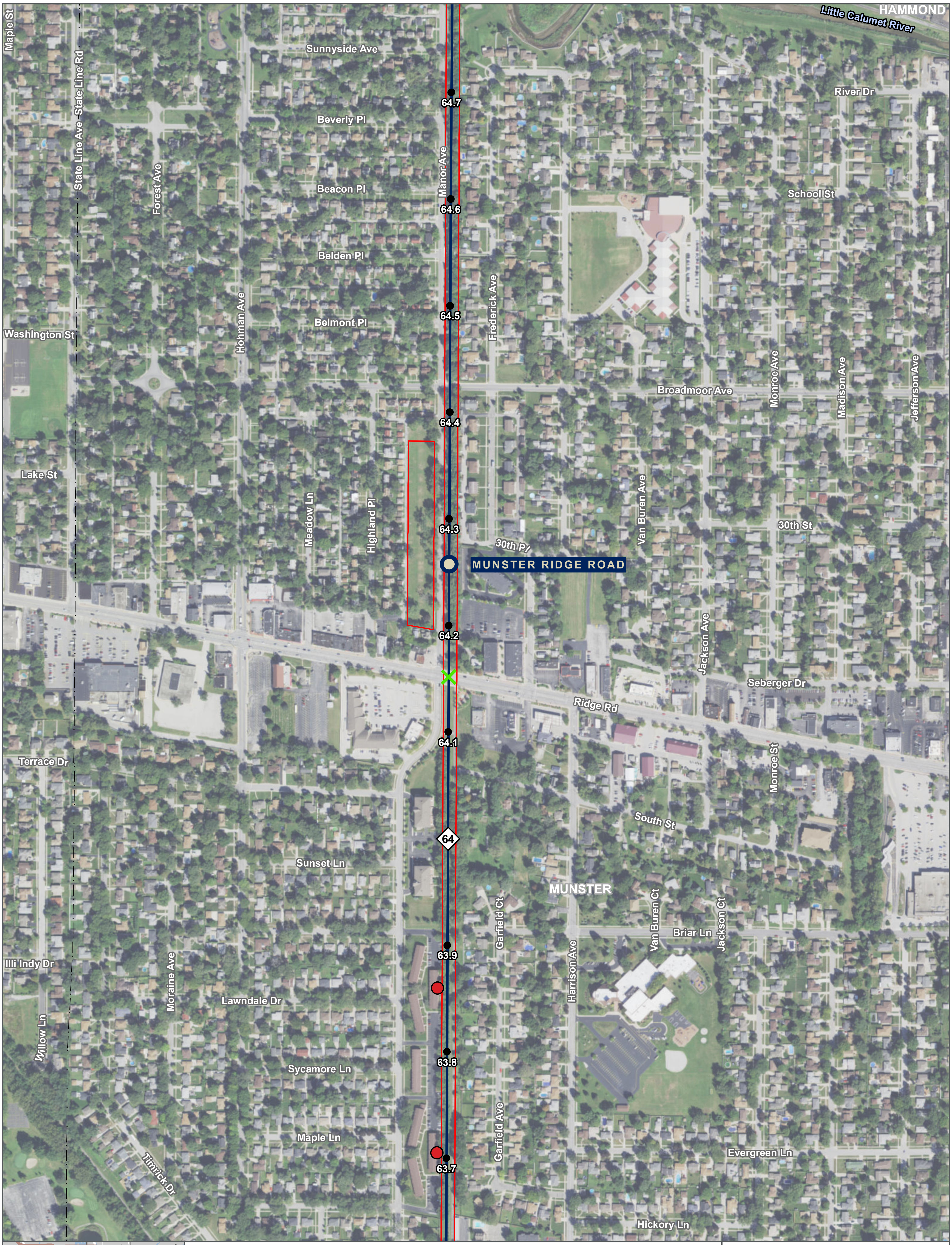
0 500
FEET

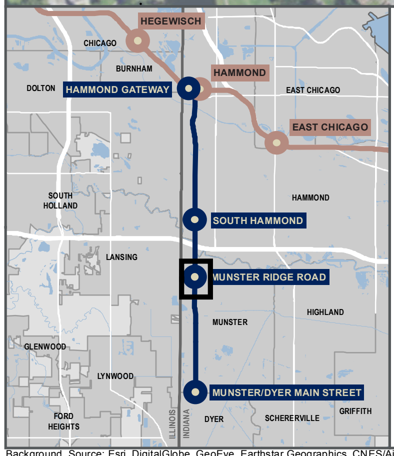
WEST LAKE CORRIDOR

SHEET 1 OF 3

Data for Reference Only

Background Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community





Existing Station
Proposed Station
Existing South Shore Line
FEIS Preferred Alternative
Project Footprint
Milepost
Milepost Stationing
Proposed Turnouts
Proposed Grade Crossing
Vibration Impact

*Note: Sheets along the corridor are only shown where vibration impacts occur

FIGURE B-2
VIBRATION IMPACTS

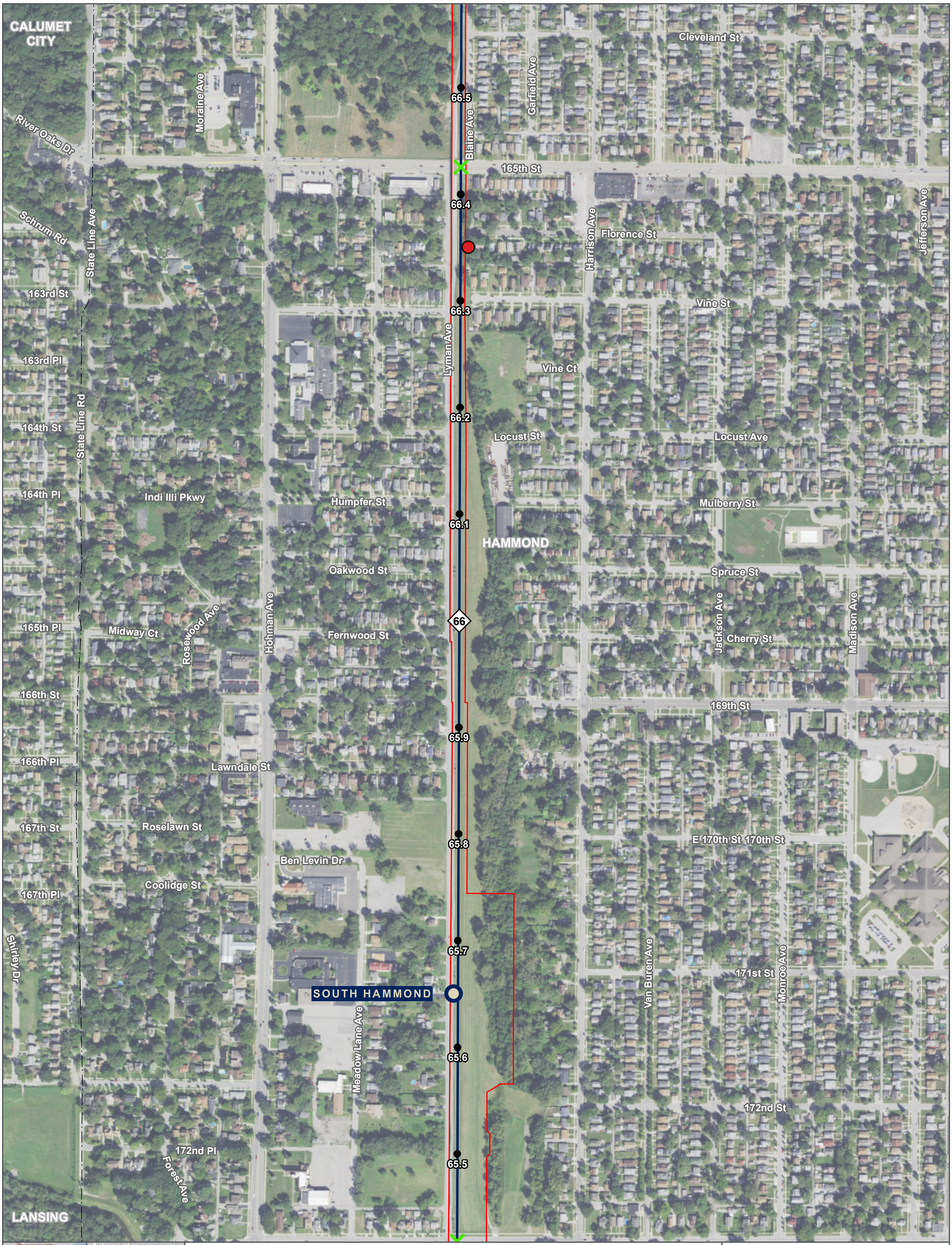
0 500
FEET

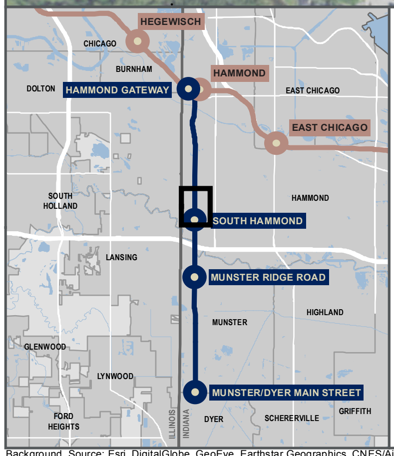
WEST LAKE CORRIDOR

SHEET 2 OF 3

Data for Reference Only

Background Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community





- Existing Station
- Proposed Station
- Existing South Shore Line
- FEIS Preferred Alternative
- Project Footprint
- Milepost
- Milepost Stationing
- Proposed Turnouts
- Proposed Grade Crossing
- Vibration Impact

**Note: Sheets along the corridor are only shown where vibration impacts occur*

FIGURE B-2
VIBRATION IMPACTS

0 500
FEET

WEST LAKE CORRIDOR

SHEET 3 OF 3

Data for Reference Only

Background Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

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