Noise Technical Report
Build Year 2040

GORDIE HOWE INTERNATIONAL BRIDGE

Prepared For:

Michigan Department of Transportation

April 2018

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1.0 Executive Summary

The present traffic noise study re-evaluation analysis was completed as part of an Administrative Re-evaluation of the Environmental Impact Statement (EIS) for the Gordie Howe International Bridge crossing (GHIB); formerly known as the New International Trade Crossing and the Detroit River International Crossing. The study was undertaken consistent with the requirements of the Federal Highway Administration (FHWA) traffic noise regulations as defined in 23 Code of Federal Regulations Part 772 (23 CFR 772) and to conform with the re-evaluation requirements set forth in CFR 771.129. In the State of Michigan, the guidelines governing traffic noise assessment requirements are contained in the Michigan Department of Transportation (MDOT) *Highway Noise Analysis and Abatement Handbook* dated July 2011.

The sound barriers identified in the 2008 GHIB study and subsequently approved as part of the January 14, 2009 ROD commitments were recommended prior to the 2010 revisions to 23 CFR 772 covering Type I roadway improvements. The major elements of the revisions to 23 CFR 772 includes expanding the Noise Abatement Criteria from five to seven land use categories, how dwelling unit equivalents (DUE) are calculated, and how "feasibility and reasonableness" are determined. The details of MDOT's implementation of the 2011 traffic noise policy revisions are described in Chapter 3 of this report. Therefore, the three original sound barriers recommended in 2008 remain recommended today as per the January 2009 ROD commitments and were re-evaluated and optimized for noise reduction based on the present proposed Preferred Alternative highway design configuration under Build Year 2040 traffic projections. In addition, this noise study summarizes the existing and future noise environment and evaluates any additional sound barriers found warranted applying MDOT's present noise abatement policy requirements.

The general project location and the U.S. and Canadian Ports of Entry are shown in Figure 1. The Study Area limits are in the Delay area within the city of Detroit, Wayne County, Michigan as depicted in Figure 2. It is primarily located between Lafayette Street just north of I-75 and the Detroit River to the south, and West End Street and Clark Street (as the respective west and east limits). The river crossing is between Zug Island and historic Fort Wayne, approximately two miles downstream of the existing Ambassador Bridge. This project also includes the relocation of public and private utilities such as gas, electric, combined sewers, water mains, and communication facilities. However, the basic configuration of these project elements has not changed significantly since FHWA approved the Record of Decision (2009). Furthermore, the proposed interior configuration of the toll plaza building may change depending on U.S. General Services Administration (GSA) and U.S. Customs and Border Protection (CBP) requirements.

Noise abatement within the GHIB Study Area evaluated the three previously approved sound barriers identified as part of the January 2009 Record of Decision (ROD) plus three additional sound barrier locations where abatement consideration was warranted based on new impact findings. The previously recommended sound barriers are identified as: Original Barrier 1, Original Barrier 2 and Original Barrier 3. The noise abatement analysis findings at the Original Barrier 2 and 3 now includes barrier extensions that are a result of acoustic effectiveness optimization refinements to the abatement analysis based on the present proposed Preferred Alternative highway design using 2040 Build Year traffic projections. The extension to the Original Barrier 2 is called Extension 2 and the two extensions to Original Barrier 3 are identified as Extension 3A and Extension 3B. Furthermore, the three proposed new sound barriers exceeded MDOT's maximum reasonable cost limit of $45,942 (2017 dollars) per dwelling benefit and are therefore not recommended for further consideration. Figures depicting the location of each of the six sound barriers are contained in Appendix C and a summary of all the abatement analysis findings is provided in Table 10.

2.0 Introduction

This traffic noise analysis has been prepared to evaluate traffic noise as part of an Administrative Re-evaluation of the Environmental Impact Statement (EIS) for the Gordie Howe International Bridge crossing (GHIB); formerly known as the New International Trade Crossing and the Detroit River International Crossing. This report is organized in the following eight sections: Executive Summary (Section 1.0); Introduction (Section 2.0); Fundamental Concepts of Roadway Noise (Section 3.0); Impact Analysis (Section 4.0); Future 2040 Build Conditions with Abatement (Section 5.0); Highway Construction Related Noise (Section 6.0) Conclusions (Section 7.0) and References (Section 8.0). The three appendices are organized as follows: Appendix A includes information related to the noise measurement activities; Appendix B includes illustrations identifying the properties above the noise impact threshold under future build conditions and Appendix C includes illustrations of the location of each evaluated sound barrier and those properties which achieve benefit from the proposed abatement measure.

2.1 Purpose of Study

The present traffic noise study re-evaluation analysis was completed in satisfaction of the requirements of the Federal Highway Administration (FHWA) traffic noise regulations as defined in 23 Code of Federal Regulations Part 772 (23 CFR 772) and to conform with the re-evaluation requirements set forth in CFR 771.129. In the State of Michigan, the guidelines governing traffic noise assessment requirements are contained in the Michigan Department of Transportation (MDOT) *Highway Noise Analysis and Abatement Handbook* dated July 2011. This traffic noise study was completed in full compliance with these requirements.

The sound barriers identified in the 2008 GHIB study and subsequently approved as part of the January 14, 2009 ROD commitments were recommended prior to the 2010 revisions to 23 CFR 772 covering Type I roadway improvements. The major elements of the revisions to 23 CFR 772 include expanding the Noise Abatement Criteria from five to seven land use categories, how dwelling unit equivalents (DUE) are calculated, and how "feasibility and reasonableness" are determined. The details of MDOT's implementation of the 2011 traffic noise policy revisions are described in Section 3.0 of this report. Therefore, the three original sound barriers recommended in 2008 DRIC EIS remain recommended today as per the January 2009 ROD commitments and were re-evaluated and optimized for noise reduction based on the present proposed Preferred Alternative highway design configuration under Build Year 2040 traffic projections. In addition, this noise study summarizes the existing and future noise environment and evaluates any additional sound barriers found warranted applying MDOT's present noise abatement policy requirements.

2.2 Project Description

The proposed Gordie Howe International Bridge is in the cities of Detroit, Michigan, and Windsor, Ontario. It is a bi-national effort to provide safe, efficient movement of people and goods across the U.S.–Canadian border at the Detroit River, including improved connections to national, provincial, and regional systems such I-75 and Highway 401. The proposed project is in the Southeast Michigan Council of Governments' 2040 Regional Transportation Plan and the 2017–2020 Transportation Improvement Program.

In summary, the elements of the Gordie Howe International Bridge project on the US side of the Detroit River include the following:

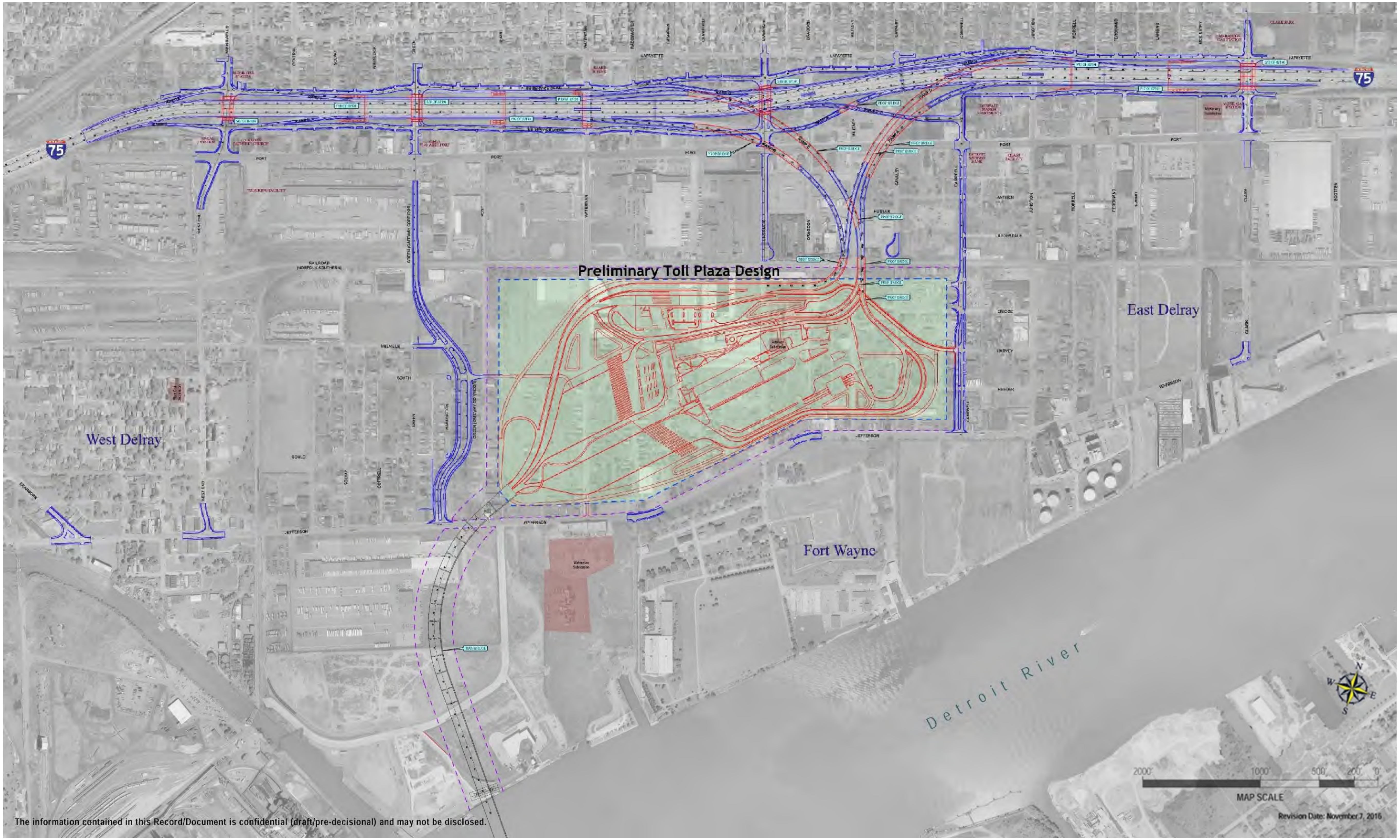
- Construction of a new border crossing between Detroit, Michigan, and Windsor, Ontario
- A new U.S. border inspection plaza
- Replacement of the existing interchange with I-75 in the area defined by Livernois Avenue and Dragoon Street in Detroit, Michigan
- Replacement of five existing pedestrian/bicycle bridges over I-75 near their original locations
- Property acquisition of residential and commercial properties (both occupied and vacant) and nonprofit entities
- Construct a new railroad spur to Zug Island which will divert a maximum of 2 trains per day that pass by the former Southwestern High School and which will also result in the elimination of all idling trains.

This project also includes the relocation of public and private utilities such as gas, electric, combined sewers, water mains, and communication facilities. However, the basic configuration of these project elements has not changed significantly since FHWA approved the Record of Decision (2009). Furthermore, the proposed interior configuration of the toll plaza building may change depending on U.S. General Services Administration(GSA) and U.S. Customs and Border Protection (CBP) requirements.

Figure 1. Project Location

Source: WSP, 2018

Figure 2. Study Area Limits



Source: WSP, 2018

3.0 Fundamental Concepts of Roadway Noise

Physically in the natural environment, sound is generated by the vibration of the air molecules. The vibrations of the air molecules result in small fluctuations in air pressure. A sound wave is created when a series of these pressure waves move through the air. Sound waves vibrate at different rates or "frequencies." The faster an object vibrates, the higher the frequency of the sound wave. Slower vibration rates produce lower frequencies of sound. The human ear can detect a wide range of frequencies from about 20 Hz to 17,000 Hz. The decibel (dB) scale was developed to measure and quantify the loudness of sound energy of different levels of intensity. However, because human hearing sensitivity varies with the frequency of the sound, a weighting system was developed to provide a single number measure that better accounts for the human responses to environmental noise. The following sections describe some of the noise descriptors and impact criteria developed associated with the range of human hearing.

3.1 A-Weighted Sound Level

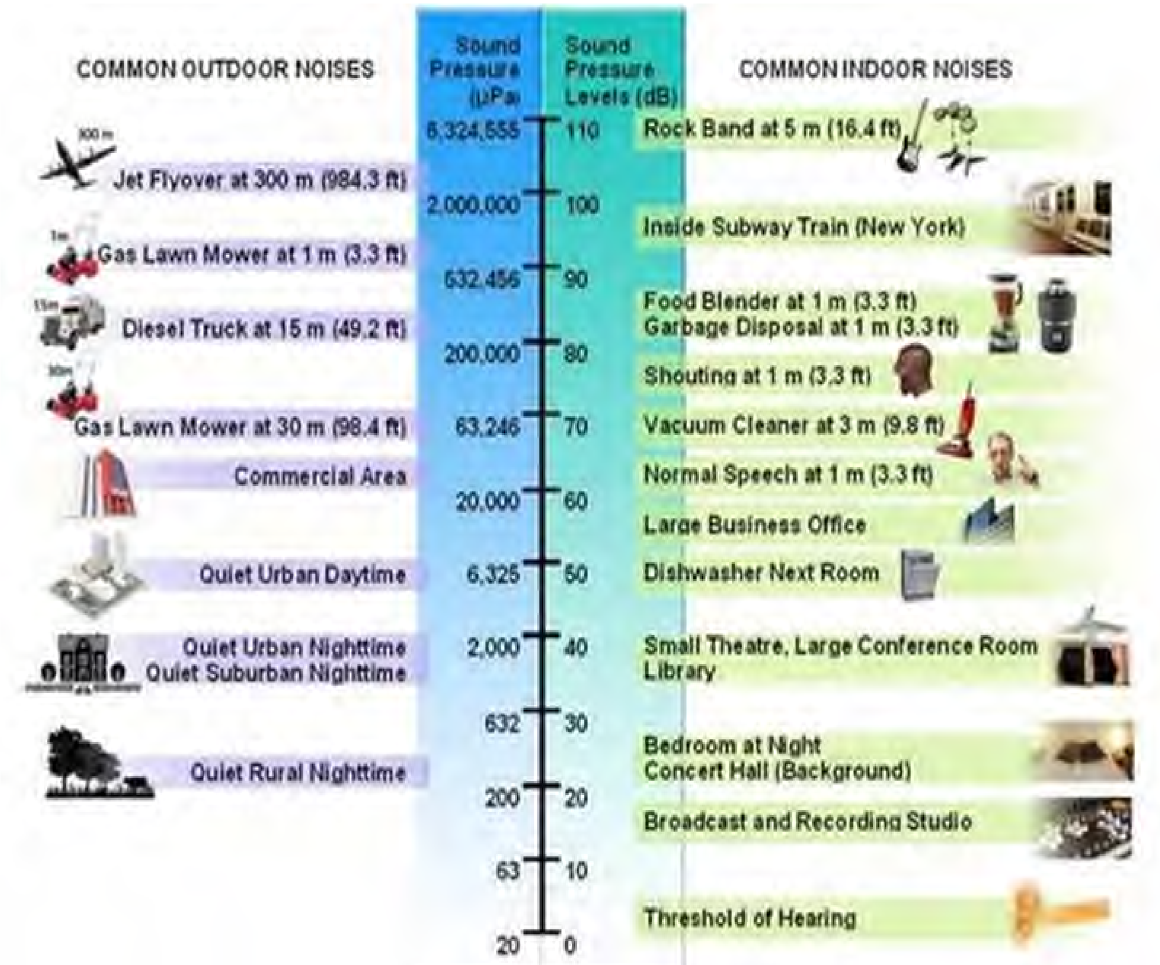
Sounds affecting humans occurs in the natural environment all the time. Some sounds are necessary or desirable for communication or pleasure, many go unnoticed, and other sounds are truly unwanted or irritating. These unwanted sounds result in annoyance and disturbance to the people living or working in the area; therefore, unwanted sound is referred to as noise.

From many experiments with human participants, scientists have found that—unlike animals—the human ear is more sensitive to midrange frequencies as compared to either low or very high frequencies; therefore, at the same sound level, the human ear perceives to hear midrange frequencies louder than low or very high frequencies. This characteristic of the human ear is considered by adjusting or weighting the spectrum of the measured sound level for the sensitivity of human hearing range. The weighting scale that best accounts for the sensitivity of the human hearing range is referred to as the A-weighted scale and is denoted by the "dB(A)" notation. The A-weighted sound level is a measure of sound intensity with one-third octave frequency characteristics that correspond to human response to noise. Acousticians accept the A-weighted sound level as a preferred descriptor for assessing human exposure and annoyance from environmental noise. Figure 3 illustrates some common noise sources and sound pressure levels. An understanding of the following relationships is also helpful in providing a subjective impression of changes in the A-weighted sound level:

- A 3 dB(A) decrease in A-weighted noise level is considered Barely Perceptible and represents a 50 percent loss in sound energy.
- A 5 dB(A) decrease in A-weighted noise level is considered Readily Perceptible and represents a 67 percent loss in sound energy.

- A 10 dB(A) decrease in A-weighted noise level is considered half as loud and represents a 90% loss in sound energy.
- A 20 dB(A) decrease in A-weighted noise level is considered One-Fourth as Loud and represents a 99% loss in sound energy.

Figure 3. Typical Noise Levels



Source: National Highway Institute Course "Highway Traffic Noise" (Publication Number: FHWA-NHI-13-024)

3.2 Noise Level Descriptors

A basic characteristic parameter of environmental noise, particularly near roadways; is its time-varying nature that fluctuates from moment to moment. These fluctuations constitute the time-varying property of roadway noise. Because traffic noise fluctuations vary from moment to moment, it is common practice to condense all the sound energy into a single number, called the “equivalent” sound level (L_{eq}). The L_{eq} is a measure of the average sound energy during a specified period-of- time (typically 1-hour duration). The L_{eq} is defined as the constant level, over a given time interval, that consists of the same amount of acoustical energy at the receiver as the actual time-varying sound. Studies have shown that the A-weighted L_{eq} noise descriptor correlates well with human annoyance to sound; therefore, this descriptor is widely used by government agencies for environmental noise impact assessments. The L_{eq} measured over a 1-hour period is referred to as the hourly L_{eq} or L_{eq} (1-hour) and has been established by FHWA as the preferred noise descriptor to evaluate, analyze, and assess highway traffic noise exposure.

3.3 Noise Impact Criteria

The proposed Gordie Howe International Bridge project and associated roadway improvements are defined as Type I roadway improvements. This classification refers to projects that include federal funding for construction of highways on a new location alignment or to alter an existing highway, resulting in a substantial change in either the horizontal or vertical alignment and or an increase in the number of through-traffic lanes. The noise analysis for this project was conducted in compliance with the federal requirements governing traffic noise outlined in Title 23 of the Code of Federal Regulations, Part 772 (23 CFR 772), entitled: *Procedures for Abatement of Highway Traffic Noise and Construction Noise* and the guidance contained in USDOT/ FHWA report entitled: *Highway Traffic Noise: Analysis and Abatement Guidance*. The basic goals of noise criteria, as they apply to highway projects, are to minimize potential adverse noise impacts to an adjacent community and where determined to be appropriate, provide feasible and reasonable measures to abate noise impacts caused by the proposed roadway improvements.

To determine if highway noise levels are compatible with various land uses, the FHWA has developed noise abatement criteria and procedures to be used in the planning and design of highways. Table 1 presents a summary of the FHWA Noise Abatement Criteria (NAC) for various land uses. These NAC levels represent the lower limit of what would constitute a highway traffic noise impact for specific exterior land uses and activities and for certain indoor activities. An impact occurs when the predicted noise level at a qualified receptor approaches or exceeds the FHWA NAC, or when the difference between existing and future noise levels results in a substantial increase in noise level.

Table 1. FHWA Noise Abatement Criteria (NAC)[1] Hourly A-Weighted Sound Level in dB(A)

Activity Category	Activity Criteria[2]		Evaluation Location	Activity Description
	$L_{eq}(h)$[3]	L10(h)[4]		
A	57	60	Exterior	Lands on which serenity and quiet are of extraordinary significance and serve an important public need and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose.
B[5]	67	70	Exterior	Residential.
C[5]	67	70	Exterior	Active sport areas, amphitheaters, auditoriums, campgrounds, cemeteries, day care centers, hospitals, libraries, medical facilities, parks, picnic areas, places of worship, playgrounds, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, recreation areas, Section 4(f) sites, schools, television studios, trails, and trail crossings.
D	52	55	Interior	Auditoriums, day care centers, hospitals, libraries, medical facilities, places of worship, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, schools, and television studios.
E[5]	72	75	Exterior	Hotels, motels, offices, restaurants/bars, and other developed lands, properties or activities not included in A-D or F.
F	—	—		Agriculture, airports, bus yards, emergency services, industrial, logging, maintenance facilities, manufacturing, mining, rail yards, retail facilities, shipyards, utilities and warehousing.
G	—	—		Undeveloped lands that are not permitted.

1 MDOT defines a noise impact as a 10 dB(A) increase between the existing noise level to the design year predicted noise level OR a predicted design year noise level that is 1 dB(A) less than the levels shown in Table 1.
2 Either $L_{eq}(h)$ or L10(h) (but not both) may be used on a project. MDOT uses $L_{eq}(h)$. The $L_{eq}(h)$ and L10(h) Activity Criteria values are for impact determination only, and are not design standards for noise abatement measures.
3 L_{eq} is the equivalent steady-state sound level which in a stated period-of-time contains the same acoustic energy as the time-varying sound level during the same time-period, with $L_{eq}(h)$ being the hourly value of L_{eq}.
4 L10 is the sound level that is exceeded ten percent of the time (90th percentile) for the period under consideration, with L10 being the hourly value of L10.
5 Includes undeveloped lands permitted for this activity category.

The MDOT interpretation of the federal requirement is in the *MDOT Highway Noise Analysis and Abatement Handbook,* July 2011. MDOT defines "approach" as being within 1 decibel (dB(A)) of each NAC category. Therefore, all residential properties that have exterior L_{eq} levels of 66 dB(A) or higher are considered to "approach or exceed" the NAC "B" land use activity criteria. Similarly, all properties covered by NAC "C" with L_{eq} values of 66 dB(A) or higher would "approach or exceed" the NAC "C" criteria. In addition to the approach threshold impact, MDOT also considers an impact to occur if there is a projected "substantial" noise level increase. A substantial noise level increase is defined as a projected design year noise level increase of 10 dB(A) or more above the corresponding existing noise level. Therefore, a noise impact can occur two separate ways: either when design year noise levels approach or exceed the NAC or when a substantial increase from existing noise levels to project design year conditions is predicted to occur.

When changes to the horizontal or vertical alignment of existing roadways are proposed (Type I roadway improvements), and traffic noise impacts are identified because of these proposed roadway modifications, noise mitigation must be considered. A noise abatement measure is any positive action taken to reduce the impact of traffic noise on an activity area. Consideration for noise abatement does not in itself guarantee the abatement is warranted. In affected communities, several assessment steps are evaluated to determine the *feasibility and reasonableness* of the abatement. The evaluation is based on many factors and considerations, which in equal order of importance include the following:

- Engineering constructability
- Restriction to traffic flow or property access
- Cost effectiveness
- Wall height constraints
- Acoustic effectiveness
- Whether zoning revisions to the existing land use are expected soon

MDOT's specific feasibility and reasonableness requirements are described in the following section.

3.4 Feasibility and Reasonableness

In the communities where impacts are predicted to occur, MDOT has defined a required, specific two-step process to determine if abatement is possible. The following two steps, in respective order, must be considered. It should be noted that if a proposed sound barrier does not pass the *feasibility* phase, the second step of analysis for the *reasonableness* phase is not required, because the sound barrier is no longer considered viable.

- Step 1: Is it **feasible** to provide highway traffic noise abatement from engineering, safety, and the acoustic effectiveness standpoint?
- Step 2: Is it **reasonable** to provide highway traffic noise abatement based on the consideration of the cost/benefit analysis, the viewpoint of a majority of the benefiting residences and property owners, and in providing sufficient noise attenuation?

3.4.1 Step 1: Feasibility Consideration

Once the future build highway design noise modeling analysis has been completed and the properties that exceed the NAC are identified, the noise abatement design is evaluated and assessed for feasibility. The following factors must ***all*** be met in the feasibility phase (Step 1) to continue to the reasonableness phase (Step 2):

1. Can a noise reduction of at least 5 dB(A) be achieved by 75 percent of impacted receptors?
2. Can the sound barrier be designed and physically constructed at the proposed location?
3. Will placement of the sound barrier cause a visual safety problem?
4. Will placement of the sound barrier restrict access to vehicular or pedestrian travel?
5. Will the sound barrier impact utilities or will the utilities impact the sound barriers?
6. Will the sound barrier impact drainage or will the drainage impact the sound barrier?

3.4.2 Step 2: Reasonableness Consideration

Once the feasibility phase steps have been evaluated and if they have been satisfied, a proposed sound barrier is evaluated for reasonableness. All the following cost adjusted for 2017 estimates and acoustic requirements must be satisfied for a proposed sound barrier to be considered reasonable:

1. Determine the total square footage (length multiplied by height) assuming a $45 per square foot unit cost. Determine if the proposed sound barrier be constructed such that the cost per benefiting unit (CPBU) remains below $45,942 (2017).
2. The recommended noise abatement is approved by 50% of benefiting property owners and residents. A benefited receptor is any receptor that achieves a noise reduction of 5 dB(A) or greater noise reduction because of the proposed sound barrier.
3. The reasonableness phase requires a proposed sound barrier to achieve a noise reduction of 10 dB(A) or greater for at least one benefiting receptor and provide at least a 7 dB(A) reduction for 50 percent or more of the benefiting receptor sites.

3.4.2.1 Public Involvement

The views of the property owners and tenants are an essential factor of the reasonableness phase. No recommended abatement measure will be constructed without the approval of the benefitting property owners and residents where the abatement measures are found feasible and reasonable. This approval is determined at a public meeting during the project's final design phase by a majority vote (50% or greater) of the benefiting property owners, residents, and tenants. The meeting may include all affected property owners and residents who are solicited for their opinions and views on the noise barrier's aesthetics (color and texture) as part of the MDOT's Context Sensitive Solution (CSS) process.

4.0 Impact Analysis

Existing noise levels throughout the Study Area were determined for the defined peak-hour PM time periods using the project-developed 2015 traffic volumes. However, before the corridor-wide existing peak-hour estimates can be completed, short-term noise measurements and model validation must be completed. Section 4.1 describes these activities.

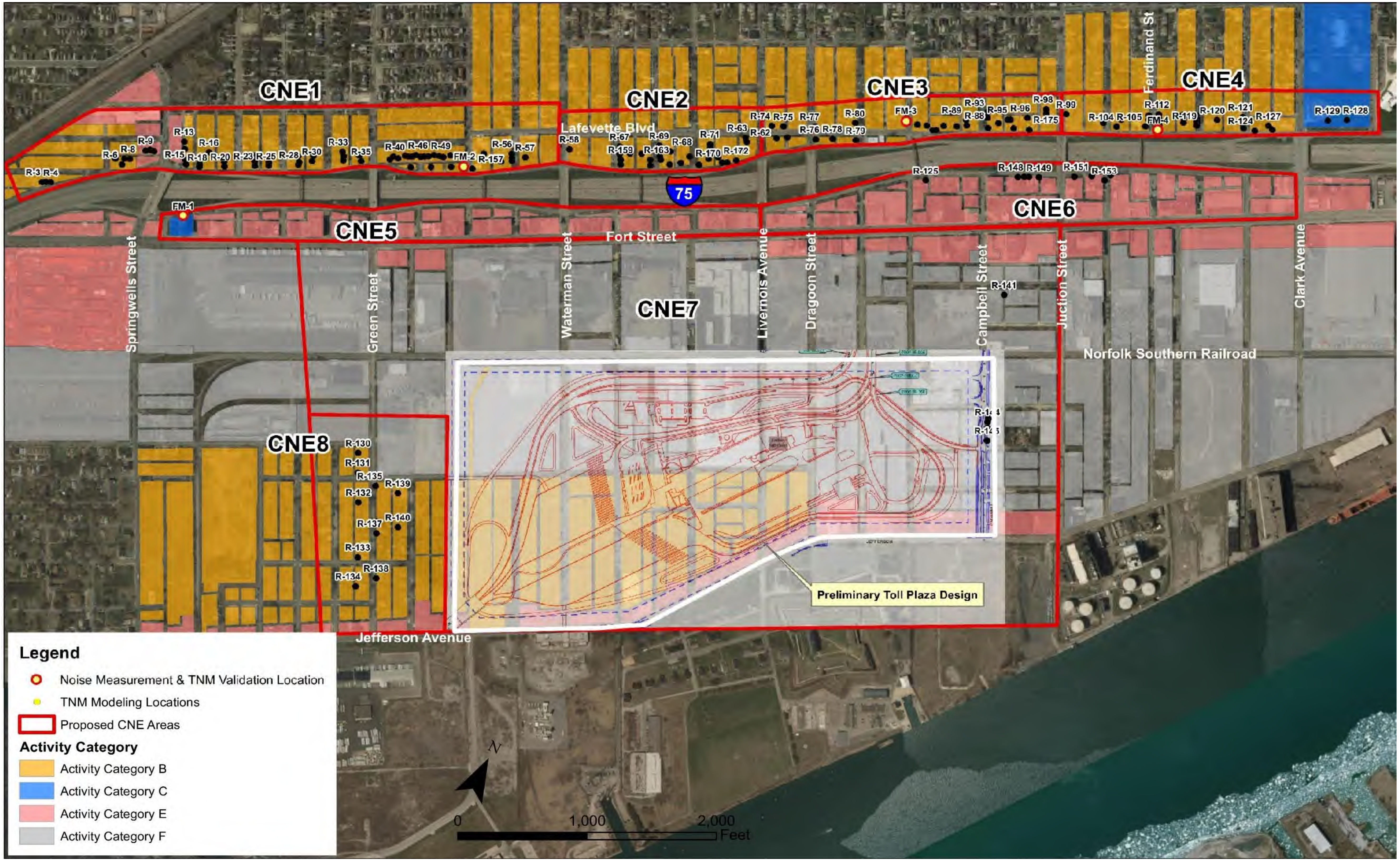
4.1 Traffic Noise Model (TNM) Validation

In accordance with MDOT traffic noise policy requirements, the model of the Study Area needs to be validated to ensure that model estimates of existing noise levels at a specific receptor site are in reasonable agreement with measured levels collected at the same location. Once validated, corridor-wide estimates of TNM model projections can then be made on a large-scale basis throughout the Study Area. To complete the model validation process, simultaneous 15-minute duration noise measurement and traffic counts are conducted at several representative locations that provide a good line-of-sight to I-75. To ensure adequate data is collected for the validation process, several repeated sets of simultaneous traffic counts and noise measurements are collected at each site. During each noise measurement, the traffic counts are collected in the TNM vehicle classification format. Once the traffic counts and noise measurements have been collected, based on observations during the measurement survey, a geometric representation of the study area adjacent to each measurement site is developed and created in TNM using project mapping. In some cases, based on observations made during the field survey, adjustments to the model's physical geometrics are made. At each measurement site, the collected traffic count data are inputted into the TNM model and the file is executed. Once the TNM file is completed, the model-estimated noise levels are compared to the corresponding measured level collected during that traffic count. The TNM estimated noise level must be within plus or minus 3 dB(A) of the corresponding measured level to be considered in good agreement. This process is repeated for each pair of simultaneous traffic count and noise measurement data collected with the final product of this effort providing a series of measured versus predicted noise levels at each site.

The representative sites selected for noise measurement were based on the eight Common Noise Environments (CNE) areas that characterize the ambient noise exposure environment within the project Study Area boundaries. Within these eight CNE Study Areas, MDOT approved the validation at four representative locations identified by the red circle sites depicted in Figure 4. These representative measurement sites were selected based on the Common Noise Environment's (CNE) that characterize the ambient noise environment within the study area. The first site—a frequently used community house of worship, located adjacent to the northbound direction of I-75—was selected for determining window attenuation requirements at this property to ensure interior noise levels do not exceed criteria. The other three noise measurement sites—located in dense residential areas facing I-75 in the southbound direction—were selected in residential communities where noise abatement was considered in the previous November 2008 Traffic Noise Addendum study report.

Noise measurements were collected on several midweek consecutive days using a calibrated Brüel & Kjær (B&K) Type 2238 sound level meter. The microphone was fitted with a windshield, and the sound level meter was mounted on a tripod at approximately 5 feet above the ground. Noise measurement and traffic counts were completed during midweek precipitation-free days with wind conditions of 12 miles per hour or less. During each noise reading, simultaneous traffic counts were collected in the TNM classification format consisting of automobiles, medium trucks (two axles), and heavy trucks (three or more axles). The principal sources of noise in the Study Area were motor vehicles traveling on the I-75 and adjoining service drives. Over a two-day period covering August 8 and 9, 2017, noise readings at each of the four sites were sampled four times from 9:45 AM to about 3:15 PM, when traffic was flowing steadily along the I-75. At the end of the 15-minute measurement period, the L_{eq} noise levels and traffic count data for each reading were recorded and saved. Table 2 provides a summary of the recorded short-term noise measurements and TNM validation results. Therefore, these findings indicate that TNM model of the existing Study Area is considered validated and thus the model can be expanded to include other relevant receptor sites identified throughout the Study Area limits. Appendix A contains a summary of the measured noise levels and associated traffic counts.

Figure 4. Noise Measurement and Prediction Receptor Locations Within Each Common Noise Environment (CNE)



Source: WSP, 2018

Table 2. TNM Validation – Short-Term Noise Measurements versus TNM Estimated Existing Levels

TNM Receptor Number	Address	Land Use	Date	Start Time (1)	Measured (1) Noise Level L_{eq} (1-hr) dB(A)	TNM Noise Level L_{eq} (1-hr) dB(A)	Delta Difference dB(A)
FM-1	7824 Fort Street	House of Worship (All Saints Church)	8/8/17	9:45 AM	72.0	70.7	+ 1.3
			8/8/17	1:25 PM	71.1	71.1	0.0
			8/9/17	9:54 AM	72.4	71.1	+ 1.3
			8/9/17	2:31 PM	72.3	71.7	+ 0.6
						Average Difference	**+ 1**
FM-2	815 Beard Street	Residential	8/8/17	10:30 AM	65.1	66.9	- 1.8
			8/8/17	1:52 PM	64.5	66.9	-2.4
			8/9/17	10:22 AM	65.5	66.9	-1.4
			8/9/17	2:07 PM	67.1	67.2	- 0.1
						Average Difference	**- 1**
FM-3	1015 Cavalry Street	Residential	8/8/17	11:11 AM	62.6	63.0	- 0.4
			8/8/17	2:21 PM	64.8	63.9	+ 0.9
			8/9/17	10:47 AM	63.2	63.4	- 0.2
			8/9/17	1:27 PM	64.6	63.7	+0.9
						Average Difference	**+ 0**
FM-4	1002 Ferdinand Street	Residential	8/8/17	11:40 AM	67.7	69.2	- 1.5
			8/8/17	2:47 PM	68.9	69.6	- 0.7
			8/9/17	11:14 AM	68.8	68.2	+ 0.6
			8/9/17	3:01 PM	68.4	68.9	- 0.5
						Average Difference	**- 1**

(1) Noise measurements were recorded for 15-minute duration per reading.
Source: WSP, 2018

4.2 Predicted Peak-Hour Existing Noise Levels and Impacted Analysis

4.2.1 Existing Noise Levels

A single TNM receiver site is a discrete or representative exterior modeling location of sensitive properties for any of the land uses listed in Table 1 and therefore, each TNM receiver modeling site can represent a single or multiple number of dwelling units. The peak-hour existing noise analysis was determined at 154 receiver locations scattered throughout the Study Area. A depiction of the modeling sites is shown in Figure 4. First and second-row properties that are expected to be taken under future build conditions were not modeled. Table 3 provides a summary of the 2015 peak-hour PM noise level estimates for all TNM modeling receiver sites within the Study Area. Previous TNM analysis completed in the study area indicate the peak PM traffic hour resulted in the greatest noise exposure in the southbound direction which also corresponds to same I-75 direction where most of residential properties and ROD approved sound barriers are located. Noise levels above the impact threshold are shown in bold font. The analysis findings indicate that peak-hour noise levels at or above the 66 dB(A) threshold are projected to occur at 67 out of the 154 TNM modeling sites in the Study Area. In general, noise levels at or above 66 dB(A) were found to occur at the first-row properties to I-75 that have an unobstructed view of the highway.

Most first-row properties have peak-hour noise exposure levels above 66 dB(A). This is particularly acute adjacent to I-75 in the southbound direction where the largest concentrations of residential properties are located within the Study Area. The maximum projected existing peak hour noise level reached 75 dB(A) at receivers R3 and R4. In addition, there were ten other receivers (FM-1, R1, R124–R126, R147–R148 and R150–R152) that have peak-hour noise levels of 74 dB(A). Conversely, existing peak-hour noise levels in the general area of the proposed Inspection Facility area are generally significantly lower the further away from I-75. Peak hour noise levels in the West and East Delray communities adjacent to Green and Campbell Streets were found to be anywhere from 10 or more decibels below the 66 dB(A) impact threshold.

Table 3. Existing and Future Build Noise Level[1] Estimates and Noise Level Change

ID	Land Use	NAC Category	Receptor Units	Sound Level, dB(A) L_{eq}(1h) [1]			
				NAC [2]	Existing (Year)	Build[3] (Year)	Change
					PM	PM	PM
FM-1	House of Worship	C & D	1	67/52	**74**	**75**	1
R-1	Residential	B	1	67	**74**	**75**	1
R-3	Residential	B	1	67	**75**	**75**	0
R-4	Residential	B	1	67	**75**	**76**	1
R-5	Residential	B	1	67	56	57	1
R-6	Residential	B	1	67	**70**	**71**	1
R-7	Residential	B	1	67	63	64	1
R-8	Residential	B	1	67	64	**67**	3
R-9	Residential	B	1	67	**67**	**69**	2
R-10	Residential	B	1	67	**67**	**70**	3
R-11	Residential	B	1	67	**67**	**71**	4
R-12	Residential	B	1	67	63	**66**	3
R-13	Residential	B	1	67	60	63	3
R-14	Residential	B	1	67	**68**	**70**	2
R-15	Residential	B	1	67	**71**	**73**	2
R-16	Residential	B	1	67	**65**	**67**	2
R-17	Residential	B	1	67	**69**	**71**	2
R-18	Residential	B	1	67	**73**	**75**	2
R-19	Residential	B	1	67	**67**	**69**	2
R-20	Residential	B	1	67	**73**	**75**	2
R-21	Residential	B	1	67	64	**66**	2
R-22	Residential	B	1	67	**67**	**69**	2
R-23	Residential	B	1	67	**72**	**74**	2
R-24	Residential	B	1	67	**67**	**69**	2
R-25	Residential	B	1	67	**72**	**74**	2
R-26	Residential	B	1	67	65	**67**	2
R-27	Residential	B	1	67	**70**	**71**	1
R-28	Residential	B	1	67	**73**	**74**	1
R-29	Residential	B	1	67	**66**	**68**	2
R-30	Residential	B	1	67	**70**	**72**	2
R-31	Residential	B	1	67	**69**	**71**	2
R-32	Residential	B	1	67	**66**	**68**	2
R-33	Residential	B	1	67	64	**66**	2
R-34	Residential	B	1	67	**66**	**69**	3
R-35	Residential	B	1	67	**72**	**74**	2
R-36	Residential	B	1	67	**68**	**69**	1
R-37	Residential	B	1	67	**66**	**68**	2
R-38	Residential	B	1	67	**67**	**68**	1
R-39	Residential	B	1	67	65	**67**	2

(1) All noise level and noise reduction estimates shown are rounded to nearest whole number.
(2) NAC noise impact threshold level is one decibel less than the values shown.
(3) Impacted receptor locations are shown in bold face font and gray shadow highlight.
Source: WSP, 2018

Table 3. Existing and Future Build Noise Level[1] Estimates and Noise Level Change (continued)

ID	Land Use	NAC Category	Receptor Units	Sound Level, dB(A) L_{eq}(1h) (1)			
				NAC (2)	Existing (Year) PM	Build(3) (Year) PM	Change PM
R-40	Residential	B	1	67	64	**67**	3
R-41	Residential	B	1	67	63	**67**	4
R-42	Residential	B	1	67	63	**66**	3
R-43	Residential	B	1	67	63	**66**	3
R-44	Residential	B	1	67	63	65	2
R-45	Residential	B	1	67	63	**66**	3
R-46	Residential	B	1	67	63	**66**	3
R-47	Residential	B	1	67	64	**67**	3
R-48	Residential	B	1	67	64	**68**	4
R-49	Residential	B	1	67	63	**67**	4
R-51	Residential	B	1	67	63	**67**	4
FM-2	Residential	B	1	67	**67**	Take	Take
R-52	Residential	B	1	67	60	**66**	6
R-53	Residential	B	1	67	**67**	**69**	2
R-54	Residential	B	1	67	**66**	**69**	3
R-55	Residential	B	1	67	64	**67**	3
R-56	Residential	B	1	67	64	**66**	2
R-57	Residential	B	1	67	**67**	**69**	2
R-58	Educational	C	2	67/52	63	65	2
R-59	Residential	B	1	67	65	**70**	5
R-60	Residential	B	1	67	62	**69**	7
R-61	Residential	B	1	67	65	**67**	2
R-62	Residential	B	1	67	61	64	3
R-63	Residential	B	1	67	61	65	4
R-64	Residential	B	1	67	64	**71**	7
R-65	Residential	B	1	67	64	**71**	7
R-66	Residential	B	1	67	64	**69**	5
R-67	Residential	B	1	67	63	**67**	4
R-68	Residential	B	1	67	64	**69**	5
R-69	Residential	B	1	67	63	**67**	4
R-70	Residential	B	1	67	62	**68**	6
R-71	Residential	B	1	67	61	**67**	6
R-72	Residential	B	1	67	65	**66**	1
R-73	Residential	B	1	67	63	65	2
R-74	Residential	B	1	67	58	61	3
R-75	Residential	B	1	67	58	60	2
R-76	Residential	B	1	67	**69**	**70**	1
R-77	Residential	B	1	67	62	64	2
R-78	Residential	B	1	67	**67**	**68**	1

(1) All noise level and noise reduction estimates shown are rounded to nearest whole number.
(2) NAC noise impact threshold level is one decibel less than the values shown.
(3) Impacted receptor locations are shown in bold face font and gray shadow highlight.
Source: WSP, 2018

Table 3. Existing and Future Build Noise Level[1] Estimates and Noise Level Change (continued)

ID	Land Use	NAC Category	Receptor Units	Sound Level, dB(A) L_{eq}(1h) (1)			
				NAC (2)	Existing (Year) PM	Build(3) (Year) PM	Change PM
R-79	Residential	B	1	67	**69**	**67**	-2
R-80	Residential	B	1	67	60	62	2
R-81	Residential	B	1	67	60	63	3
FM-3	Residential	B	1	67	62	64	2
R-82	Residential	B	1	67	**66**	**67**	1
R-83	Residential	B	1	67	**66**	**66**	0
R-84	Residential	B	1	67	**70**	**70**	0
R-85	Residential	B	1	67	**70**	**70**	0
R-86	Residential	B	1	67	**68**	**67**	-1
R-87	Residential	B	1	67	**70**	**68**	-2
R-88	Residential	B	1	67	**70**	**69**	-1
R-89	Residential	B	1	67	65	65	0
R-90	Residential	B	1	67	63	63	0
R-91	Residential	B	1	67	65	65	0
R-92	Residential	B	1	67	65	64	-1
R-93	Residential	B	1	67	62	63	1
R-94	Residential	B	1	67	55	**67**	12
R-95	Residential	B	1	67	57	**67**	10
R-96	Residential	B	1	67	56	**68**	12
R-97	Residential	B	1	67	59	**67**	8
R-98	Residential	B	1	67	59	**66**	7
R-99	Residential	B	1	67	62	**68**	6
R-101	Residential	B	1	67	61	**66**	5
R-102	Residential	B	1	67	**67**	**69**	2
R-103	Residential	B	1	67	63	65	2
R-104	Residential	B	1	67	**69**	**72**	3
R-105	Residential	B	1	67	**69**	**70**	1
R-106	Residential	B	1	67	65	**66**	1
R-107	Residential	B	1	67	62	62	0
R-108	Residential	B	1	67	**70**	**72**	2
R-109	Residential	B	1	67	**67**	**68**	1
R-110	Residential	B	1	67	65	**66**	1
R-111	Residential	B	1	67	62	64	2
R-112	Residential	B	1	67	61	63	2
R-113	Residential	B	1	67	**66**	**67**	1
FM-4	Residential	B	1	67	**71**	**73**	2
R-114	Residential	B	1	67	63	65	2
R-115	Residential	B	1	67	62	64	2
R-116	Residential	B	1	67	62	63	1

(1) All noise level and noise reduction estimates shown are rounded to nearest whole number.
(2) NAC noise impact threshold level is one decibel less than the values shown.
(3) Impacted receptor locations are shown in bold face font and gray shadow highlight.
Source: WSP, 2018

Table 3. Existing and Future Build Noise Level[1] Estimates and Noise Level Change (continued)

ID	Land Use	NAC Category	Receptor Units	Sound Level, dB(A) $L_{eq}(1h)$ (1) NAC (2)	Existing (Year) PM	Build(3) (Year) PM	Change PM
R-117	Residential	B	1	67	63	65	2
R-118	Residential	B	1	67	65	**67**	2
R-119	Residential	B	1	67	**68**	**70**	2
R-120	Residential	B	1	67	64	**66**	2
R-121	Residential	B	1	67	63	65	2
R-122	Residential	B	1	67	**66**	**68**	2
R-123	Residential	B	1	67	**71**	**73**	2
R-124	Residential	B	1	67	**74**	**75**	1
R-125	Residential	B	1	67	**74**	**75**	1
R-126	Residential	B	1	67	**74**	**75**	1
R-127	Residential	B	1	67	**70**	**70**	0
R-128	Playground	C	2	67	**71**	**72**	1
R-129	Playground	C	2	67	**72**	**73**	1
R-130	Residential	B	1	67	45	46	1
R-131	Residential	B	1	67	50	51	1
R-132	Residential	B	1	67	51	52	1
R-133	Residential	B	1	67	48	50	2
R-134	Residential	B	1	67	47	52	5
R-135	Residential	B	1	67	58	52	-6
R-136	Residential	B	1	67	56	50	-6
R-137	Residential	B	1	67	56	49	-7
R-138	Residential	B	1	67	56	48	-8
R-139	Residential	B	1	67	51	52	1
R-140	Residential	B	1	67	48	52	4
R-141	Residential	B	1	67	58	58	0
R-142	Residential	B	1	67	54	56	2
R-143	Residential	B	1	67	54	56	2
R-144	Residential	B	1	67	54	56	2
R-145	Residential	B	1	67	54	56	2
R-146	Residential	B	1	67	**73**	**74**	1
R-147	Residential	B	1	67	**74**	**75**	1
R-148	Residential	B	1	67	**74**	**75**	1
R-149	Residential	B	1	67	**73**	**74**	1
R-150	Residential	B	1	67	**74**	**74**	0
R-151	Residential	B	1	67	**74**	**74**	0
R-152	Residential	B	1	67	**74**	**75**	1
R-153	Residential	B	1	67	**71**	**70**	-1

(1) All noise level and noise reduction estimates shown are rounded to nearest whole number.
(2) NAC noise impact threshold level is one decibel less than the values shown.
(3) Impacted receptor locations are shown in bold face font and gray shadow highlight.
Source: WSP, 2018

4.2.2 Future Build Noise Levels

Table 3 provides a summary of the future build year 2040 Build noise levels under 2040 peak-hour PM traffic conditions for all 154 TNM modeling receiver sites evaluated within the Study Area. A single TNM receiver point is a discrete or representative exterior modeling location of sensitive properties for any of the land uses listed in Table 1 and therefore each TNM receiver modeling site can represent a single or multiple number of equivalent dwelling units (receptors). Most of the modeled receivers within the Study Area consist of single family homes and as such are evaluated as NAC "B" land use activity category which has an impact threshold level of 66 dB(A). In addition, few receivers consist of NAC category "C" land use category that consist of a place of worship (FM-1, All Saints Church, recently closed as a place of worship, but currently being used as a pantry), playground (R-128 and R-129) and Beard Elementary School (R-58). NAC "C" land uses are evaluated applying the 66 dB(A) exterior noise impact threshold plus a 51 dB(A) interior impact criterion for churches and schools. The land use categories of all the receiver sites modeled are listed in Table 3.

Future Build year 2040 noise level estimates were determined using the peak hour AM and PM traffic projections developed for the Study Area. The highway design geometrics of the proposed Preferred Alternative were inputted into the TNM model and noise level estimates for both time peak time periods were determined at each of the 154 receiver locations identified throughout the Study Area. A depiction of the TNM modeling sites is shown in Figure 4. Except for receiver FM-2, which served as a validation site, properties that are expected to be taken because of I-75 widening under future build conditions were not modeled. A summary of the future 2040 Build peak hour AM and PM noise level estimates are shown in Table 3. The analysis findings indicate that peak-hour noise levels at or above the 66 dB(A) threshold are expected to occur at 109 out of the 154 TNM modeling sites evaluated within the Study Area. Modeling sites in Table 3 where future noise level impacts are projected to occur are identified by bold face text and a gray shadow box. In general, future 2040 Build noise levels at or above 66 dB(A) are projected to occur at the first and second-row properties to I-75 that have at least a partial view of the highway with the highest noise exposure levels occurring at those properties that have an unobstructed view of I-75 traffic movements. Illustrations identifying the properties which are projected to exceed the impact threshold during future peak hour traffic conditions are provided in Appendix B of this report. A red dot indicates an exterior noise level at or above 66 dB(A) and a green dot represents a property expected to remain below the impact threshold. Most of noise sensitive properties within the Study Area will have peak-hour noise exposure above the 66 dB(A) impact threshold. This is particularly acute adjacent to I-75 in the southbound direction where the largest concentration of residential properties is located. The maximum projected noise levels under future build condition was reported to be 76 dB(A) at receiver R4 and there were nineteen other properties, identified by TNM receivers R1, R3, R18, R20, R23, R24, R28, R35, R125, R126, R146 to R152, FM1 and FM4 have projected build year 2040 peak-hour noise exposure level reaching 74 or 75 dB(A). Additionally, the greatest existing to build increase in noise levels is projected to occur at receptors R94, R95 and R96 reaching 10 to 12 dB(A). The large existing to build noise level increase is due in part to the fact that first row properties in front of these three sites are being removed under the proposed build design. Consequently, these second-row properties lose their first row shielding and as a result they become first row properties under build conditions- thus increases their I-75 noise exposure. Furthermore, these three properties have a partial visual exposure to the proposed I-75 connecting ramps (Ramps D and H) which exacerbates their noise exposure condition further. The projected build noise level at R94, R95 and R96 is expected to reach slightly above the 66 dB(A) impact threshold reaching 67 to 68 dB(A). Fortunately, these impacts are mitigated by Original Barrier 2 and the proposed Original Barrier 3A extension.

Conversely, south of I-75, in the West and East Delray residential communities adjacent to Green and Campbell Street in the general area of the proposed US side Inspection Facility projected peak-hour noise levels are significantly lower and range anywhere from 5 to 10 dB(A) below 66 dB(A) impact threshold. Moreover, due to the proposed relocation of Green Street away from these properties some receivers (R-135 to R-138) are projected to result in lower future build noise levels than existing peak hour levels experienced today. Lastly, interior noise levels at the two NAC "D" land uses, FM-1 (All Saints Church) and R58 (Beard Elementary School) are expected to remain below the 51 dB(A) interior noise impact threshold assuming a 25 dB(A) window attenuation.

5.0 Future 2040 Build Conditions with Abatement

Noise abatement is considered in residential communities where projected future build noise levels are found to exceed MDOT impact criteria. The first step of the abatement process requires noise abatement to be evaluated for feasibility. Feasibility considerations involve primarily engineering and safety concerns plus achieving a 5 dB(A) noise reduction at 75 percent of the impacted receptors. The details of the feasibility requirements are described in Section 3.4.1. If all the feasibility requirements are satisfied, then reasonableness is considered. Section 3.4.2 describes these requirements in detail. Reasonableness deals primarily with overall acoustic and cost-effectiveness requirements as defined by MDOT policy. For example, for a proposed sound barrier to be cost effective, the maximum cost per benefited dwelling unit (CPBU) cannot exceed $45,942. The noise abatement analysis findings are discussed in detail in the following section.

5.1 Noise Abatement Findings

Noise abatement within the GHIB Study Area was re-evaluated at the three previously approved sound barriers locations identified in the January 2009 Record of Decision (ROD). Furthermore, the present 2040 Build year noise impact analysis identified three additional sound barrier locations that were evaluated applying the present MDOT feasibility and reasonableness requirements. Five of the six sound barriers are positioned along the southbound side of I-75 where the largest cluster of residential properties is located within the Study Area. The noise abatement analysis was completed for the peak PM time-period which under build conditions generated the highest (worst) traffic noise exposure adjacent to the southbound direction. The previously ROD recommended sound barriers are identified as: Original Barrier 1, Original Barrier 2 and Original Barrier 3. The noise abatement analysis at Original Barrier 2 and 3 now includes barrier extensions that are a result of further noise reduction refinements to the abatement analysis based on the present proposed Preferred Alternative. The extension to Original Barrier 2 is called Extension 2 and the extensions to Original Barrier 3 are identified as Extension 3A and Extension 3B. The three-new proposed sound barriers are referred as: New Barrier 1A and 1B, New Barrier 4A and 4B and Northbound Sound Barrier. A depiction of the configuration of each of these sound barriers is contained in Appendix C.

TNM receivers depicted in the Appendix C sound barrier illustrations fall into three categories: receivers that achieve a 5 dB(A) or greater noise reduction (depicted by a green dot), receivers that are not benefited (depicted by a red dot) and a third category which indicates a non-impacted receiver that achieves a 5 dB(A) or greater noise reduction (depicted by a blue dot). In accordance with MDOT policy requirements, summary tables of the feasibility and reasonableness of each sound barrier are contained in Table 4 to Table 9. In addition, a condensed summary of all the abatement analysis findings is provided in Table 10.

The sound barriers identified in the 2008 GHIB study that were approved in the January 14, 2009 ROD were re-assessed and optimized for noise reduction, cost and overall acoustic effectiveness. These three original sound barriers were recommended prior to the 2010 revisions of the FHWA traffic noise regulations contained in 23 Code of Federal Regulations (CFR) Part 772 covering Type I roadway improvements. The revisions to the federal traffic noise policy requirements as implemented by the MDOT are described in detail in MDOT Highway Noise Analysis and Abatement Handbook (July 2011). The most noteworthy changes to 23 CFR 772 since the completion of 2008 GHIB noise study, include expanding the Noise Abatement Criteria from five to seven land use categories, how dwelling unit equivalents (DUE) are calculated, and how "feasibility and reasonableness" are determined. The details of MDOT's abatement policy requirements are described in Section 3.0 of this report. Therefore, these three original sound barriers that were recommended in 2008 remain recommended today as per the January 2009 ROD commitments. However, in the present study these 2009 ROD approved sound barriers were re-evaluated and optimized for noise reduction based on the present proposed Preferred Alternative highway design configuration under Build Year 2040 traffic projections. A summary of the feasibility and reasonableness analysis findings at the three ROD walls is contained in Tables 4, 5 and 6.

In addition, the present 2040 impact analysis identified three additional areas where noise abatement is warranted and therefore sound barriers are considered. Abatement was not considered in these areas in the 2008 study and therefore since these are new sound barrier locations each proposed sound wall was evaluated against the 2011 MDOT traffic noise abatement policy requirements described in Section 3.0. The TNM modeling feasibility and reasonableness analysis findings for the new proposed sound barrier locations are contained in Table 7 through Table 9. All three proposed sound barriers achieve a 5 dB(A) or greater noise reduction at 75% or more of the impacted properties, however, none could achieve these noise reductions at reasonable cost. All new proposed sound barriers exceeded MDOT's reasonable unit cost of $45,942 per benefiting dwelling. Therefore, these three-new proposed sound barrier locations are not recommended and thus should be dropped from further consideration.

Table 4. Feasibility and Reasonableness Assessment of Proposed Southbound Original Barrier 1

FEASIBILITY CONSIDERATION	YES OR NO
Engineering Consideration: Can the abatement measure be built?	Yes [(1)]
Acoustic Consideration: Does the proposed abatement measure provide a reduction of at least 5 dB(A) at 75% of the impacted receptors?	Yes [(1)]
REASONABLENESS CONSIDERATION	**YES OR NO**
Design Goal: Does the proposed abatement measure provide a reduction of 10 dB(A) for one benefiting receptor and at least 7 dB(A) at 50% or more of the benefiting receptor sites?	No, but wall was recommended as per ROD [(1)]
Design Goal: Does the proposed abatement measure cost less than $45,942 per benefiting receptor site?	No, but wall was recommended as per ROD [(1)]
Viewpoint of Benefiting Property Owners and Residences: Were positive responses in favor of the abatement measure obtained from at least 50% or more of the tallied votes?	Next Phase [(1)]
DETAILS OF THE ABATEMENT MEASURE COST AND ACOUSTIC EFFECTIVE FINDINGS	
Impacted Receptors Behind Proposed Sound Barrier(s)	20
# of Impacted Receptors with 5 dB(A) Noise Reduction	6
% of Impacted Receptors with 5 dB(A)Noise Reduction	30%
Total number of Impacted Plus Non-Impacted Benefits	6
# of Impacted Receptors with 7 dB(A) Noise Reduction	0
% of Impacted Receptors with 7 dB(A) Noise Reduction	0%
# of Impacted Receptors with 10 dB(A)Noise Reduction	0
Total Cost (dollars)	$787,500
Cost Per Benefitting Receptor Unit (CPBU in dollars)	$131,250
Total Length (feet)	1,250 ft.
Average Height (feet)	14 ft.
Total Square Footage (feet^2)	17,500 ft.^{2}

(1) If all the questions can be answered "Yes" then the abatement measure is considered feasible and reasonable.
Source: WSP, 2018

Table 5. Feasibility and Reasonableness Assessment of Proposed Southbound Original Barrier 2 with Extension

FEASIBILITY CONSIDERATION	YES OR NO
Engineering Consideration: Can the abatement measure be built?	Yes (1)
Acoustic Consideration: Does the proposed abatement measure provide a reduction of at least 5 dB(A) at 75% of the impacted receptors?	Yes (1)
REASONABLENESS CONSIDERATION	**YES OR NO**
Design Goal: Does the proposed abatement measure provide a reduction of 10 dB(A) for one benefiting receptor and at least 7 dB(A) at 50% or more of the benefiting receptor sites?	No, but wall was recommended as per ROD (1)
Design Goal: Does the proposed abatement measure cost less than $45,942 per benefiting receptor site?	No, but wall was recommended as per ROD (1)
Viewpoint of Benefiting Property Owners and Residences: Were positive responses in favor of the abatement measure obtained from at least 50% or more of the tallied votes?	Next Phase (1)
DETAILS OF THE ABATEMENT MEASURE COST AND ACOUSTIC EFFECTIVE FINDINGS	
Impacted Receptors Behind Proposed Sound Barrier(s)	13
# of Impacted and non-impacted Receptors with 5 dB(A) Noise Reduction	13
% of Impacted Receptors with 5 dB(A)Noise Reduction	100%
Total number of Impacted Plus Non-Impacted Benefits	18
# of Impacted Receptors with 7 dB(A) Noise Reduction	10
% of Impacted Receptors with 7 dB(A) Noise Reduction	77%
# of Impacted Receptors with 10 dB(A)Noise Reduction	0
Total Cost (dollars)	$1,296,675
Cost Per Benefitting Receptor Unit (CPBU in dollars) includes 14 non-impacted benefited receptors)	$72,038
Total Length (feet)	1,921 ft.
Average Height (feet)	15 ft.
Total Square Footage (feet^2)	28,815 ft.^{2}

(1) If all the questions can be answered “Yes” then the abatement measure is considered feasible and reasonable.

Source: WSP, 2018

Table 6. Feasibility and Reasonableness Assessment of Proposed Southbound Original Barrier 3 plus New Barrier Extension 3A and 3B

FEASIBILITY CONSIDERATION	YES OR NO
Engineering Consideration: Can the abatement measure be built?	Yes (1)
Acoustic Consideration: Does the proposed abatement measure provide a reduction of at least 5 dB(A) at 75% of the impacted receptors?	Yes (1)
REASONABLENESS CONSIDERATION	**YES OR NO**
Design Goal: Does the proposed abatement measure provide a reduction of 10 dB(A) for one benefiting receptor and at least 7 dB(A) at 50% or more of the benefiting receptor sites?	No, but wall was recommended as per ROD (1)
Design Goal: Does the proposed abatement measure cost less than $45,942 per benefiting receptor site?	No, but wall was recommended as per ROD (1)
Viewpoint of Benefiting Property Owners and Residences: Were positive responses in favor of the abatement measure obtained from at least 50% or more of the tallied votes?	Next Phase (1)
DETAILS OF THE ABATEMENT MEASURE COST AND ACOUSTIC EFFECTIVE FINDINGS	
Impacted Receptors Behind Proposed Sound Barrier(s)	22
# of Impacted Receptors with 5 dB(A) Noise Reduction	18
% of Impacted Receptors with 5 dB(A)Noise Reduction	82%
Total number of Impacted Plus Non-Impacted Benefits	27
# of Impacted Receptors with 7 dB(A) Noise Reduction	11
% of Impacted Receptors with 7 dB(A) Noise Reduction	50%
# of Impacted Receptors with 10 dB(A)Noise Reduction	0
Total Cost (dollars)	$1,440,450
Cost Per Benefitting Receptor Unit (CPBU in dollars) includes 14 non-impacted benefited receptors)	$53,350
Total Length (feet)	2,134 ft.
Average Height (feet)	15 ft.
Total Square Footage (feet^2)	32,010 ft.^{2}

(1) If all the questions can be answered “Yes” then the abatement measure is considered feasible and reasonable
Source: WSP, 2018

Table 7. Feasibility and Reasonableness Assessment of Proposed Southbound New Barrier 1A and 1B

FEASIBILITY CONSIDERATION	YES OR NO
Engineering Consideration: Can the abatement measure be built?	Yes (1)
Acoustic Consideration: Does the proposed abatement measure provide a reduction of at least 5 dB(A) at 75% of the impacted receptors?	Yes (1)
REASONABLENESS CONSIDERATION	**YES OR NO**
Design Goal: Does the proposed abatement measure provide a reduction of 10 dB(A) for one benefiting receptor and at least 7 dB(A) at 50% or more of the benefiting receptor sites?	No (1)
Design Goal: Does the proposed abatement measure cost less than $45,942 per benefiting receptor site?	No (1)
Viewpoint of Benefiting Property Owners and Residences: Were positive responses in favor of the abatement measure obtained from at least 50% or more of the tallied votes?	Not Required (1)
DETAILS OF THE ABATEMENT MEASURE COST AND ACOUSTIC EFFECTIVE FINDINGS	
Impacted Receptors Behind Proposed Sound Barrier(s)	23
# of Impacted Receptors with 5 dB(A) Noise Reduction	18
% of Impacted Receptors with 5 dB(A)Noise Reduction	78%
Total number of Impacted Plus Non-Impacted Benefits	18
# of Impacted Receptors with 7 dB(A) Noise Reduction	11
% of Impacted Receptors with 7 dB(A) Noise Reduction	48%
# of Impacted Receptors with 10 dB(A)Noise Reduction	0
Total Cost (dollars)	$859,518
Cost Per Benefitting Receptor Unit (CPBU in dollars)	$47,751
Total Length (feet)	1,447 ft.
Average Height (feet)	13.2 ft.
Total Square Footage (feet^2)	19,100 ft.^{2}

(1) If all the questions can be answered "Yes" then the abatement measure is considered feasible and reasonable.
Source: WSP, 2018

Table 8: Feasibility and Reasonableness Assessment of Proposed Southbound New Barrier 4A and 4B

FEASIBILITY CONSIDERATION	YES OR NO
Engineering Consideration: Can the abatement measure be built?	Yes (1)
Acoustic Consideration: Does the proposed abatement measure provide a reduction of at least 5 dB(A) at 75% of the impacted receptors?	Yes (1)
REASONABLENESS CONSIDERATION	**YES OR NO**
Design Goal: Does the proposed abatement measure provide a reduction of 10 dB(A) for one benefiting receptor and at least 7 dB(A) at 50% or more of the benefiting receptor sites?	No (1)
Design Goal: Does the proposed abatement measure cost less than $45,942 per benefiting receptor site?	No (1)
Viewpoint of Benefiting Property Owners and Residences: Were positive responses in favor of the abatement measure obtained from at least 50% or more of the tallied votes?	Not Required (1)
DETAILS OF THE ABATEMENT MEASURE COST AND ACOUSTIC EFFECTIVE FINDINGS	
Impacted Receptors Behind Proposed Sound Barrier(s)	11
# of Impacted and non-impacted Receptors with 5 dB(A) Noise Reduction	11
% of Impacted Receptors with 5 dB(A)Noise Reduction	100%
Total number of Impacted Plus Non-Impacted Benefits	11
# of Impacted Receptors with 7 dB(A) Noise Reduction	4
% of Impacted Receptors with 7 dB(A) Noise Reduction	36%
# of Impacted Receptors with 10 dB(A)Noise Reduction	0
Total Cost (dollars)	$1,257,300
Cost Per Benefitting Receptor Unit (CPBU in dollars)	$114,300
Total Length (feet)	1,397 ft.
Average Height (feet)	20 ft.
Total Square Footage (feet^2)	27,940 ft.^{2}

(1) If all the questions can be answered "Yes" then the abatement measure is considered feasible and reasonable.
Source: WSP, 2018

Table 9: Feasibility and Reasonableness Assessment of Proposed Northbound Sound Barrier (NBB)

FEASIBILITY CONSIDERATION	YES OR NO
Engineering Consideration: Can the abatement measure be built?	Yes (1)
Acoustic Consideration: Does the proposed abatement measure provide a reduction of at least 5 dB(A) at 75% of the impacted receptors?	Yes (1)
REASONABLENESS CONSIDERATION	**YES OR NO**
Design Goal: Does the proposed abatement measure provide a reduction of 10 dB(A) for one benefiting receptor and at least 7 dB(A) at 50% or more of the benefiting receptor sites?	Yes (1)
Design Goal: Does the proposed abatement measure cost less than $45,942 per benefiting receptor site?	No (1)
Viewpoint of Benefiting Property Owners and Residences: Were positive responses in favor of the abatement measure obtained from at least 50% or more of the tallied votes?	Not Required (1)
DETAILS OF THE ABATEMENT MEASURE COST AND ACOUSTIC EFFECTIVE FINDINGS	
Impacted Receptors Behind Proposed Sound Barrier(s)	8
# of Impacted Receptors with 5 dB(A) Noise Reduction	8
% of Impacted Receptors with 5 dB(A)Noise Reduction	100%
Total number of Impacted Plus Non-Impacted Benefits	8
# of Impacted Receptors with 7 dB(A) Noise Reduction	7
% of Impacted Receptors with 7 dB(A) Noise Reduction	88%
# of Impacted Receptors with 10 dB(A)Noise Reduction	0
Total Cost (dollars)	$486,090
Cost Per Benefitting Receptor Unit (CPBU in dollars)	$60,761
Total Length (feet)	982 ft.
Average Height (feet)	11 ft.
Total Square Footage (feet^2)	10,802 ft.^{2}

(1) If all the questions can be answered "Yes" then the abatement measure is considered feasible and reasonable.
Source: WSP, 2018

Table 10: Noise Wall Analysis Feasibility and Reasonableness Comparison for 2040 Build Conditions

						Feasibility Assessment				Reasonableness Considerations						
						Engineering Considerations	Acoustic Considerations 5 dB(A) Reduction at 75% or > Impacts			Design Goal 7 dB(A) Reduction at 50% or > Impacts (Yes/No)			Design Goal CPBU < $45,942 (Yes/No)		Does one Benefiting Receptor Achieve a 10 dB(A) Noise Reduction	
Barrier Name	Barrier Height (feet)	Barrier Length (feet)	Barrier Approved in ROD (Yes/No)	Total Barrier Cost (Dollars)	Number of Impacts	Yes/No	Yes/No	%	Total Number of Benefits	Yes/No	%	Number of Benefits	Yes/No	CPBU ($)	Yes/No	Barrier Recommended (Yes/ No)
Original Barrier 1	14	1,250	Yes	$787,500	20	Yes	No	30%	6	No (1)	0%	0	No (1)	$131,250	No (1)	**Yes** (1)
Original Barrier 2 With Extension	15	1,921	Yes	$1,296,675	13	Yes	Yes	100%	18(2)	Yes (1)	77%	10	No (1)	$72,038	No (1)	**Yes** (1)
Original Barrier 3 With Extensions	15	2,134	Yes	$1,440,450	22	Yes	Yes	82%	27(3)	Yes (1)	50%	11	No (1)	$53,350	No (1)	**Yes** (1)
New Barriers 1A & 1B	13.2	1,447	No	$859,518	23	Yes	Yes	78%	18	No	48%	11	No	$47,751	Yes	No
New Barriers 4A & 4B	20	1,397	No	$1,257,300	11	Yes	Yes	100%	11	No	36%	4	No	$114,300	No	No
New Northbound Barrier	11	982	No	$486,090	8	Yes	Yes	100%	8	Yes	88%	7	No	$60,761	No	No

(1) These sound barriers are recommended as per the findings of the January 2009 Record of Decision.
(2) Total count includes five non-impacted benefits in the CPBU estimate.
(3) Total count includes nine non-impacted benefit in the CPBU estimate.
Source: WSP, 2018

5.2 Statement of Likelihood

Based on the studies thus far accomplished, MDOT intends to install highway traffic noise abatement in the form of a barrier(s) as reflected in recommended sound barriers identified in Table 10 and further illustrated in Appendix C in this document. If it subsequently develops during final design that these conditions have substantially changed, the abatement measure(s) may not be provided. The final decision of the installation and aesthetics of the abatement measure(s) will be made upon completion of the project final design and the Content Sensitive Design process.

6.0 Highway Construction-Related Noise

Generally, annoyance effects can be expected during construction at sites within 250 feet of the activity. Actual distances at which noise impacts would occur depend on several factors including the type and number of construction equipment in site and their duration of usage.

6.1 Noise Effects during Construction

Noise from construction activities will add to the average noise level during the construction phase. Construction activities are temporary in nature and all activities are expected to occur during normal daytime waking hours; however, noise from construction could result in annoyance or disruption of sleep if nighttime operations should occur. In any case, construction operations should adhere to any local construction noise ordinances. Noise may also be generated by increases in heavy truck traffic to and from the Study Area. This increase in noise will typically occur during daylight hours.

Construction activities within the project corridor would have short-term noise effects on receptors in the immediate vicinity of the construction. Effects on community noise levels during construction would result from construction equipment and delivery vehicles traveling to and from the site. The level of effect would depend on the noise characteristics of the equipment and activities involved, such as, the duration of the activity, the construction schedule, and the distance from receptors. Resultant noise levels at a given receptor location would depend on the type and number of pieces of construction equipment being operated and the distance from the construction site. Noise levels from construction activities can vary widely, depending on the phase of construction, which include land clearing and excavation, construction of new roadways and retaining walls. Noise generated from construction activity would be highest typically during the first year when excavation and heavy daily truck traffic would occur.

Typical noise levels from construction equipment, which may be employed during the construction period, are presented in Table 11. Noise levels measured at 50 feet from the construction equipment range from 81 dB(A) for generators to 101 dB(A) for pile drivers. The total hourly average sound energy [L_{eq} (1-hr) dB(A)] at 50 feet from the construction site boundary is in the order of 80 to 85 dB(A). Noise levels at receptors located at known distances from the construction site boundary can be conservatively estimated by assuming a 6 dB(A) drop-off rate per doubling of distance from each type of construction equipment and by combining the noise contributions from all the construction equipment at the receptor site.

Table 11: Typical Roadway Construction Equipment Noise Levels

Equipment	Typical Noise Level (dB(A) at 50 feet from Source) *
Air Compressor	81
Backhoe	80
Ballast Equalizer	82
Ballast Tamper	83
Compactor	82
Concrete Mixer	85
Concrete Pump	82
Concrete Vibrator	76
Crane Derrick	88
Crane Mobile	83
Dozer	85
Generator	81
Grader	85
Impact Wrench	85
Jack Hammer	88
Loader	85
Paver	89
Pile Driver (Impact)	101
Pile Driver (Sonic)	96
Pneumatic Tool	85
Pump	76
Rail Saw	90
Rock Drill	98
Roller	74
Saw	76
Scarifier	83
Scraper	89
Shovel	82
Spike Driver	77
Tie Cutter	84
Tie Handler	80
Tie Inserter	85
Truck	88

Source: Federal Transit Administration (FTA), *Noise and Vibration Impact Assessment*; May 2006

6.2 Construction Noise Abatement Measures

Although increases in noise levels due to construction of the project are temporary, measures should be taken to minimize the impact of additional generated noise. Recommended standard measures include the following:

- Informing the public when work is going to be performed,
- Keep a telephone log of complaints,
- Limit the number and duration of idling equipment on site,
- Provide mufflers or silencers to construction equipment operated by internal combustion engines and maintain all construction equipment in good repair,
- Reduce noise from all stationary equipment by utilizing suitable enclosures,
- Minimize the use of back-up alarms,
- Schedule and space truck loading and unloading operations to minimize noise impacts,
- Limit operation of heavy equipment and other noisy procedures to daylight hours whenever possible, and
- Locate equipment and vehicle staging areas as far from noise sensitive areas as possible.

7.0 Conclusion

The three original recommended sound barriers identified in the 2009 ROD were re-analyzed and optimized in height and length to provide maximum noise reduction possible within the new proposed highway design improvements. In the case of Original Barrier 2 and Original Barrier 3 barrier wall extensions were added to improve noise reduction at the properties nearest the ends of each of these two sound barriers.

Furthermore, the 2040 Build year traffic noise impact analysis findings identified three additional sound barrier locations where abatement consideration was warranted. Noise abatement was not found feasible and reasonable at any of the three-proposed new sound barrier locations and thus these new proposed locations should be dropped from further consideration.

Therefore, in summary, the final design and public involvement phases of the GHIB project will consider just the three optimized 2009 ROD approved original wall locations that were found feasible and reasonable.

8.0 References

Federal Highway Administration and US Department of Transportation. *Final Report: Measurement of Highway-Related Noise*, PB97-120489. May 1996.

Federal Highway Administration. Federal Highway Administration *Procedures for Abatement of Highway Traffic Noise and Construction Noise*, 23 CFR 772. July 2010.

Federal Highway Administration. *Highway Traffic Noise: Analysis and Abatement Guidance*, FHWA-HEP-10-025. Revised December 2011.

Federal Transit Administration. *Transit Noise and Vibration Impact Assessment Manual Report,* FTA-VA-90-1003-06. May 2006.

Michigan Department of Transportation. *Highway Noise Analysis and Abatement Handbook*. July 2011

US Department of Transportation Federal Highway Administration, Office of Research and Development. *The Audible Landscape: A Manual for Highway Noise and Land Use*. November 1974.

US Department of Transportation; Research and Special Programs Administration, Federal Highway Administration's (FHWA) *Traffic Noise Model (TNM) Users Guide* (Version 2.5 Addendum). April 2004.

Appendix A Noise Measurements, Traffic Counts and Noise Meter Calibration Certificates

Site 1: All Saints Church – 7824 W. Fort St

Source: WSP, 2018

Noise Measurements and Traffic Counts at Site 1[1]

Time	Measured L_{eq}
8/8 AM – 9:45 AM	72.0
8/8 PM – 1:35 PM	71.1
8/9 AM – 9:55 AM	72.4
8/9 PM – 2:30 PM	72.3

	8/8 – 9:45 AM		8/9 AM – 9:55 AM	
Vehicles	**15-minute Vehicle Counts**	**1-Hour Vehicles**	**15-minute Vehicle Counts**	**1-Hour Vehicles**
	Northbound I-75		**Northbound I-75**	
Automobiles	374	1496	306	1224
Medium Truck	16	64	14	56
Heavy Truck	78	312	84	336
Buses	0	0	1	4
Motorcycles	3	12	0	0
	Southbound Off-Ramp		**Southbound Off-Ramp**	
Automobiles	130	520	126	504
Medium Truck	5	20	9	36
Heavy Truck	21	84	30	120
Buses	0	0	0	0
Motorcycles	0	0	0	0
	Northbound On-Ramp		**Northbound On-Ramp**	
Automobiles	65	260	55	220
Medium Truck	2	8	4	16
Heavy Truck	19	76	23	92
Buses	0	0	0	0
Motorcycles	0	0	0	0
	Northbound Frontage		**Northbound Frontage**	
Automobiles	N/A	N/A	13	52
Medium Truck	N/A	N/A	0	0
Heavy Truck	N/A	N/A	4	16
Buses	N/A	N/A	0	0
Motorcycles	N/A	N/A	0	0

Source: WSP, 2018

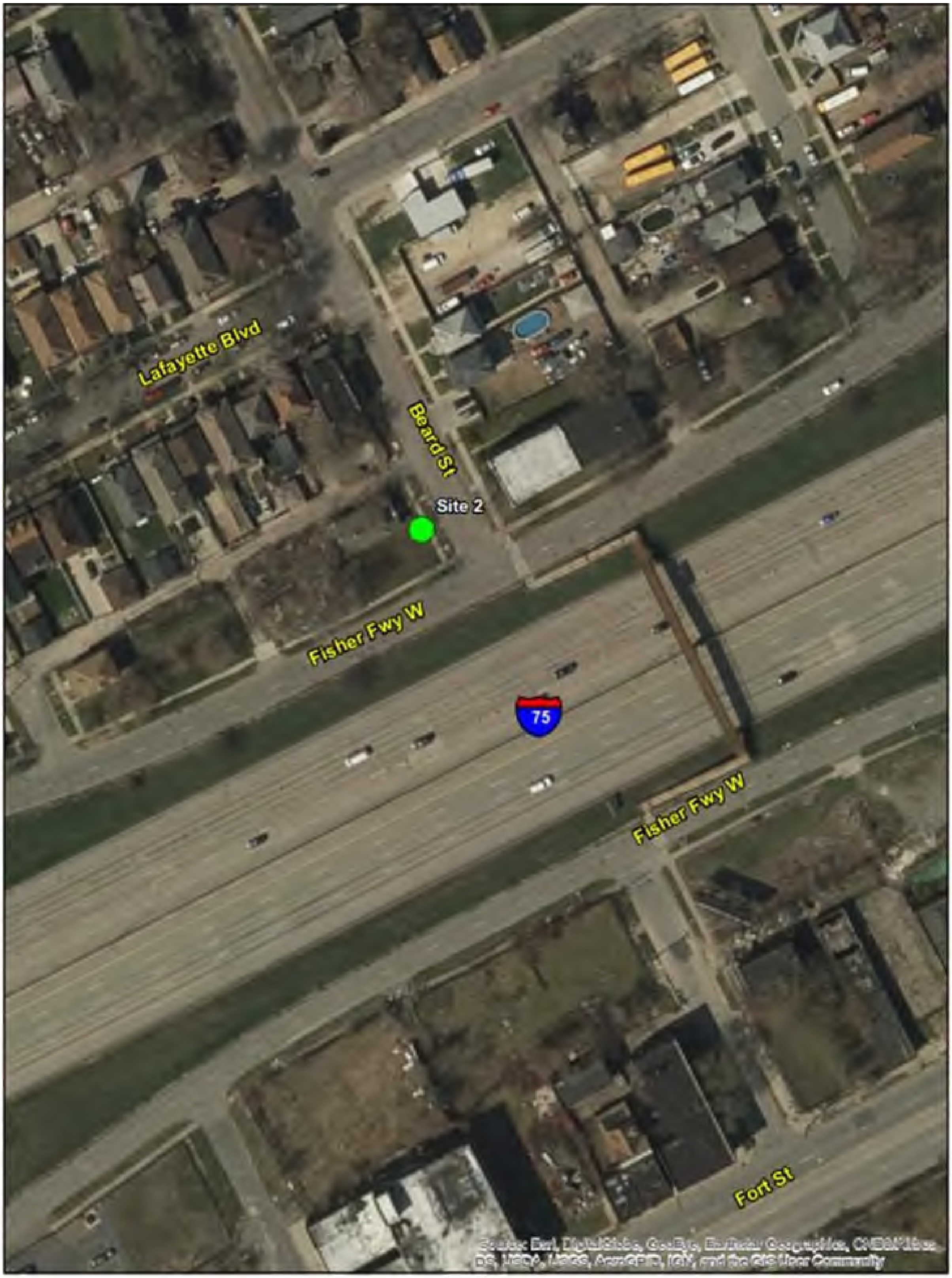
[1] See Site 1 figure for location of noise measurement site.

Noise Measurements and Traffic Counts at Site 1 (continued)

	8/8 PM – 1:35 PM		8/9 PM – 2:30 PM	
Vehicles	15-minute Vehicle Counts	1-Hour Vehicles	15-minute Vehicle Counts	1-Hour Vehicles
	Northbound I-75		Northbound I-75	
Automobiles	334	1336	404	1616
Medium Truck	12	48	20	80
Heavy Truck	106	424	106	424
Buses	0	0	0	0
Motorcycles	2	8	2	8
	Southbound Off-Ramp		Southbound Off-Ramp	
Automobiles	132	528	146	584
Medium Truck	5	20	5	20
Heavy Truck	27	108	15	60
Buses	2	8	4	16
Motorcycles	0	0	4	16
	Northbound On-Ramp		Northbound On-Ramp	
Automobiles	77	308	97	388
Medium Truck	3	12	3	12
Heavy Truck	16	64	22	88
Buses	0	0	0	0
Motorcycles	0	0	0	0
	Northbound Frontage		Northbound Frontage	
Automobiles	13	52	11	44
Medium Truck	0	0	0	0
Heavy Truck	4	16	1	4
Buses	0	0	0	0
Motorcycles	0	0	0	0

Source: WSP, 2018

Site 2: 815 Beard Street



Source: WSP, 2018

Noise Measurements and Traffic Counts at Site 2[2]

Time	Measured L_{eq}
8/8 AM – 10:30 AM	65.1
8/8 PM – 1:50 PM	64.5
8/9 AM – 10:20 AM	65.5
8/9 PM – 2:10 PM	67.1

	8/8 – 10:30 AM		8/9 AM – 10:20 AM	
Vehicles	15-minute Vehicle Counts	1-Hour Vehicles	15-minute Vehicle Counts	1-Hour Vehicles
	Northbound I-75		Northbound I-75	
Automobiles	384	1536	445	1780
Medium Truck	26	104	23	92
Heavy Truck	121	484	124	496
Buses	0	0	0	0
Motorcycles	3	12	2	8
	Southbound I-75		Southbound I-75	
Automobiles	111	444	94	376
Medium Truck	4	16	2	8
Heavy Truck	23	92	20	80
Buses	0	0	0	0
Motorcycles	0	0	0	0
	Northbound Frontage		Northbound Frontage	
Automobiles	13	52	5	20
Medium Truck	0	0	0	0
Heavy Truck	1	4	0	0
Buses	0	0	0	0
Motorcycles	0	0	0	0
	Southbound Frontage		Southbound Frontage	
Automobiles	11	44	17	68
Medium Truck	1	4	1	4
Heavy Truck	1	4	0	0
Buses	0	0	0	0
Motorcycles	0	0	0	0

Source: WSP, 2018

[2] See Site 2 figure for location of noise measurement site.

Noise Measurements and Traffic Counts at Site 2 (continued)

	8/8 PM – 1:50 PM		8/9 PM – 2:10 PM	
Vehicles	**15-minute Vehicle Counts**	**1-Hour Vehicles**	**15-minute Vehicle Counts**	**1-Hour Vehicles**
	Northbound I-75		**Northbound I-75**	
Automobiles	459	1836	476	1904
Medium Truck	25	100	19	76
Heavy Truck	119	476	130	520
Buses	0	0	3	12
Motorcycles	2	8	2	8
	Southbound I-75		**Southbound I-75**	
Automobiles	120	480	156	624
Medium Truck	6	24	2	8
Heavy Truck	15	60	24	96
Buses	2	8	0	0
Motorcycles	0	0	0	0
	Northbound Frontage		**Northbound Frontage**	
Automobiles	77	308	7	28
Medium Truck	3	12	0	0
Heavy Truck	16	64	0	0
Buses	0	0	0	0
Motorcycles	0	0	0	0
	Southbound Frontage		**Southbound Frontage**	
Automobiles	28	112	19	76
Medium Truck	3	12	0	0
Heavy Truck	1	4	0	0
Buses	0	0	0	0
Motorcycles	0	0	1	4

Source: WSP, 2018

Site 3: 6006 W. Lafayette Blvd

Source: WSP, 2018

Noise Measurements and Traffic Counts at Site 3[3]

Time	Measured L_{eq}
8/8 AM – 11:10 AM	62.6
8/8 PM – 2:20 PM	64.8
8/9 AM – 10:40 AM	63.2
8/9 PM – 1:30 PM	64.6

	8/8 AM – 11:10 AM		8/9 AM – 10:40 AM	
Vehicles	15-minute Vehicle Counts	1-Hour Vehicles	15-minute Vehicle Counts	1-Hour Vehicles
	Northbound I-75		Northbound I-75	
Automobiles	385	1540	365	1460
Medium Truck	15	60	18	72
Heavy Truck	108	432	130	520
Buses	0	0	3	12
Motorcycles	1	4	0	0
	Southbound I-75		Southbound I-75	
Automobiles	90	360	96	384
Medium Truck	5	20	4	16
Heavy Truck	13	52	20	80
Buses	0	0	0	0
Motorcycles	0	0	0	0
	Northbound On-Ramp		Northbound On-Ramp	
Automobiles	42	168	16	64
Medium Truck	4	16	1	4
Heavy Truck	21	84	13	52
Buses	0	0	0	0
Motorcycles	1	4	0	0
	Southbound Off-Ramp		Southbound Off-Ramp	
Automobiles	27	108	29	116
Medium Truck	2	8	5	20
Heavy Truck	19	76	24	96
Buses	0	0	0	0
Motorcycles	0	0	0	0
	Northbound Lafayette		Northbound Lafayette	
Automobiles	9	36	10	40
Medium Truck	1	4	0	0
Heavy Truck	0	0	0	0
Buses	0	0	0	0
Motorcycles	0	0	0	0

[3] See Site 3 figure for location of noise measurement site.

8/8 AM – 11:10 AM			8/9 AM – 10:40 AM	
Vehicles	**15-minute Vehicle Counts**	**1-Hour Vehicles**	**15-minute Vehicle Counts**	**1-Hour Vehicles**
Southbound Lafayette			**Southbound Lafayette**	
Automobiles	14	56	14	56
Medium Truck	0	0	0	0
Heavy Truck	1	4	0	0
Buses	0	0	0	0
Motorcycles	0	0	0	0

Source: WSP, 2018

Noise Measurements and Traffic Counts at Site 3 (continued)

	8/8 PM – 2:20 PM		8/9 PM – 1:30 PM	
Vehicles	15-minute Vehicle Counts	1-Hour Vehicles	15-minute Vehicle Counts	1-Hour Vehicles
	Northbound I-75		Northbound I-75	
Automobiles	534	2136	425	1700
Medium Truck	14	56	15	60
Heavy Truck	106	424	110	440
Buses	3	12	5	20
Motorcycles	2	8	5	20
	Southbound I-75		Southbound I-75	
Automobiles	131	524	131	524
Medium Truck	3	12	2	8
Heavy Truck	16	64	22	88
Buses	1	4	1	4
Motorcycles	0	0	2	8
	Northbound On-Ramp		Northbound On-Ramp	
Automobiles	55	220	27	108
Medium Truck	2	8	0	0
Heavy Truck	15	60	18	72
Buses	0	0	0	0
Motorcycles	0	0	0	0
	Southbound Off-Ramp		Southbound Off-Ramp	
Automobiles	100	400	47	188
Medium Truck	1	4	2	8
Heavy Truck	27	108	20	80
Buses	0	0	0	0
Motorcycles	0	0	0	0
	Northbound Lafayette		Northbound Lafayette	
Automobiles	18	72	11	44
Medium Truck	0	0	0	0
Heavy Truck	0	0	1	4
Buses	0	0	0	0
Motorcycles	18	72	0	0
	Southbound Lafayette		Southbound Lafayette	
Automobiles	15	60	16	64
Medium Truck	0	0	0	0
Heavy Truck	1	4	1	4
Buses	0	0	0	0
Motorcycles	15	60	0	0

Source: WSP, 2018

Site 4: 1002 Ferdinand Street

Source: WSP, 2018

Noise Measurements and Traffic Counts at Site 4[4]

Time	Measured L_{eq}
8/8 AM – 11:40 AM	67.7
8/8 PM – 2:45 PM	68.9
8/9 – 11:15 AM	68.8
8/9 PM – 1:00 PM	68.4

	8/8 AM – 11:40 AM		8/9 – 11:15 AM	
Vehicles	15-minute Vehicle Counts	1-Hour Vehicles	15-minute Vehicle Counts	1-Hour Vehicles
	Northbound I-75		Northbound I-75	
Automobiles	390	1560	431	1724
Medium Truck	29	116	9	36
Heavy Truck	127	508	59	236
Buses	0	0	1	4
Motorcycles	0	0	0	0
	Southbound I-75		Southbound I-75	
Automobiles	144	576	146	584
Medium Truck	6	24	11	44
Heavy Truck	39	156	44	176
Buses	1	4	1	4
Motorcycles	0	0	0	0
	Northbound Off-Ramp		Northbound Off-Ramp	
Automobiles	18	72	17	68
Medium Truck	0	0	1	4
Heavy Truck	1	4	7	28
Buses	0	0	0	0
Motorcycles	0	0	1	4
	Northbound Frontage		Northbound Frontage	
Automobiles	22	88	7	28
Medium Truck	2	8	0	0
Heavy Truck	1	4	1	4
Buses	0	0	0	0
Motorcycles	0	0	0	0
	Southbound Frontage		Southbound Frontage	
Automobiles	28	112	31	124
Medium Truck	0	0	1	4
Heavy Truck	0	0	2	8
Buses	0	0	0	0
Motorcycles	0	0	0	0

Source: WSP, 2018

[4] See Site 4 figure for location of noise measurement site.

Noise Measurements and Traffic Counts at Site 4 (continued)

	8/8 PM – 2:45 PM		8/9 PM – 1:00 PM	
Vehicles	**15-minute Vehicle Counts**	**1-Hour Vehicles**	**15-minute Vehicle Counts**	**1-Hour Vehicles**
	Northbound I-75		**Northbound I-75**	
Automobiles	553	2212	431	1724
Medium Truck	17	68	8	32
Heavy Truck	113	452	125	500
Buses	0	0	1	4
Motorcycles	0	0	0	0
	Southbound I-75		**Southbound I-75**	
Automobiles	343	1372	142	568
Medium Truck	7	28	4	16
Heavy Truck	36	144	35	140
Buses	3	12	0	0
Motorcycles	0	0	0	0
	Northbound Off-Ramp		**Northbound Off-Ramp**	
Automobiles	43	172	25	100
Medium Truck	0	0	1	4
Heavy Truck	4	16	0	0
Buses	0	0	0	0
Motorcycles	0	0	0	0
	Northbound Frontage		**Northbound Frontage**	
Automobiles	N/A	N/A	31	124
Medium Truck	N/A	N/A	0	0
Heavy Truck	N/A	N/A	0	0
Buses	N/A	N/A	0	0
Motorcycles	N/A	N/A	0	0
	Southbound Frontage		**Southbound Frontage**	
Automobiles	56	224	28	112
Medium Truck	1	4	0	0
Heavy Truck	0	0	0	0
Buses	1	4	0	0
Motorcycles	56	224	0	0

Source: WSP, 2018

Odin Metrology, Inc.
Calibration of Sound & Vibration Instruments

Certificate Number: **23348-10**

Certificate of Calibration for Brüel & Kjær Sound Level Calibrator

This calibration is performed by comparison with measurement reference standard pistonphones:

Type No.	4220	4228
Serial No.	1048473	1504084
Calibrated by	TE	TE
Cal Date	15 NOV 2016	15 NOV 2016
Due Date	15 NOV 2017	15 NOV 2017

a) Estimated uncertainty of comparison: ± **0.05** dB
b) Estimated uncertainty of calibration service for standard pistonphone: ± **0.06** dB
c) Total uncertainty: $\sqrt{a^2+b^2}$ = ± **0.08** dB
d) Expanded uncertainty (coverage factor k = 2 for 95% confidence level): = ± **0.16** dB

This acoustic calibrator has been calibrated using standards with values traceable to the National Institute of Standards and Technology. This calibration is traceable to NIST Test Number **TN-683/286992-15.**

Condition of Test		
Ambient Pressure	**986.31**	hPa
Temperature	**23**	°C
Relative Humidity	**36**	%
Date of Calibration	**10 JUL 2017**	
Re-calibration due on	**10 JUL 2018**	

The calibration of this acoustic calibrator was performed using a test system conforming to the requirements of ANSI/NCSLZ540-1, 1994, ISO 17025, and ISO 9001-2008, Certification NQA No. 11252.

Calibration procedure: Brüel & Kjær 4231, **23.3, 20170608.**

Calibration performed by Harold Lynch

Harold Lynch, Service Manager

Calibrator type	**4231**
Serial no.	**3011291**
Submitted by	**WSP** **Orange, CA 92868**
Purchase order no.	**Project# 7338**
Asset no.	**N/A**

This calibrator has been found to perform **within** the specifications listed below at the normalized conditions stated.

SPL produced in coupler terminated by a loading volume of 1.333 cm^3	94.0 ± 0.2 dB
Level Step	20 ± 0.1 dB
Frequency	1,000 Hz ± 0.1%
Distortion	< 1%
At 1,013 hPa, 20°C, and 65% relative humidity	

Performance as Received		
Frequency	**1000.0**	Hz
SPL	**94.00**	dB
SPL+20 dB	**113.98**	dB
Distortion	**0.3**	%
Battery Voltage	**1.54**	V

Was repair or adjustment performed?	**No**
Were parts replaced?	**No**
Were batteries replaced?	**No**

Final Performance		
Frequency	**1000.0**	Hz
SPL	**94.00**	dB
SPL+20 dB	**113.98**	dB
Distortion	**0.3**	%

Note: This calibrator was **within** manufacturer's specifications as received.

ODIN METROLOGY, INC.
3533 OLD CONEJO ROAD, SUITE 125
THOUSAND OAKS, CA 91320
PHONE: (805) 375-0830; FAX: (805) 375-0405

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Source: WSP, 2018

CERTIFICATE OF CALIBRATION
23348-2
FOR BRÜEL & KJÆR
SOUND LEVEL METER

Model **2238** Serial No. **2160276**
ID No. **N/A**
With Microphone Model **4188** Serial No. **2157051**

Customer: **WSP**
Orange, CA 92868 P.O. No. **Project# 7338**

was tested and met factory specifications at the points tested and as outlined in
ANSI S1.4-1983 Type 1; IEC 651-1979 Type 1; IEC-61672-3:2006 Class 1

on **05 JUL 2017** **BY** **HAROLD LYNCH**
Service Manager

As received and as left condition: Within Specification.
Re-calibration due on: **05 JUL 2018**

Certified References*

Mfg.	Type	Serial No.	Cal Date	Due Date
B&K	1049	1314996	09 JUN 2017	09 JUN 2018
B&K	2636	1423390	03 JAN 2017	03 JAN 2018
B&K	4226	2141942	02 DEC 2016	02 DEC 2017
B&K	4231	1770857	15 SEP 2016	15 SEP 2017
HP	34401A	MY45023668	10 FEB 2017	10 FEB 2018
HP	3458A	2823A07179	30 JUL 2016	30 JUL 2017

Performed in Compliance with ANSI, NCSL Z-540-1, 1994
and ISO 17025, ISO 9001:2008 Certification NQA No. 11252
*References are traceable to NIST (National Institute of Standards and Technology).

Note: For calibration data see enclosed pages.
The data represent both "as found" and "as left" condition.

Reference Test Procedure: **ACCT Procedure 2238 Version 2.1.0.** (Rev. Aug 2013)
Brüel & Kjær Factory Service Instructions: **2238**

Temperature	Relative Humidity	Barometric Pressure
23°C	**36** %	**988.28** hPa

Note: This calibration report shall not be reproduced, except in full, without written consent by Odin Metrology, Inc.

Signed: Harold Lynch

ODIN METROLOGY, INC.
CALIBRATION OF BRÜEL & KJÆR INSTRUMENTS
3533 OLD CONEJO ROAD, SUITE 125 THOUSAND OAKS CA 91320
PHONE: (805) 375-0830 FAX: (805) 375-0405

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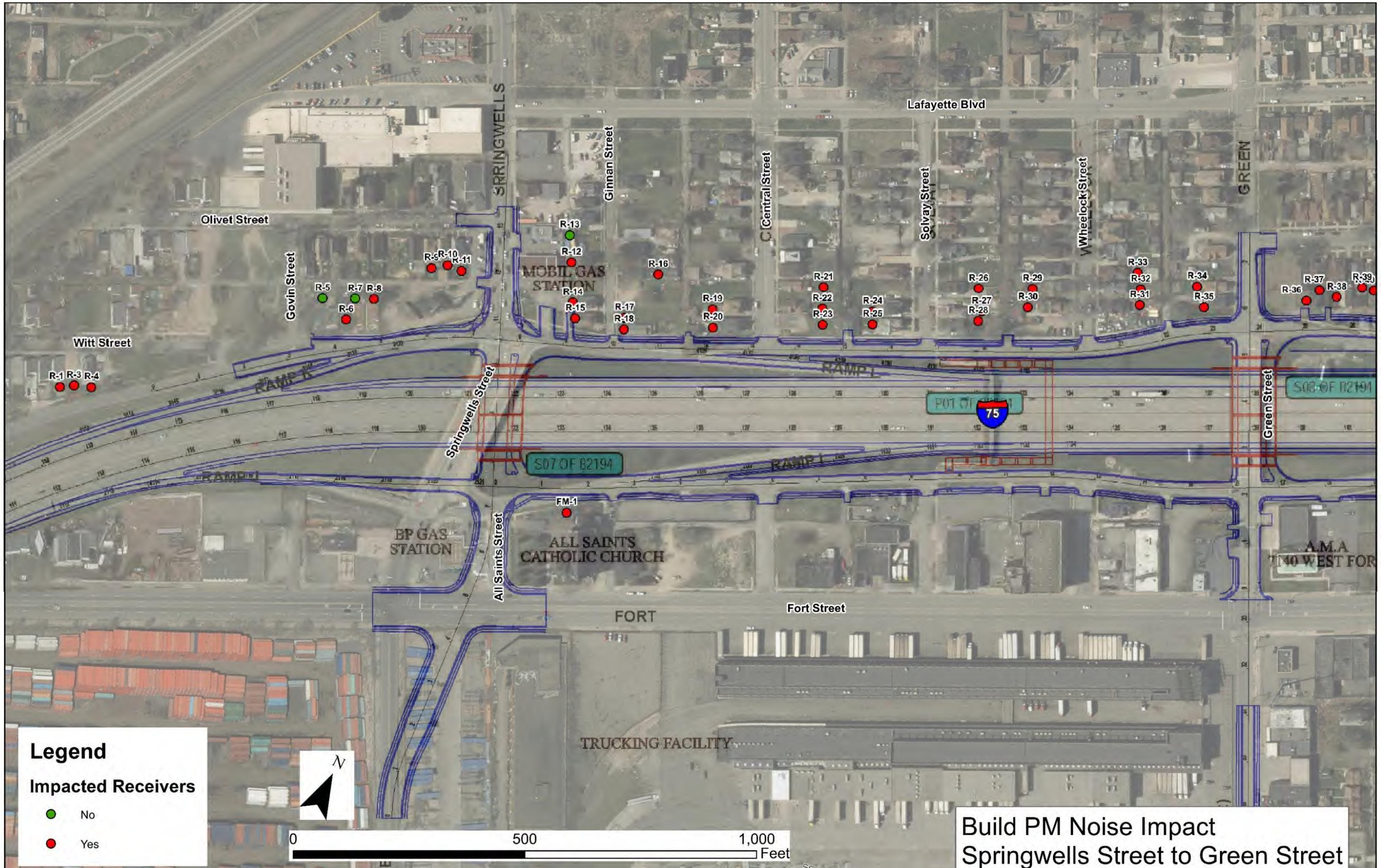
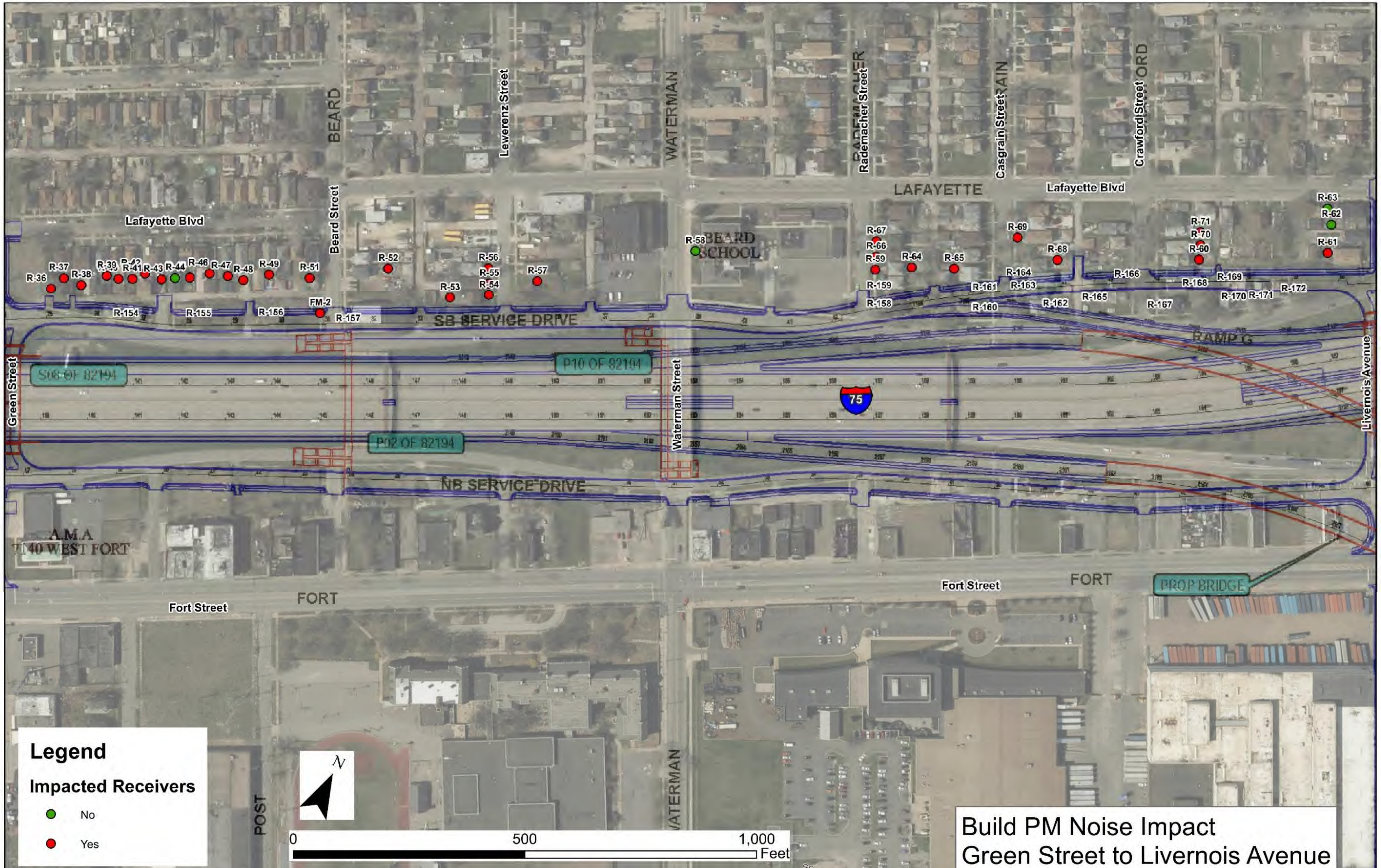
Source: WSP, 2018

Appendix B 2040 Build Peak Hour PM Noise Illustrations

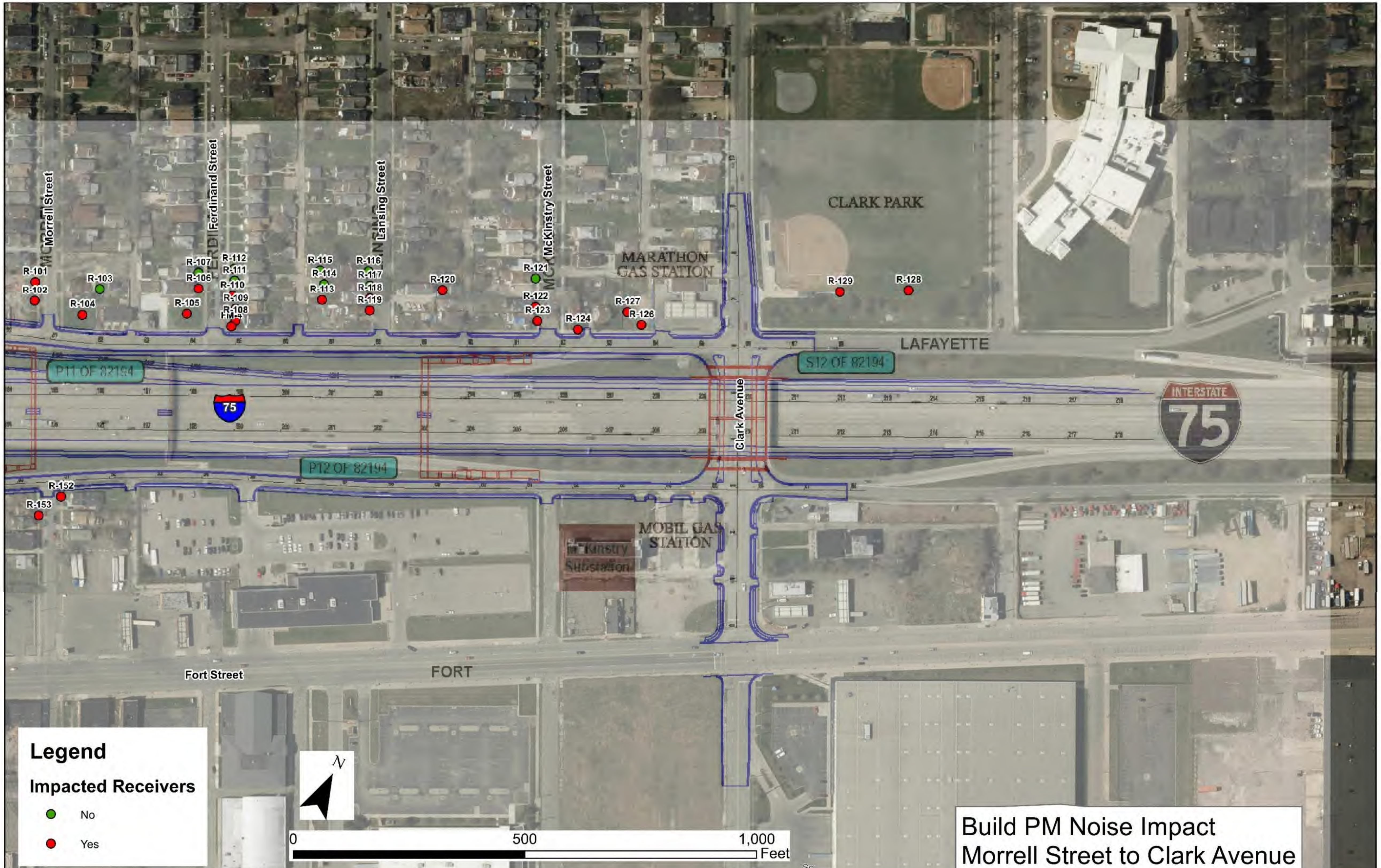


Source: WSP, 2018

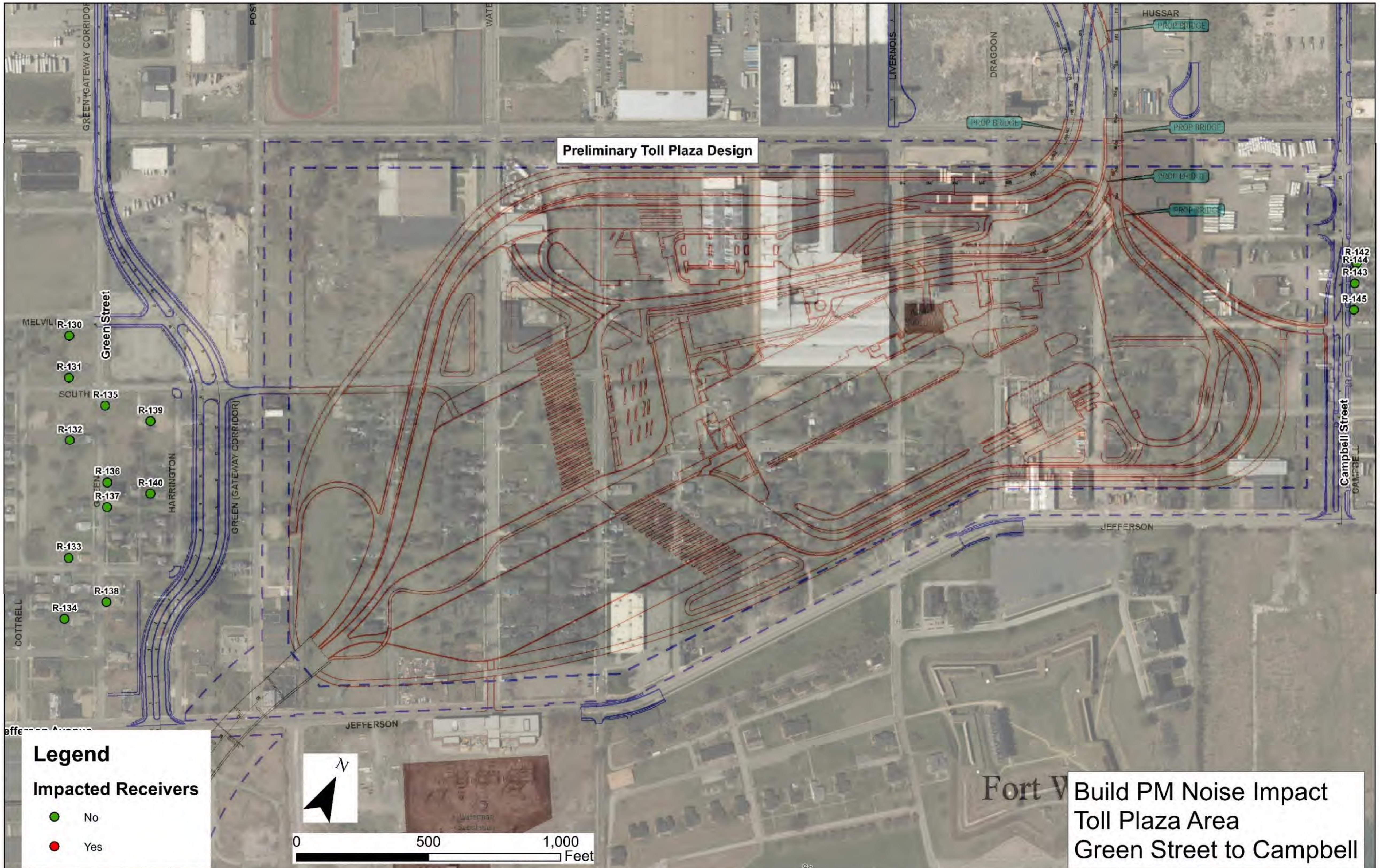


Source: WSP, 2018

Source: WSP, 2018

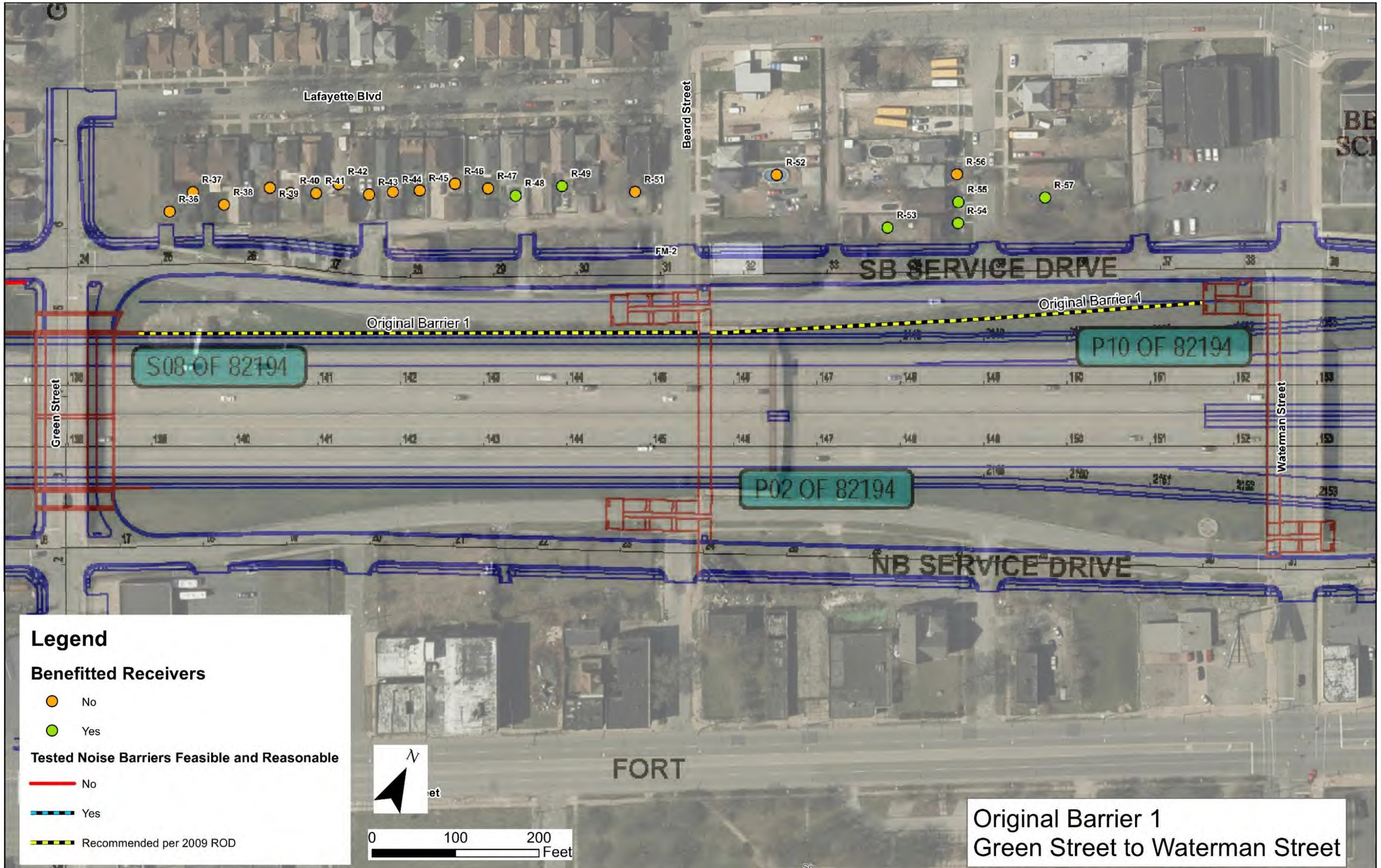


Source: WSP, 2018

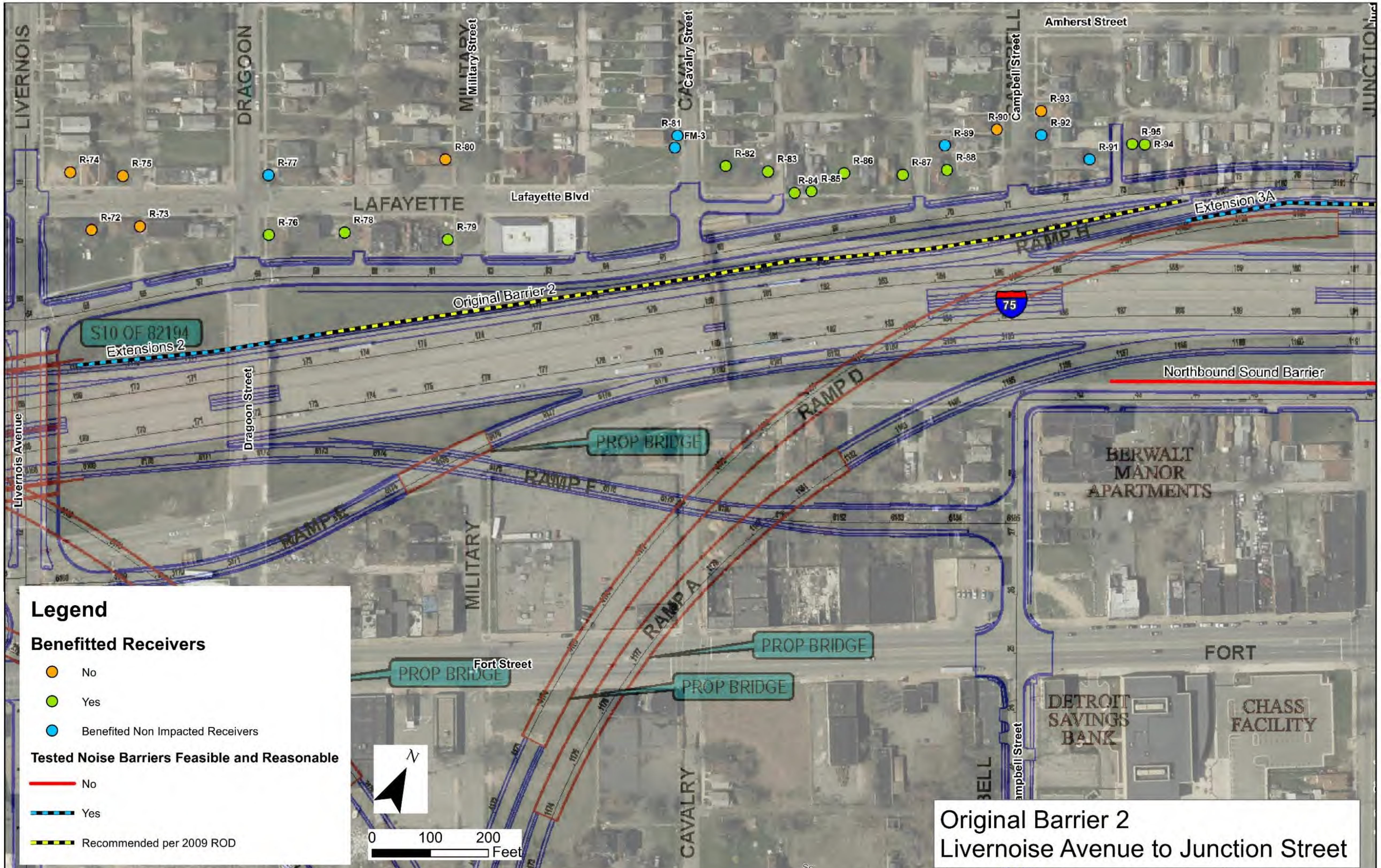


Source: WSP, 2018

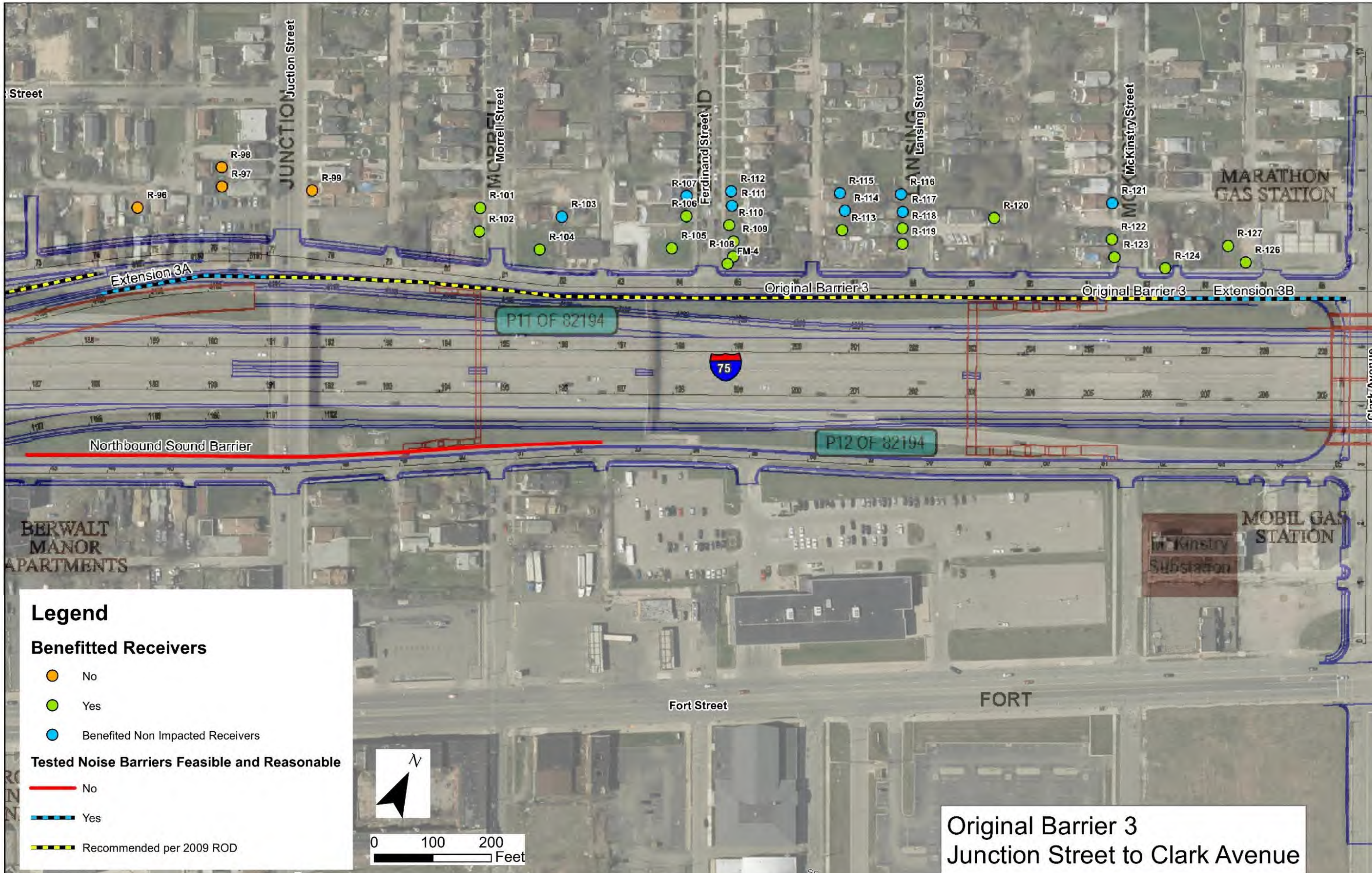
Appendix C 2040 Build PM with Abatement Illustrations



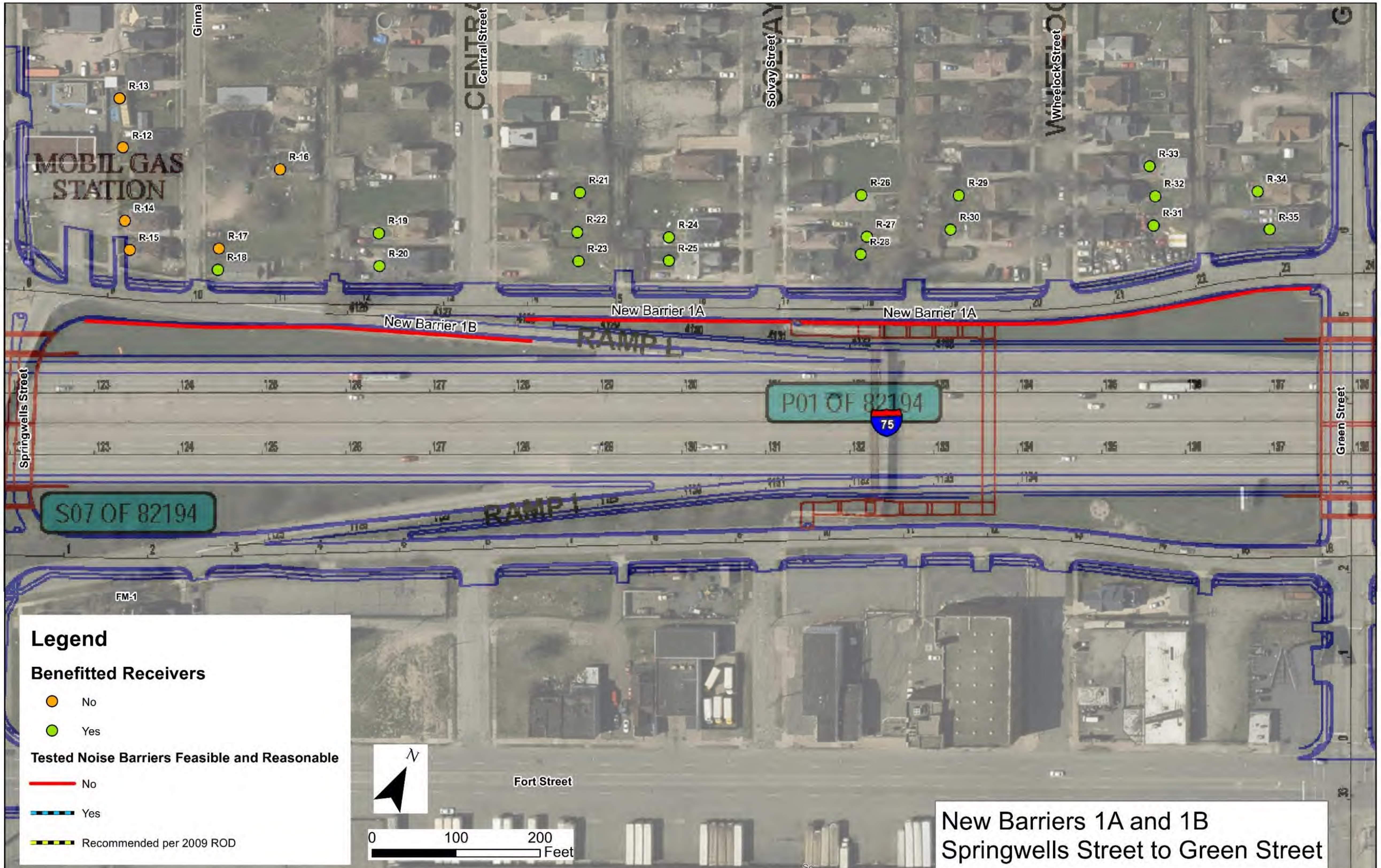
Source: WSP, 2018



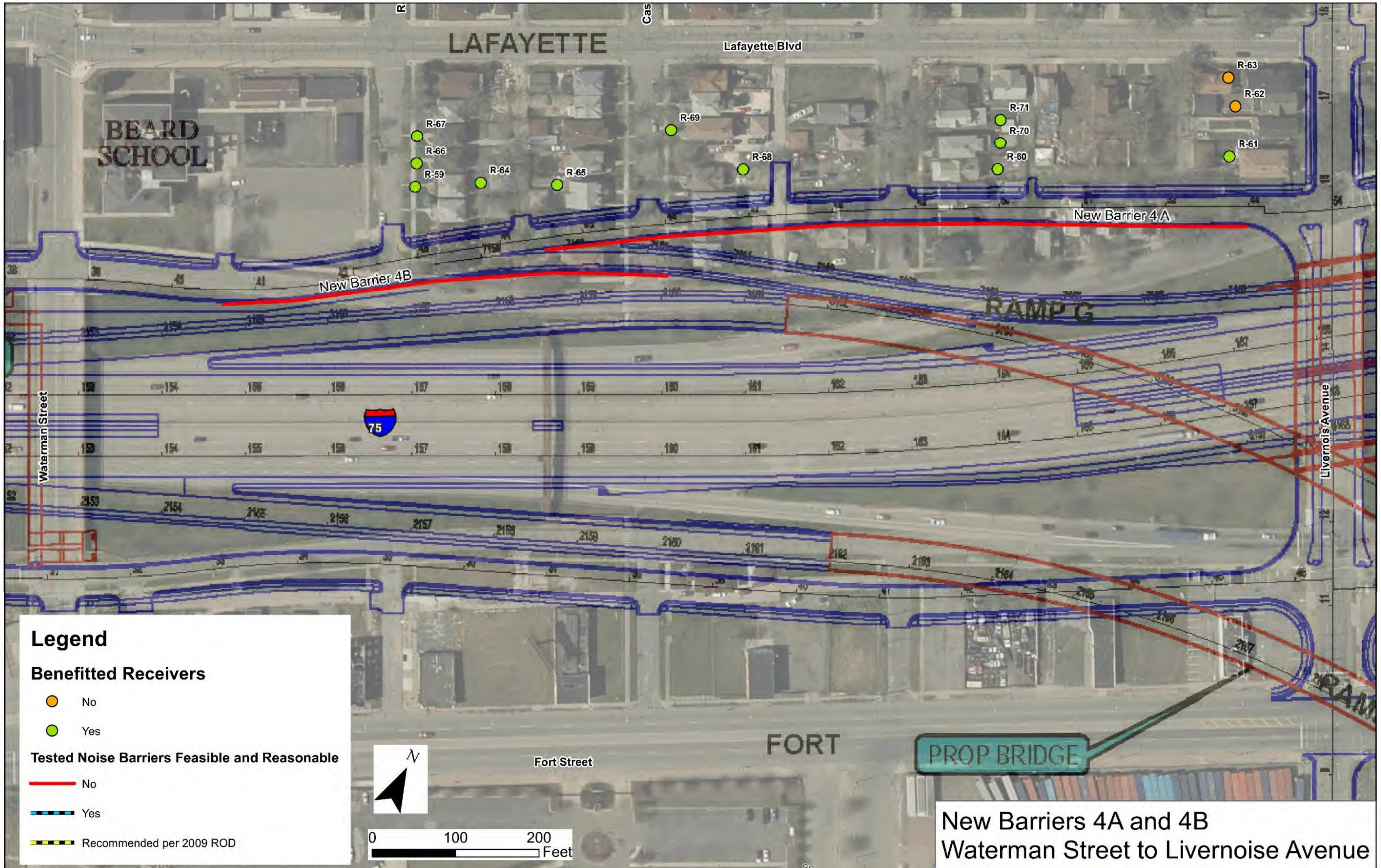
Source: WSP, 2018



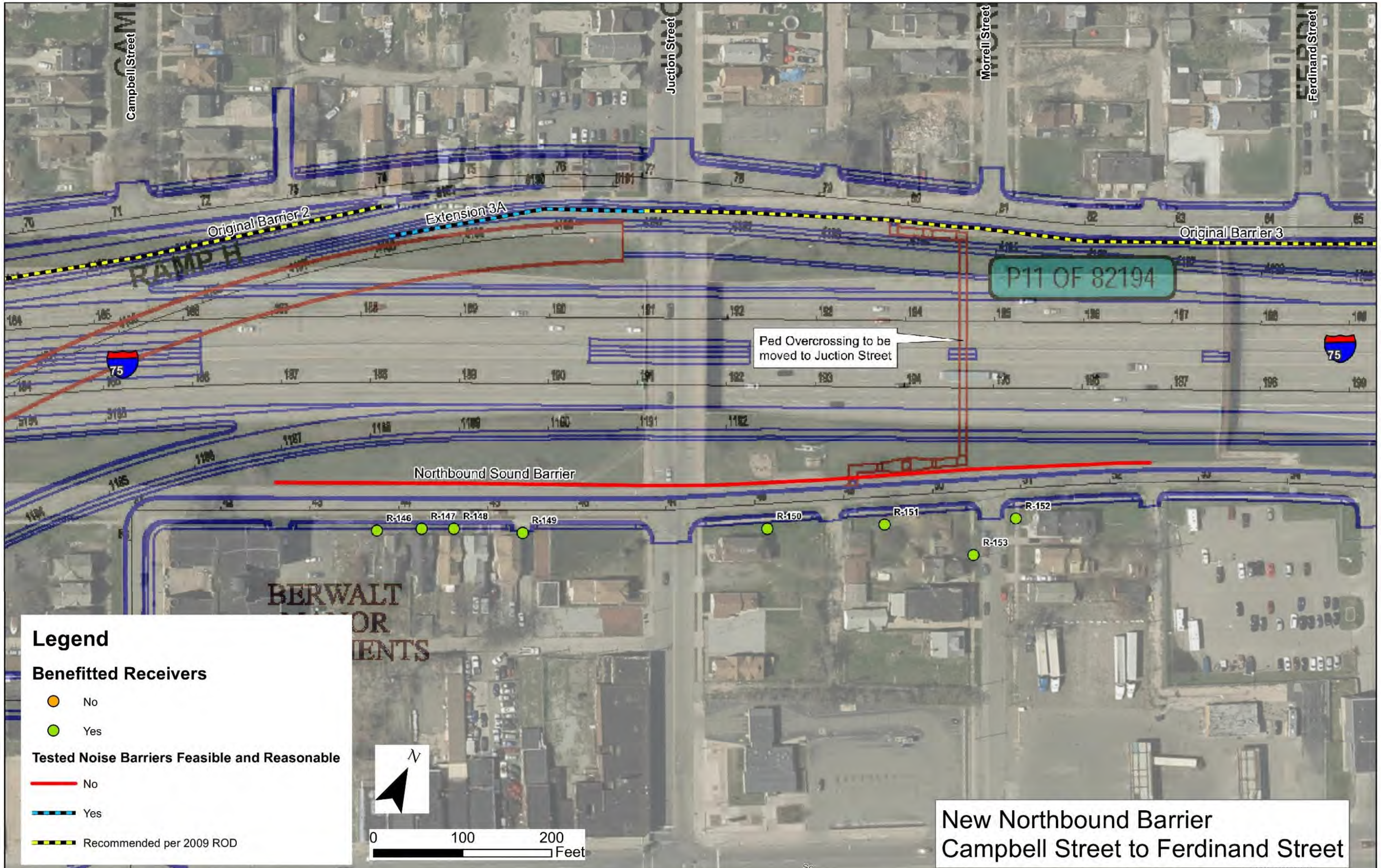
Source: WSP, 2018



Source: WSP, 2018



Source: WSP, 2018



Source: WSP, 2018