Michigan Department of Transportation

US-127 Corridor
Revised Preliminary
Noise Analysis Report

I-96 to Clark Rd

MDOT University Region,
Ingham and Clinton Counties, MI
Alaiedon Township, Charter Township of Lansing,
City of Lansing, City of East Lansing, Delhi Township,
and Dewitt Township

Aug 2022

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Noise Analysis Report

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1. EXECUTIVE SUMMARY

This study evaluated the potential highway traffic noise impacts of the proposed improvements to the I-496/US-127 corridor between the US-127/I-96/I-496 interchange and the northern limits of the US-127/I-69 interchange in Cities of Lansing and East Lansing, Delhi, Lansing, Alaiedon, and DeWitt Townships, Ingham and Clinton Counties. This study was completed in conformance with corresponding State and Federal regulations and guidance. The goal of this project is to address the infrastructure deficiencies based on a review of existing geometrics, a corridor wide crash analysis and operational analysis.

The project is being studied as a Type I project because proposed improvements will increase the capacity of the existing roadway by adding, extending, and realigning lanes and ramps between the US-127/I-96/I-496 and the US-127/I-496/Trowbridge Rd interchanges. The proposed fix from the US-127/I-496/Trowbridge Rd interchange northerly to the US-127/I-69 interchange is a 3R project, which includes but is not limited to resurfacing the roadway, minor side slope modifications, and improving roadside features like signs and guardrail. The addition of new, extended, and realigned travel lanes and ramps fits under the definition of a Type I project under 23 CFR 772.5 and such projects are required to undergo a noise analysis. Moreover, under the Type I definition: "(8) If a project is determined to be a Type I project under this definition, then the entire project area as defined in the environmental document is a Type I project" which means the noise analysis will extend northerly to the US-127/I-69 interchange.

The noise analysis presents the existing (2019) and future build (2045) acoustical environment at various receptors located along the I-496/US-127 corridor and around the I-96, Dunckel Rd, US-127/I-496/Trowbridge Rd, Kalamazoo St, Saginaw St (M-43), Lake Lansing Rd, and I-69 interchanges. The recommendations for noise abatement measures and locations are in compliance with the FHWA's *Procedures for Abatement of Highway Traffic Noise and Construction Noise* as presented in the Code of Federal Regulations, Title 23 Part 772 (23 CFR 722), and the Michigan Department of Transportation (MDOT): *Highway Noise Analysis and Abatement Handbook, July 2011*. The MDOT: *Highway Noise Analysis and Abatement Handbook* is in compliance with the MDOT *State Transportation Commission Policy 10136 Noise Abatement,* dated July 31, 2003.

The traffic noise prediction program, TNM®2.5, was used to model Existing (2019), and Future Build (2045) traffic noise levels within the study area. The 2019 and 2045 design years are consistent with the traffic study that was completed by WSP Michigan Inc. (sub-vendor to Bergmann) for this project. 2019 was used as the existing design year to eliminate the traffic reductions that resulted from the COVID pandemic. Table 11 lists the number of receptors within each CNE that approach or exceed the FHWA Noise Abatement Criteria (NAC). The limits of the CNEs are depicted in Appendix C. The noise measurement sites that are associated with these CNEs are denoted in Table 5. The Build (2045) traffic noise levels, within the overall project area, would result in an increase of no more than 3 dB(A), L_{eq} over the existing conditions.

Noise barriers were evaluated for all the CNEs that have receptors that approach or exceed the NAC. Table 1 summarizes the results of the noise barrier evaluation. The limits of the noise barriers that were evaluated are depicted in Appendix C.

Table 1: Noise Abatement Summary[1]

Noise Barrier ID	Locations	Analysis Results
NB-C	West side, between Jolly Rd and Dunckel Rd	A 2,400 ft long wall with and average height of approximately 17.4 ft was evaluated and was found to meet MDOTs preliminary requirements for feasibility and reasonableness.
NB-E	West side, near the Beekman Center	A 900 ft long wall was evaluated but it couldn't be designed to meet noise reduction requirements.
NB-F1	East side north of the Forest Rd	A 600 ft long wall was evaluated but it couldn't be designed to meet noise reduction requirements.
NB-F2	East side, Dunckel Rd interchange	A 600 ft long wall was evaluated but it couldn't be designed to meet noise reduction requirements.
NB-G	West side, along shoulder, south of Forest Rd	A 1,500 ft long wall with and average height of approximately 25.7 ft was evaluated and was found to meet MDOTs preliminary requirements for feasibility and reasonableness.
NB-H	West side, north of Forest Rd	A 300 ft long supplementary wall was evaluated but it couldn't be designed to meet noise reduction requirements.
NB-I	West side, south of Mt Hope Ave	A 500 ft long wall was evaluated but it couldn't be designed to meet noise reduction requirements.
NB-J	West side, north side of the Mt Hope Ave overpass	A 1,200 ft long wall was evaluated but it couldn't be designed to meet noise reduction requirements.
NB-M1	East side, along Right-of-Way, US-127/I-496 interchange	A 1,400 ft long wall was evaluated but it couldn't be designed to meet noise reduction requirements.
NB-M2	East side, along ramp shoulder, US-127/I-496 interchange	A 1,770 ft long wall was evaluated but it couldn't be designed to meet noise reduction requirements.

1. The noise barriers that are being recommended for construction are highlighted in blue. The existing noise barriers to be retained are highlighted in yellow.

Table 1: Noise Abatement Summary[1] (Continued)

Noise Barrier ID	Locations	Analysis Results
NB-O1	Along WB I-496, between Francis Ave and Hayford Ave	A 1,200 ft long wall was evaluated but it couldn't be constructed to meet the cost per benefited receiver requirement.
NB-O2	West side, south of Kalamazoo St	A 600 ft long wall was evaluated but it couldn't be designed to meet noise reduction requirements.
NB-P	West side, between Kalamazoo St and Michigan Ave	A 1,100 ft long wall was evaluated but it couldn't be designed to meet noise reduction requirements.
NB-Q	East side, between Kalamazoo St and Michigan Ave	A 1,100 ft long wall was evaluated but it couldn't be designed to meet noise reduction requirements.
NB-R	West side, north of Vine St overpass	A 1,300 ft long wall was evaluated but it couldn't be designed to meet noise reduction requirements.
NB-U (EX)	Existing noise barrier on the west side, between Saginaw Ave and Lake Lansing Rd	The existing barrier was evaluated and was found to satisfy MDOTs feasibility and reasonableness requirements. The existing barrier will be retained without modifications.
NB-Y (EX)	Existing noise barrier on the east side, between Saginaw Ave and Lake Lansing Rd	The existing barrier was evaluated and was found to satisfy MDOTs feasibility and reasonableness requirements. The existing barrier will be retained without modifications.
NB-AB	West side, Lake Lansing Rd interchange	A 500 ft long wall was evaluated but it couldn't be constructed to meet the cost per benefited receiver requirement.
NB-AC	West side, south of the State Rd	A 3,300 ft long wall with and average height of approximately 12.9 ft was evaluated and was found to meet MDOTs preliminary requirements.
NB-AD	East side, Lake Lansing Rd interchange	A 600 ft long wall was evaluated but it couldn't be constructed to meet the cost per benefited receiver requirement.
NB-AE	West side, north of the State Rd	A 1,500 ft long wall with and average height of approximately 14.0 ft was evaluated and was found to meet MDOTs preliminary requirements.
NB-AG	Western Side, north of the Clark Rd	A 550 ft long wall was evaluated but it couldn't be constructed to meet the cost per benefited receiver requirement.

1. The noise barriers that are being recommended for construction are highlighted in blue. The existing noise barriers to be retained are highlighted in yellow.

2. PURPOSE OF THE REPORT

This study evaluates the potential highway traffic noise impacts of the proposed improvements to the I-496/US-127 corridor between the US-127/I-96/I-496 interchange and the northern limits of the US-127/I-69 interchange in Cities of Lansing and East Lansing, Delhi, Lansing, Alaiedon, and DeWitt Townships, Ingham and Clinton Counties. This study was completed in conformance with State and Federal regulations and guidance. The project is being studied as Type I project because the roadway improvements will increase the capacity of the roadway between the US-127/I-96/I-496 and US-127/I-496/Trowbridge Rd interchanges. The proposed fix from the US-127/ I-496/Trowbridge Rd interchange northerly to the US-127/I-69 interchange is a 3R project, which includes but is not limited to resurfacing the roadway, minor side slope modifications, and improving roadside features like signs and guardrail. The addition of new, extended, and realigned travel lanes and ramps fits under the definition of a Type I project under 23 CFR 772.5 and such projects are required to undergo a noise analysis. Moreover, under the Type I definition: “(8) If a project is determined to be a Type I project under this definition then the entire project area as defined in the environmental document is a Type I project” which means the noise analysis will also cover the I-496/US-127 corridor to the US-127/I-69 interchange.

The recommendations for noise abatement measures and locations are in compliance with the FHWA’s *Procedures for Abatement of Highway Traffic Noise and Construction Noise* as presented in the Code of Federal Regulations, Title 23 Part 772 (23 CFR 722), and the Michigan Department of Transportation (MDOT): *Highway Noise Analysis and Abatement Handbook, July 2011*. The MDOT: *Highway Noise Analysis and Abatement Handbook* is in compliance with the *State Transportation Commission Policy 10136 Noise Abatement*, dated July 31, 2003.

3. PROJECT DESCRIPTION

US-127 is a major north/south travel route that runs between Grayling, MI to the north and Jackson, MI to the south. This portion of the US-127 corridor includes a portion of I-496, is approximately 10 miles long, and runs between the I-96 overpass to the south to the Clark Rd overpass to the north. This corridor consists primarily of a four-lane roadway (two-lanes in each direction) with intermittent merge weave lanes and an open median. This corridor includes the US-127/I-496/I-96, Dunckel Rd, US-127/I-496/Trowbridge Rd, Kalamazoo St, Saginaw Ave (M-43), Lake Lansing Rd, and the US-127/I-69 interchanges.

The goal of this project is to address infrastructure deficiencies based on a review of existing geometrics, a corridor wide crash analysis, and operational analysis.

4. TRAFFIC NOISE CONCEPTS, POLICY, AND GUIDELINES

4.1. Basic Acoustic Concepts

Noise can be described as unwanted sound that may interfere with communication or may disturb the community. Three characteristics of noise that have been identified as being important to analyzing the subjective community response to noise include: intensity, frequency, and the time-varying characteristics of the noise.

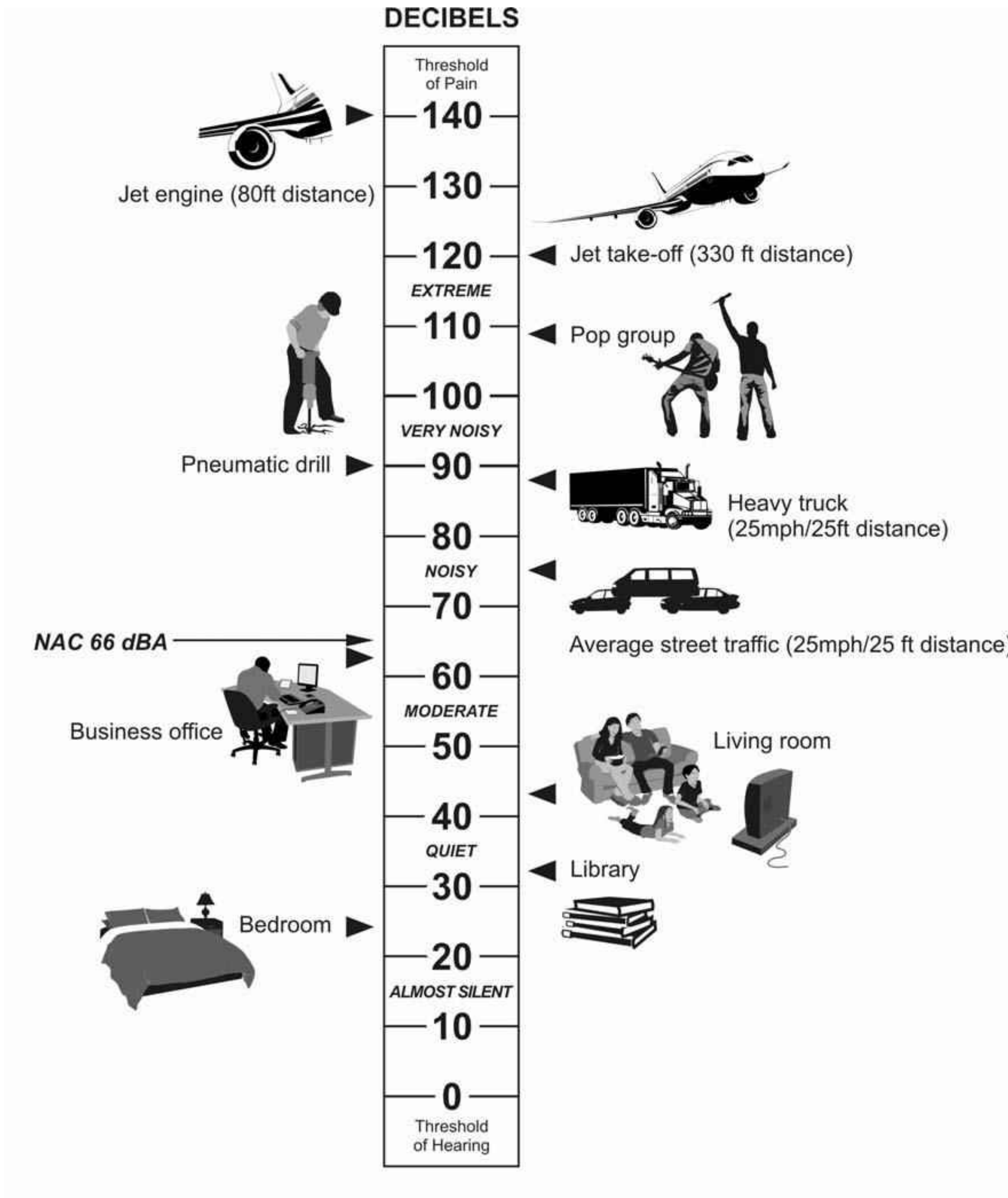
Intensity is a measure of the magnitude or energy of the sound and is directly related to pressure level. The human ear is capable of sensing a wide range of pressure levels. Pressure levels are expressed in terms of a logarithmic scale with units called decibels (dB). As the intensity of a noise increases, it is judged to be more annoying.

The decibel scale is a logarithmic representation of the actual sound pressure variations. The manner in which the logarithmic nature of sound is perceived as loudness, and the accompanying change in traffic volumes is depicted in Table 2: Logarithmic Nature of Sound.

Table 2: Logarithmic Nature of Sound

Change in L_{eq} (1h) Sound Level	Relative Loudness in the Natural Environment
+/- 3 dB(A)	Barely Perceptible Change
+/- 5 dB(A)	Readily Perceptible Change
+/- 10 dB(A)	Considered Twice or Half as Loud

Frequency is a measure of the tonal qualities of sound. The spectrum of frequencies provides the identity of a sound. People are most sensitive to sounds in the middle to high frequencies; therefore, higher frequencies tend to cause more annoyance. This sensitivity led to the use of the A-weighted sound level, which provides a single number measure that weighs different frequencies of the frequency spectrum in a manner similar to the sensitivity of the human ear. Thus, the A-weighted sound level in decibels (dB(A)) provides a simple measure of intensity and frequency that correlates well with the human response to environmental noise. Figure 1 depicts how logarithmic decibel scale relates to frequently encountered environments and noise sources.



Adopted from "Environmental Criteria for Road Traffic Noise," Environmental Protection Authority, South Sydney, NSW, May 1999, Page 38.

Figure 1: Sound Levels of Typical Noise Sources

It is necessary to use a method of measure that will account for the time-varying nature of sound when studying environmental noise. The equivalent sound pressure level (L_{eq}) is defined as the continuous steady sound level that would have the same total A-weighted sound energy as the real fluctuating sound measured over a given period of time. As a result, the three characteristics of noise combine to form a single descriptor (L_{eq} in dB(A)) that helps to evaluate human response to noise and has been chosen for use in this study. The time period used to determine noise levels is typically one hour and uses the descriptor L_{eq}(1h).

Traffic noise at a receiver is influenced by the following major factors: distance from the traffic to the receiver, volume of traffic, speed of traffic, vehicle mix, and acoustical shielding.

Tire sound levels increase with vehicle speed, but also depend upon road surface, vehicle weight, tread design and wear. Change in any of these can vary noise levels, however, average tire and pavement conditions are assumed in the noise prediction model. At lower speeds, especially in trucks and buses, the dominant noise source is the engine and exhaust.

4.2. Federal Regulations and Guidance

FHWA's *Procedures for Abatement of Highway Traffic Noise and Construction Noise*, 23 CFR 772, requires the following during the planning and design of a highway project.

1) Identification of highway traffic noise impacts;
2) Examination of potential abatement measures;
3) Gather viewpoints of benefiting receptors for noise abatement measures found to be reasonable and feasible;
4) Incorporation of reasonable and feasible highway traffic noise abatement measures into the highway project;
5) Coordination with local officials to provide helpful information on compatible land use planning and control; and
6) Identification and incorporation of necessary measures to abate construction noise

The highway traffic noise impact identification process involves a review of the existing land use activity categories that parallel the roadway corridor and determining existing and future noise levels within those areas. Existing land use of developed lands is identified by inspecting aerial photography and verified with site reconnaissance. Highway traffic noise analyses are also performed for undeveloped lands when they are considered permitted developments in accordance with the development's permitted NAC.

The existing noise levels are then determined based on a noise model validation process that compares modeled noise levels to actual measured noise levels. The existing noise environment is determined by gathering noise measurements and concurrent site and traffic information. The FHWA recommends the use of the most recent version of the Traffic Noise Model® (TNM) software be used to construct these models. TNM 2.5 was used to construct these models because TNM 3.0 and 3.1 were still under development at the beginning of this project. Additional information concerning TNM software is provided in Section 5.1 of this report. The noise model must predict noise levels that are within 3 dB(A) of the actual levels in order to be considered valid. Future design year traffic is applied to a model that has been validated for the existing condition to estimate future 2045 noise levels.

A traffic noise impact is defined as a future noise level that approaches or exceeds the FHWA Noise Abatement Criteria (NAC); or a future noise level that creates a substantial noise increase over existing noise levels. An approaching noise level is defined as being 1 dB(A) less than, equal to, or greater than the noise level value listed in the NAC for Activity Category A through E listed in Table 3. The FHWA allows States to define a substantial noise increase as an increase of anywhere between 5 and 15 dB(A).

The NAC, presented in 23 CFR 772, establishes the noise abatement criteria for various land uses, and is presented in Table 3.

Table 3: Noise Abatement Criteria [1]

Activity Category	Activity Criteria[2]		Evaluation Location	Description of Activity Category
	L_{eq} (1h)[3]	L_{10} (1h)[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	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 (water resources, water treatment, electrical), 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 3.
2) Either L_{eq}(h) or L_{10}(h) (but not both) may be used on a project. MDOT only uses L_{eq}(h). The L_{eq}(h) and L_{10}(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) L_{10} is the sound level that is exceeded 10 percent of the time (90th percentile) for the period under consideration, with L_{10}(h) being the hourly value of L_{10}.
5) Includes undeveloped lands permitted for this activity category

The potential abatement alternatives are examined after the traffic noise impacts are identified. The following abatement alternatives, which are listed in 23 CFR 772.15(c) are permitted and can be evaluated where applicable:

1) Construction of noise barriers including acquisition of property rights, either within or outside the highway right-of-way;
2) Traffic management measures;
3) Alteration of horizontal and vertical alignments;
4) Acquisition of real property or interests therein, to serve as a buffer zone to preempt development;
5) Noise insulation of Activity Category D land use facilities listed in Table 3.

At a minimum, State highway agencies are required to consider noise abatement in the form of noise barriers.

FHWA defines feasible highway traffic noise abatement as abatement that meets objective engineering considerations (e.g., barrier be built given the topography of the location; substantial noise reduction be achieved given certain access, drainage, safety, or maintenance requirements; are other noise sources present in the area, etc.). An abatement measure must also achieve a noise reduction of at least 5 dB(A) to be considered feasible, according 23 CFR 772.13 (d)(1)(i). MDOT's feasibility criteria are provided in Section 4.3.

The FHWA lists three required reasonableness factors when considering noise barriers: cost effectiveness; viewpoints of benefitting receptors; and achievement of noise reduction design goals. For reasonableness, 23 CFR 772.13 (d)(2)(iii) requires State DOTs to define design year reduction goals somewhere between 7 and 10 dB(A). FHWA lists optional reasonableness factors that can be added to, but not overrule the required reasonableness factors. MDOT's reasonableness criteria are provided in Section 4.3.

FHWA has developed a process, "Consideration of Existing Noise Barrier in a Type I Noise Analysis" (FHWA-HEP-12-051) for considering the feasibility and reasonableness of replacing or improving existing noise barriers, which are present in 3 locations within the project area (Noise barrier H [CNE H], Noise barrier U [CNEs U and AA], and Noise barrier Y [CNEs V, W, X, and Y]).

The noise analysis process involves determination of existing noise levels and prediction of future noise levels associated with construction of the proposed project. The noise analysis for locations with existing noise barriers should be conducted exactly as it would for any other location and include the existing noise barrier in the analysis. If there are no noise impacts behind the barrier, the process is complete. If impacts are predicted for the future build conditions, further consideration is necessary.

The next step in the assessment, if there are noise impacts behind the barrier, is to determine noise levels for impacted CNEs with existing noise barriers in a "no barrier" scenario. This is a prediction of the design year noise levels for the CNEs without the presence of a barrier. The "no barrier" case is then compared to the "with barrier" case to determine whether the existing noise barrier(s) satisfies the requirements of the MDOT noise policy. If the barrier(s) meet these requirements, no further action is necessary. This approach is acceptable, even though impacts still exist, because the goal of noise abatement is to achieve a substantial reduction in noise levels; not to reduce noise levels below the Noise Abatement Criteria (NAC). In this case, the existing noise barrier achieves an abatement design that is acceptable under the MDOT noise policy.

If the existing MDOT barrier does not meet the current MDOT policy requirements, the existing noise barriers should be retrofitted, or replaced to satisfy MDOT noise policy requirements.

4.3. State Rules and Procedures

MDOT's *Highway Noise Analysis and Abatement Handbook* is the State's tool for implementing 23 CFR 772, which was discussed in Section 4.2. The *Highway Noise Analysis and Abatement Handbook* expands on 23 CFR 772 by refining definitions and establishing milestones within the design phase for the completion of noise impact analysis and mitigation development.

The *Highway Noise Analysis and Abatement Handbook* includes the following definitions:

<u>Common Noise Environment (CNE)</u> A group of receptors within the same Activity Category (Table 3) that are exposed to similar noise sources and levels; traffic volumes, traffic mix, and speed; and topographic features. Generally, common noise environments occur between two secondary noise sources such as interchanges, intersections, and cross roads

<u>Noise Impact:</u> A substantial noise increase or a predicted design year noise level that is 1 dB(A) less, equal to, or greater than the NAC level.

<u>Substantial Noise Increase:</u> A 10 dB(A) or greater increase between the existing noise level and the design year predicted noise level.

<u>Feasible Noise Barrier:</u> A barrier that has no construction impediments, meets safety requirements for the traveling public, and provides at least 5 dB(A) noise reduction at 75% of the impacted receptors.

<u>Reasonable Noise Barrier:</u> A barrier that is cost effective, favorable to benefitting receptors, and achieves noise reduction design goals by meeting or exceeding the reasonableness factor.

<u>Cost Effective Noise Barrier:</u> A noise barrier analyzed for environmental clearance with a preliminary construction cost that is not more than 3% above the allowable cost per benefited receptor unit (CPBU) of $49,907 (year 2022), assuming a $45.00 per square foot noise barrier construction cost.

<u>Benefited Receptor:</u> A receptor that receives a 5 dB(A) or greater insertion loss as a result of a proposed noise barrier.

<u>Attenuation Requirement:</u> Reduce design year traffic noise by 10 dB(A) for at least one benefited receptor and provide at least a 7 dB(A) reduction for 50% or more of the benefited receptor sites.

Permitted Development: Any presently undeveloped lands that have received a building permit from the local township or municipality.

Dwelling Unit Equivalent (DUE): The receptor count for public areas such as parks, schools, libraries, and churches, which is determined based on the number of employees or attendees and frequency of used. See the *Highway Noise Analysis and Abatement Handbook* for examples of how DUE are calculated.

5. NOISE ANALYSIS

5.1. FHWA Traffic Noise Model (TNM)

TNM is FHWA's computer program for highway traffic noise prediction and analysis. State and Federal regulations require the use of the most recent version of TNM® software for all traffic noise related projects. TNM 3.0 and 3.1 were under development when this project stated, so TNM 2.5 was used for this project. The following parameters are used in this model to calculate an hourly L_{eq} at a specific receiver location:

- Distance between roadway and receiver;
- Relative elevations of roadway and receiver;
- Hourly traffic volumes by classification;
- Vehicle speeds;
- Ground absorption;
- Weather conditions; and
- Topographic features, including retaining walls and berms.

Hourly traffic volumes have been divided into five vehicle classifications: automobiles (A); medium trucks (MT); heavy trucks (HT); Buses (B); and Motorcycles (M). Each vehicle class is defined by the *FHWA Traffic Noise Model, User's Guide, (February 1998); TNM v2.5 Update Sheet, Technical Manual: Part 1* as follows:

- Automobiles – all vehicles with two axles and four tires, includes passenger vehicles and light trucks, less than 9,900 pounds.
- Medium trucks – all vehicles having two axles and six tires, vehicle weight between 9,900 and 26,400 pounds.
- Heavy trucks – all vehicles having three or more axles, vehicle weight greater than 26,400 pounds.
- Buses – all vehicles designed to carry more than nine passengers.
- Motorcycles – all vehicles with two or three tires and an open-air driver/passenger compartment.

5.2. Analysis

5.2.1. Land Use and Field Measured Levels

Land use in the project area is a mixture of single and multi-family residential, commercial properties, retail facilities, hotels, sports areas, cemeteries, schools, agricultural properties, and undeveloped lands. Sites within the US-127 and I-496 corridor with similar land use and traffic, i.e. land use and traffic characteristics were grouped into Common Noise Environments (CNEs) for analysis. Descriptions of each CNE within the project limits are provided in Table 4.

Table 4: Project Area Common Noise Environments

CNE	Site Description	CNE	Site Description
A	Low Density Residential	N1	Undeveloped
B1	Agricultural	N2	Undeveloped
B2	Agricultural	O	Low Density Residential
B3	Office Buildings	P1	Medium Density Residential
C	Multi-family Residential	P2	Retail Facilities
D1	Post Office	Q1	Retail Facilities
D2	Multi-family Residential	Q2	Medium Density Residential
E1	Undeveloped Swamp	R	Medium Density Residential
E2	School	S	Retail Facilities
F1	Hotel	T	Retail Facilities
F2	Schools	U*	Multi-family Residential
F3	Undeveloped	V*	Low Density Residential
F4	Hospital	W*	Undeveloped
F5	Sports Facility	X*	Multi-family Residential
G	Multi-family Residential	Y*	Multi-family Residential
H[1]	Multi-family Residential	Z	Retail Facilities
I1	Cemetery	AA*	Low Density Residential
I2	Low Density Residential	AB	Retail Facilities & Undeveloped
J	Low Density Residential	AC	High Density Residential
K	Multi-family Residential	AD	Retail Facilities & Undeveloped
L	Retail Facilities	AE	High Density Residential
M1	Low Density Residential	AF	Low Density Residential
M2	Multi-family Residential	AG	Low Density Residential
M3	Retail Facilities	AH	Low Density Residential
M4	Multi-family Residential	AI	Low Density Residential

* CNE protected by existing noise barriers

Field measurements with concurrent traffic counts were taken to compare with modeled noise levels to validate the TNM for use on this project to predict existing (2019) and future build (2045) noise levels. Existing noise level measurements were conducted on October 13, 14, 19, and 20, 2021, November 3, 4, 9, 10, and 14, 2021, and May 31, 2022 at twenty-nine (29) representative sites in the project vicinity. Most of the measurements were completed during free flow conditions and when traffic was unaffected by construction activity in the area. Refer to Appendix A for site and measurement related information. Refer to Appendix C for maps which include the location of these sites. Refer to Table 5 for the correlation between the measurement sites and CNE areas.

A minimum fifteen (15) minute measurement was taken at each site, during peak and off-peak traffic time periods. The measurements were conducted in accordance with FHWA and MDOT guidelines using an integrating sound level analyzer. Traffic counts were taken at each site, concurrent with the noise measurements. Posted traffic speeds in the project area were verified using the floating car method during the site visits. The floating car method involves driving a vehicle with traffic and observing average speeds. Concurrent weather readings were obtained from the weather station at the Capital Region International Airport Station, for accurate modeling purposes. The data collected at the 31 sites are presented in Table 5.

Table 5: Measured Existing Noise Levels

Field Site ID (CNE)	Date	Period	Traffic[1, 5]						Measured Noise Level, dB(A) L_{eq}
			Roadway, Direction[2]	Autos[3]	Medium Trucks[4]	Heavy Trucks[4]	Buses[3]	Motor-cycles[3]	
3 (CNE C)	10/13/21	AM	SB US-127 NB US-127	1548 2556	44 44	76 128	8 0	0 0	67
	10/13/21	Off	SB US-127 NB US-127	1372 1732	48 32	100 152	16 4	4 4	68
	10/19/21	PM	SB US-127 NB US-127	2268 2132	8 12	76 60	0 4	8 4	68
4 (CNE D2)	10/13/21	AM	SB US-127 NB US-127	1264 1596	28 52	100 108	8 4	0 0	73
	10/13/21	Off	SB US-127 NB US-127	1408 1500	36 44	116 104	0 8	0 0	73
	10/19/21	PM	SB US-127 NB US-127	1936 2364	32 16	52 92	4 8	4 4	74
5 (CNE G)	10/14/21	AM	SB US-127 NB US-127	2392 2708	40 24	104 88	8 16	0 4	69
	10/13/21	Off	SB US-127 NB US-127	1856 1840	40 28	112 116	12 0	4 4	66
	11/03/21	PM	SB US-127 NB US-127	2592 1880	12 8	100 40	4 8	0 4	67

1) Vehicle counts classifications are according to Section 5.1 of this report.
2) Vehicle traffic on insignificant roadways has not been included.
3) The observed speed for this vehicle matches the posted speed limit (70 mph).
4) The observed speed for this vehicle matches the posted speed limit for trucks (65 mph).
5) Hourly traffic volumes listed.
6) Located behind an existing noise barrier.

Table 5: Measured Existing Noise Levels (Continued)

Field Site ID (CNE)	Date	Period	Traffic[1, 5]						Measured Noise Level, dB(A) L_{eq}
			Roadway, Direction[2]	Autos[3]	Medium Trucks[4]	Heavy Trucks[4]	Buses[3]	Motor-cycles[3]	
6[6] (CNE H)	10/14/21	AM	SB US-127 NB US-127	2223 2586	66 33	87 75	27 6	0 0	61
	10/13/21	Off	SB US-127 NB US-127	2664 2238	39 57	99 90	0 15	0 0	59
	11/03/21	PM	SB US-127 NB US-127	2892 2792	32 20	56 56	36 4	0 0	58
7 (CNE I)	10/14/21	AM	SB US-127 NB US-127	2040 2640	56 72	88 68	8 4	4 0	73
	10/13/21	Off	SB US-127 NB US-127	2340 2468	20 40	132 112	16 32	4 4	72
	11/03/21	PM	SB US-127 NB US-127	3688 2728	8 40	80 72	20 0	0 0	75
8 (CNE J)	11/03/21	AM	SB US-127 NB US-127	2168 2684	16 52	92 108	12 8	0 0	75
	10/13/21	Off	SB US-127 NB US-127	2184 2140	32 40	92 104	8 20	0 8	72
	11/03/21	PM	SB US-127 NB US-127	2852 2512	28 44	88 60	8 4	0 0	74
9 (CNE M1)	11/03/21	AM	Trowbridge NB NB US-127	56 1272	4 64	0 88	0 8	0 0	64
	11/03/21	Off	Trowbridge NB NB US-127	92 1388	0 8	0 108	0 12	0 0	63
	11/03/21	PM	Trowbridge NB NB US-127	172 1680	0 8	0 88	0 8	0 0	64
10 (CNE M3)	11/03/21	AM	Trowbridge EB Trowbridge WB	1048 268	8 4	0 0	4 4	0 4	69
	10/19/21	Off	Trowbridge EB Trowbridge WB	588 684	4 4	0 0	0 0	0 0	69
	10/19/21	PM	Trowbridge EB Trowbridge WB	664 860	8 4	0 4	0 8	0 0	69
12 (CNE P1)	10/19/21	AM	SB US-127 Howard St	2868 1588	0 4	168 12	0 0	4 0	76
	10/14/21	Off	SB US-127 Howard St	2036 896	56 8	100 20	0 20	0 0	74
	11/10/21	PM	SB US-127 Howard St	3360 808	20 4	88 0	8 0	4 0	73

1) Vehicle counts classifications are according to Section 5.1 of this report.
2) Vehicle traffic on insignificant roadways has not been included.
3) The observed speed for this vehicle was 70 mph.
4) The observed speed for this vehicle was 65 mph.
5) Hourly traffic volumes listed.
6) Located behind an existing noise barrier.

Table 5: Measured Existing Noise Levels (Continued)

Field Site ID (CNE)	Date	Period	Traffic[1, 5]						Measured Noise Level, dB(A) L_{eq}
			Roadway, Direction[2]	Autos[3]	Medium Trucks[4]	Heavy Trucks[4]	Buses[3]	Motor-cycles[3]	
13 (CNE Q2)	10/19/21	AM	NB US-127 Homer St	928 984	20 20	44 44	8 0	0 0	74
	10/14/21	Off	NB US-127 Homer St	960 909	12 9	87 42	27 3	0 0	74
	11/10/21	PM	NB US-127 Homer St	1336 780	60 0	96 0	4 8	0 0	73
14 (CNE R)	10/19/21	AM	SB US-127 NB US-127	1816 1236	32 32	132 52	12 4	0 0	78
	10/14/21	Off	SB US-127 NB US-127	1604 1244	12 12	160 64	12 0	4 0	77
	10/20/21	PM	SB US-127 NB US-127	1720 1792	40 4	128 28	0 0	8 0	77
15 (CNE U)	11/10/21	AM	SB US-127 NB US-127	2536 1632	20 116	188 100	8 4	0 0	80
	10/19/21	Off	SB US-127 NB US-127	1784 1516	40 28	116 88	8 4	0 0	78
	10/20/21	PM	SB US-127 NB US-127	2644 3076	20 12	136 84	8 4	4 0	79
16[6] (CNE U)	5/31/22	AM	SB US-127 NB US-127	2048 1636	44 56	88 88	24 4	4 0	60
	5/31/22	Off	SB US-127 NB US-127	1588 1452	12 32	80 120	4 4	8 0	60
	5/31/22	PM	SB US-127 NB US-127	2128 3240	24 12	84 48	4 4	4 12	61
17[6] (CNE AA)	11/09/21	AM	SB US-127 NB US-127	2428 864	16 28	180 104	8 0	0 0	62
	10/19/21	Off	SB US-127 NB US-127	1182 966	15 24	150 108	3 0	0 3	60
	10/20/21	PM	SB US-127 NB US-127	2340 1948	24 12	176 84	4 0	4 0	62

1) Vehicle counts classifications are according to Section 5.1 of this report.
2) Vehicle traffic on insignificant roadways has not been included.
3) The observed speed for this vehicle was 70 mph.
4) The observed speed for this vehicle was 65 mph.
5) Hourly traffic volumes listed.
6) Located behind an existing noise barrier.

Table 5: Measured Existing Noise Levels (Continued)

Field Site ID (CNE)	Date	Period	Traffic[1, 5] Roadway, Direction[2]	Autos[3]	Medium Trucks[4]	Heavy Trucks[4]	Buses[3]	Motor-cycles[3]	Measured Noise Level, dB(A) L_{eq}
18 (CNE AB)	11/09/21	AM	SB US-127 NB US-127 SB On Ramp	1592 800 304	16 24 20	160 76 32	8 0 0	0 0 0	71
	10/19/21	Off	SB US-127 NB US-127 SB On Ramp	1308 884 488	28 32 28	156 68 16	0 0 0	8 0 4	68
	10/20/21	PM	SB US-127 NB US-127 SB On Ramp	1828 1704 460	40 4 44	156 44 4	0 0 0	0 4 0	71
19 (CNE AB)	11/03/21	AM	SB US-127 NB US-127	1924 796	8 20	88 60	0 0	0 0	77
	10/19/21	Off	SB US-127 NB US-127	936 964	8 24	140 80	4 0	4 4	75
	10/20/21	PM	SB US-127 NB US-127	1468 2152	24 12	152 68	8 0	4 4	76
20 (CNE V)	10/19/21	AM	SB US-127 NB US-127	1704 1300	48 60	156 112	0 4	12 0	76
	10/14/21	Off	SB US-127 NB US-127	1516 1804	24 40	116 60	8 0	0 0	76
	11/04/21	PM	SB US-127 NB US-127	2480 2496	16 40	192 76	12 0	4 0	77
21[6] (CNE V)	10/19/21	AM	SB US-127 NB US-127	1600 1064	36 128	176 68	20 4	0 0	62
	10/14/21	Off	SB US-127 NB US-127	1760 1120	24 4	168 60	0 0	0 0	62
	11/04/21	PM	SB US-127 NB US-127	2548 2728	12 20	152 32	16 0	0 0	63
22[6] (CNE Y)	5/31/22	AM	SB US-127 NB US-127	2248 1548	44 64	64 88	4 4	0 0	60
	5/31/22	Off	SB US-127 NB US-127	1640 1312	8 68	80 88	0 4	8 4	59
	5/31/22	PM	SB US-127 NB US-127	2248 3164	16 44	68 60	12 8	8 4	62
23 (CNE Z)	11/09/21	AM	SB US-127 NB US-127	3492 1836	28 44	196 88	0 4	0 0	73
	10/14/21	Off	SB US-127 NB US-127	1932 2092	28 8	132 68	20 0	0 4	72
	11/04/21	PM	SB US-127 NB US-127	2364 3748	20 8	116 24	0 4	0 0	74

1) Vehicle counts classifications are according to Section 5.1 of this report.
2) Vehicle traffic on insignificant roadways has not been included.
3) The observed speed for this vehicle was 70 mph.
4) The observed speed for this vehicle was 65 mph.
5) Hourly traffic volumes listed.
6) Located behind an existing noise barrier.

Table 5: Measured Existing Noise Levels (Continued)

Field Site ID (CNE)	Date	Period	Traffic[1, 5] Roadway, Direction[2]	Autos[3]	Medium Trucks[4]	Heavy Trucks[4]	Buses[3]	Motor-cycles[3]	Measured Noise Level, dB(A) L_{eq}
24 (CNE AC)	10/20/21	AM	SB US-127 NB US-127	2920 796	12 36	148 100	0 8	0 0	72
	10/19/21	Off	SB US-127 NB US-127	1104 1236	24 12	136 80	8 0	0 0	69
	11/09/21	PM	SB US-127 NB US-127	1504 1988	16 12	128 64	4 12	0 0	71
25 (CNE AE)	10/20/21	AM	SB US-127 NB US-127	2076 832	32 20	136 96	0 0	0 0	79
	10/19/21	Off	SB US-127 NB US-127	1328 1228	24 16	152 60	0 0	4 8	78
	11/09/21	PM	SB US-127 NB US-127	1360 2100	24 8	140 56	0 4	0 0	78
26 (CNE C)	10/13/21	AM	SB US-127 NB US-127	1576 2228	32 44	116 88	20 8	0 0	70
	10/13/21	Off	SB US-127 NB US-127	1348 1516	28 28	76 112	16 16	0 0	69
	10/19/21	PM	SB US-127 NB US-127	2076 2072	8 16	52 32	0 4	0 8	72
27 (CNE F5)	10/14/21	AM	SB US-127 NB US-127	2880 3280	24 20	100 72	20 0	0 0	63
	10/14/21	Off	SB US-127 NB US-127	1500 2232	16 56	120 128	4 16	0 0	64
	11/10/21	PM	SB US-127 NB US-127	2892 2144	16 24	64 44	12 20	0 4	62
28 (CNE K)	10/14/21	AM	SB US-127 NB US-127	1260 1540	28 112	116 108	8 12	0 4	62
	10/13/21	Off	SB US-127 NB US-127	2208 1856	20 24	64 64	16 12	0 8	60
	11/10/21	PM	SB US-127 NB US-127	2604 2208	28 28	64 68	32 4	0 4	61
29 (CNE AD)	10/20/21	AM	SB US-127 NB US-127	1264 840	24 72	120 100	0 0	0 0	73
	10/19/21	Off	SB US-127 NB US-127	1280 1008	44 36	144 76	0 0	0 0	73
	11/04/21	PM	SB US-127 NB US-127	1848 2344	24 4	96 44	0 4	0 0	75

1) Vehicle counts classifications are according to Section 5.1 of this report.
2) Vehicle traffic on insignificant roadways has not been included.
3) The observed speed for this vehicle was 70 mph.
4) The observed speed for this vehicle was 65 mph.
5) Hourly traffic volumes listed.
6) Located behind an existing noise barrier.

Table 5: Measured Existing Noise Levels (Continued)

Field Site ID (CNE)	Date	Period	Traffic[1, 5] Roadway, Direction[2]	Autos[3]	Medium Trucks[4]	Heavy Trucks[4]	Buses[3]	Motor-cycles[3]	Measured Noise Level, dB(A) L_{eq}
30 (CNE M1)	11/03/21	AM	NB Ramp NB US-127	80 1148	0 40	0 136	0 4	0 0	58
	11/03/21	Off	NB Ramp NB US-127	96 1020	4 28	4 84	0 12	0 0	56
	11/03/21	PM	NB Ramp NB US-127	336 1480	0 12	4 32	0 0	0 0	58
31 (CNE AI)	5/31/22	AM	NB Ramp NB US-127	944 452	20 16	108 100	12 0	0 0	63
	5/31/22	Off	NB Ramp NB US-127	1000 472	16 16	68 60	12 0	0 0	63
	5/31/22	PM	NB Ramp NB US-127	1516 948	12 20	56 24	4 4	12 4	64
32 (CNE AG)	11/10/21	AM	EB I-69 WB I-69	916 732	44 4	168 100	0 0	0 0	63
	5/31/22	Off	EB I-69 WB I-69	928 880	12 24	112 192	0 4	0 4	57
	11/09/21	PM	EB I-69 WB I-69	1696 1272	12 28	116 100	0 4	0 0	63

1) Vehicle counts classifications are according to Section 5.1 of this report.
2) Vehicle traffic on insignificant roadways has not been included.
3) The observed speed for this vehicle was 70 mph.
4) The observed speed for this vehicle was 65 mph.
5) Hourly traffic volumes listed.
6) Located behind an existing noise barrier.

5.2.2. Field Measured vs. Modeled Noise Levels

TNM 2.5 was used to compare the field measurements to the model using the traffic count information. Comparing the modeled noise levels to the measured noise levels validates the TNM 2.5 model for use on the specific project. Table 6 provides a site-by-site comparison of the noise levels from measurement sites and model validation sites. As shown in Table 6, all the results from modeled sites were within 3 dB of the measured value and modeled sites satisfy the MDOT requirement for validation.

Table 6: Comparison of Measured and Modeled Noise Levels

Field Site ID	Noise Level, dB(A) L_{eq} (1h)						Difference in Noise Level, dB(A) L_{eq} (1h) (Modeled Minus Measured)		
	Measured			Modeled					
	AM	Off*	PM	AM	Off*	PM	AM	Off*	PM
1	72	70	70	74	71	73	+2	+1	+3
2	71	70	72	74	73	74	+3	+3	+2
3	67	68	68	70	70	71	+3	+2	+3
4	73	73	74	74	74	75	+1	+1	+1
5	69	66	67	69	68	68	0	+2	+1
6	61	59	58	59	58	59	-2	-1	+1
7	73	72	75	73	74	75	0	+2	0
8	75	72	74	73	73	74	-2	+1	0
9	64	63	64	64	64	64	0	+1	0
10	69	69	69	67	68	70	-2	-1	+1
12	76	74	73	74	72	72	-2	-2	-1
13	74	74	73	72	72	70	-2	-2	-3
14	78	77	77	75	75	75	-3	-2	-2
15	80	78	79	77	76	77	-3	-2	-2
16	60	60	61	57	57	58	-3	-3	-3
17	62	60	62	60	59	60	-2	-1	-2
18	71	68	71	68	68	68	-3	0	-3
19	77	75	76	74	73	74	-3	-2	-2
20	76	76	77	75	75	76	-1	-1	-1

* “Off” refers to off peak traffic between 9 am and 4 pm

Table 6: Comparison of Measured and Modeled Noise Levels (Continued)

Field Site ID	Noise Level, dB(A) L_{eq} (1h)						Difference in Noise Level, dB(A) L_{eq} (1h) (Modeled Minus Measured)		
	Measured			Modeled					
	AM	Off*	PM	AM	Off*	PM	AM	Off*	PM
21	62	62	63	60	60	61	-2	-2	-2
22	60	59	62	58	58	60	-2	-1	-2
23	73	72	74	73	72	74	0	0	0
24	72	69	71	73	70	71	+1	+1	0
25	79	78	78	76	76	76	-3	-2	-2
26	70	69	72	69	69	69	-1	0	-3
27	63	64	62	63	62	62	0	-2	0
28	62	60	61	62	62	62	0	+2	+1
29	73	73	75	71	71	73	-2	-2	-2
30	58	56	58	57	56	56	-1	0	-2
31	63	63	64	61	60	61	-2	-3	-3
32	63	57	63	60	60	60	-3	+3	-3

* "Off" refers to off peak traffic between 9 am and 4 pm

5.2.3. Predicted Traffic Noise Levels and Noise Impact Analysis

The traffic noise prediction program, TNM 2.5, was used to model Existing (2019) and Future Build (2045) traffic noise levels within the project area. For analysis purposes, the loudest noise hours were used to identify the impacted receivers within the US-127 and I-496 corridor. The loudest noise hours usually occur during peak traffic hours when truck volumes and vehicle speeds are the greatest and when traffic is at or near free-flow conditions. The noise levels that are generated by AM and PM peak traffic hours were typically within 1 dB(A). The existing (2019) and future build (2045) traffic volumes that were used in the modeling are shown in Table 7 through Table 10. Peak AM and Peak PM traffic volumes were used to account for the daily influx of traffic into and out of downtown Lansing. The existing (2019) and future (2045) traffic volumes were developed by WSP Michigan Inc. (sub-vendor to Bergmann) as a part of this project. 2019 was used as the existing design year to eliminate the traffic reductions that resulted from the COVID pandemic. The vehicle class distributions used in the noise impact analysis were based on information gathered during the noise measurements. In accordance with Section 2.5.2 of the *Highway Noise Analysis and Abatement Handbook*, the existing and future traffic volumes operate under free-flow conditions with a LOS of C or better.

One thousand one-hundred ninety-seven (1,197) receiver locations were included in the noise model. These receivers represent frequently used outdoor areas at the residential properties, commercial properties, cemeteries, and parks that are within 500 ft of the outside edge of existing Right-of-Way. All the receivers that were included in the model represent existing sites. For additional information concerning the receiver locations, CNE limits, noise barriers, and the 66 dB(A) contour line refer to the figures in Appendix C.

A large portion of the Spartan Village Complex (CNE K) was vacant during the noise measurements at Site 28. Based on a meeting with Michigan State University on March 18, 2022, the occupied units are used for visiting facility members, the unoccupied units will remain vacant, and the Spartan Village Complex will be redeveloped in the future. The plans for the redevelopment of this area have not been completed but may consist of a mixture of commercial, residential, and research facility properties. A 66 dB(A) noise contour line has been provided in Appendix C to depict the areas that would be impacted if redeveloped into residential properties.

The results of the noise impact analysis are provided in Appendix D. The addresses that are provide were obtained from the GIS sites for the surrounding municipalities.

Table 7: Existing 2019 Traffic Volumes (AM Peak)

Roadway	Limits	Volumes by Vehicle Type [1, 2, 3]				
		Autos	Medium Trucks	Heavy Trucks	Buses	Motor-cycles
NB US-127/ WB I-496	I-96 to Dunckel Rd	3054	46	171	10	4
SB US-127/ EB I-496	I-96 to Dunckel Rd	2323	36	131	8	3
Dunckel Rd		1091	37	124	2	3
NB US-127/ WB I-496	Dunckel Rd to I-496	3147	48	177	11	4
SB US-127/ EB I-496	Dunckel Rd to I-496	3055	47	171	10	4
EB I-496	US-127 to Pennsylvania Ave	3199	49	179	11	4
WB I-496	US-127 to Pennsylvania Ave	3316	50	186	11	4
NB US-127	I-496 to Grand River	2364	36	133	8	3
SB US-127	I-496 to Grand River	3946	60	221	13	5
EB Trowbridge Rd	US-127 to Harrison Rd	1252	21	71	5	3
WB Trowbridge Rd	US-127 to Harrison Rd	313	5	18	1	1
Homer St	Kalamazoo St to Saginaw Ave	467	16	53	1	2
Howard St	Kalamazoo St to Saginaw Ave	351	12	40	1	1
Kalamazoo St	500’ east and west of US-127	492	17	56	1	2
EB Michigan Ave	500’ east and west of US-127	291	10	34	1	1
WB Michigan Ave	500’ east and west of US-127	485	17	55	1	2
NB US-127	Grand River to Lake Lansing Rd	1848	28	104	6	2
SB US-127	Grand River to Lake Lansing Rd	3713	56	208	12	4
EB Lake Lasing Rd	500’ east and west of US-127	1164	39	132	2	3
WB Lake Lasing Rd	500’ east and west of US-127	979	33	111	2	3
NB US-127	Lake Lansing Rd to I-69	1017	16	58	4	2
SB US-127	Lake Lansing Rd to I-69	3295	50	185	11	4
EB I-69	Wood Rd to Remey Chandler Drain	1504	23	85	5	2
WB I-69	Wood Rd to Remey Chandler Drain	1328	21	75	5	2
NB US-127	I-69 to Round Lake Rd	706	11	40	3	1
SB US-127	I-69 to Round Lake Rd	1561	24	88	6	2

1) See Appendix B for additional traffic information
2) Volume distribution based on a traffic counts that were performed (93%, 1.4%, 5.2%, 0.3% and 0.1).
3) Hourly traffic volumes listed.

Table 8: Existing 2019 Traffic Volumes (PM Peak)

Roadway	Limits	Volumes by Vehicle Type [1, 2, 3]				
		Autos	Medium Trucks	Heavy Trucks	Buses	Motor-cycles
NB US-127/ WB I-496	I-96 to Dunckel Rd	2742	42	154	9	3
SB US-127/ EB I-496	I-96 to Dunckel Rd	3613	55	203	12	4
Dunckel Rd		1298	44	147	2	3
NB US-127/ WB I-496	Dunckel Rd to I-496	3487	53	196	12	4
SB US-127/ EB I-496	Dunckel Rd to I-496	3026	46	170	10	4
EB I-496	US-127 to Pennsylvania Ave	2565	39	144	9	3
WB I-496	US-127 to Pennsylvania Ave	3241	49	182	11	4
NB US-127	I-496 to Grand River	3675	56	206	12	4
SB US-127	I-496 to Grand River	2632	40	148	9	3
EB Trowbridge Rd	US-127 to Harrison Rd	723	12	43	4	3
WB Trowbridge Rd	US-127 to Harrison Rd	1359	21	77	4	1
Homer St	Kalamazoo St to Saginaw Ave	443	7	25	2	1
Howard St	Kalamazoo St to Saginaw Ave	809	28	92	1	2
Kalamazoo St	500’ east and west of US-127	835	28	95	1	2
EB Michigan Ave	500’ east and west of US-127	745	25	85	1	2
WB Michigan Ave	500’ east and west of US-127	724	25	82	1	2
NB US-127	Grand River to Lake Lansing Rd	3871	59	217	13	5
SB US-127	Grand River to Lake Lansing Rd	2130	33	120	7	3
EB Lake Lasing Rd	500’ east and west of US-127	1320	45	149	2	4
WB Lake Lasing Rd	500’ east and west of US-127	1257	42	142	2	3
NB US-127	Lake Lansing Rd to I-69	3145	48	176	11	4
SB US-127	Lake Lansing Rd to I-69	1272	20	72	5	2
EB I-69	Wood Rd to Remey Chandler Drain	1729	27	97	6	2
WB I-69	Wood Rd to Remey Chandler Drain	1790	27	101	6	2
NB US-127	I-69 to Round Lake Rd	1757	27	99	6	2
SB US-127	I-69 to Round Lake Rd	821	13	46	3	1

1) See Appendix B for additional traffic information
2) Volume distribution based on a traffic counts that were performed (93%, 1.4%, 5.2%, 0.3% and 0.1).
3) Hourly traffic volumes listed.

Table 9: Future Build 2045 Traffic Volumes (AM Peak)

Roadway	Limits	Volumes by Vehicle Type [1, 2, 3]				
		Autos	Medium Trucks	Heavy Trucks	Buses	Motor-cycles
NB US-127/ WB I-496	I-96 to Dunckel Rd	4043	61	227	14	5
SB US-127/ EB I-496	I-96 to Dunckel Rd	2323	36	131	8	3
Dunckel Rd		1384	47	157	2	4
NB US-127/ WB I-496	Dunckel Rd to I-496	4486	68	251	15	5
SB US-127/ EB I-496	Dunckel Rd to I-496	3409	52	191	12	4
EB I-496	US-127 to Pennsylvania Ave	3691	56	207	12	4
WB I-496	US-127 to Pennsylvania Ave	4483	68	251	15	5
NB US-127	I-496 to Grand River	1630	26	93	7	3
SB US-127	I-496 to Grand River	652	10	37	4	3
EB Trowbridge Rd	US-127 to Harrison Rd	2364	36	133	8	3
WB Trowbridge Rd	US-127 to Harrison Rd	4183	64	235	14	5
Homer St	Kalamazoo St to Saginaw Ave	534	18	61	1	2
Howard St	Kalamazoo St to Saginaw Ave	405	14	46	1	1
Kalamazoo St	500’ east and west of US-127	565	19	64	1	2
EB Michigan Ave	500’ east and west of US-127	333	12	38	1	1
WB Michigan Ave	500’ east and west of US-127	553	19	63	1	2
NB US-127	Grand River to Lake Lansing Rd	2125	33	119	7	3
SB US-127	Grand River to Lake Lansing Rd	4186	64	235	14	5
EB Lake Lasing Rd	500’ east and west of US-127	1328	45	150	2	4
WB Lake Lasing Rd	500’ east and west of US-127	1124	38	127	2	3
NB US-127	Lake Lansing Rd to I-69	1203	19	68	4	2
SB US-127	Lake Lansing Rd to I-69	3794	58	213	13	5
EB I-69	Wood Rd to Remey Chandler Drain	1730	27	97	6	2
WB I-69	Wood Rd to Remey Chandler Drain	1519	23	86	5	2
NB US-127	I-69 to Round Lake Rd	840	13	48	3	1
SB US-127	I-69 to Round Lake Rd	1799	28	101	6	2

1) See Appendix B for additional traffic information
2) Volume distribution based on a traffic counts that were performed (93%, 1.4%, 5.2%, 0.3% and 0.1).
3) Hourly traffic volumes listed.

Table 10: Future Build 2045 Traffic Volumes (PM Peak)

Roadway	Limits	Volumes by Vehicle Type [1, 2, 3]				
		Autos	Medium Trucks	Heavy Trucks	Buses	Motor-cycles
NB US-127/ WB I-496	I-96 to Dunckel Rd	3120	47	175	11	4
SB US-127/ EB I-496	I-96 to Dunckel Rd	3698	56	207	12	4
Dunckel Rd		1576	53	178	2	4
NB US-127/ WB I-496	Dunckel Rd to I-496	3975	60	223	13	5
SB US-127/ EB I-496	Dunckel Rd to I-496	3863	59	217	13	5
EB I-496	US-127 to Pennsylvania Ave	2565	39	144	9	3
WB I-496	US-127 to Pennsylvania Ave	3241	49	182	11	4
NB US-127	I-496 to Grand River	1630	26	93	7	3
SB US-127	I-496 to Grand River	652	10	37	4	3
EB Trowbridge Rd	US-127 to Harrison Rd	3743	57	210	13	5
WB Trowbridge Rd	US-127 to Harrison Rd	3055	47	171	10	4
Homer St	Kalamazoo St to Saginaw Ave	931	32	106	2	3
Howard St	Kalamazoo St to Saginaw Ave	709	24	80	1	2
Kalamazoo St	500’ east and west of US-127	953	32	108	2	3
EB Michigan Ave	500’ east and west of US-127	850	29	96	1	2
WB Michigan Ave	500’ east and west of US-127	825	28	94	1	2
NB US-127	Grand River to Lake Lansing Rd	3908	59	219	13	5
SB US-127	Grand River to Lake Lansing Rd	2549	39	143	9	3
EB Lake Lasing Rd	500’ east and west of US-127	1505	51	170	2	4
WB Lake Lasing Rd	500’ east and west of US-127	1438	49	163	2	4
NB US-127	Lake Lansing Rd to I-69	3271	50	183	11	4
SB US-127	Lake Lansing Rd to I-69	1460	22	82	5	2
EB I-69	Wood Rd to Remey Chandler Drain	1971	30	111	7	3
WB I-69	Wood Rd to Remey Chandler Drain	1961	30	110	7	3
NB US-127	I-69 to Round Lake Rd	1876	29	106	7	3
SB US-127	I-69 to Round Lake Rd	936	15	53	4	2

1) See Appendix B for additional traffic information
2) Volume distribution based on a traffic counts that were performed (93%, 1.4%, 5.2%, 0.3% and 0.1).
3) Hourly traffic volumes listed.

Noise impacts occur when future build noise levels either exceed existing noise levels by 10 dB(A) or more; or approach or exceed the NAC. For this project, the predicted Build loudest noise hour levels for year 2045 range from 54 dB(A) to 77 dB(A). These values vary from 0 dB(A) to 3 dB(A) higher than existing loudest hour noise levels. A summary of the noise impact assessment (or the number of receptor locations that approach or exceed the NAC) is provided in Table 11.

Table 11: Number of Receptors within CNEs that Approach or Exceed the NAC

Activity Description	2019	2045
CNE Area B2 – Agricultural	0	0
CNE Area B3 – Office Buildings	0	0
CNE Area C – Multi-family Residential	36	53
CNE Area D1 – Post Office	0	0
CNE Area D2 – Multi-family Residential	0	0
CNE Area E1 – Undeveloped Swamp	0	0
CNE Area E2 – School	0	1
CNE Area F1 – Hotel	0	0
CNE Area F2 – Schools	0	1
CNE Area F3 – Undeveloped	0	0
CNE Area F4 – Hospital	0	0
CNE Area F5 – Sports Facility	40	40
CNE Area G – Multi-family Residential	36	45
CNE Area H – Multi-family Residential	1	2
CNE Area I1 – Cemetery	0	0
CNE Area I2 – Low Density Residential	1	1
CNE Area J – Low Density Residential	2	3
CNE Area K – Multi-family Residential	0	0
CNE Area L – Retail Facilities	0	0
CNE Area M1 – Low Density Residential	5	10
CNE Area M2 – Multi-family Residential	13	13
CNE Area M3 – Retail Facilities	0	0
CNE Area M4 – Multi-family Residential	0	0
CNE Area N1 – Undeveloped	0	0
CNE Area N2 – Undeveloped	0	0
CNE Area O – Low Density Residential	8	6
CNE Area P1 – Medium Density Residential	18	18
CNE Area P2 – Retail Facilities	0	0
CNE Area Q1 – Retail Facilities	0	0
CNE Area Q2 – Medium Density Residential	43	43
CNE Area R – Medium Density Residential	30	37
CNE Area S – Retail Facilities	1	1

Table 11: Number of Receptors within CNEs that Approach or Exceed the NAC (Continued)

Activity Description			2019	2045
CNE Area T	–	Retail Facilities	0	0
CNE Area U	–	Multi-family Residential	16	16
CNE Area V	–	Low Density Residential	1	0
CNE Area W	–	Undeveloped	0	0
CNE Area X	–	Multi-family Residential	0	0
CNE Area Y	–	Multi-family Residential	8	8
CNE Area Z	–	Retail Facilities	0	0
CNE Area AA	–	Low Density Residential	1	2
CNE Area AB	–	Retail Facilities & Undeveloped	1	1
CNE Area AC	–	High Density Residential	42	46
CNE Area AD	–	Retail Facilities & Undeveloped	2	2
CNE Area AE	–	High Density Residential	14	14
CNE Area AF	–	Low Density Residential	0	0
CNE Area AG	–	Low Density Residential	1	2
CNE Area AH	–	Low Density Residential	0	0
CNE Area AI	–	Low Density Residential	0	0

6. ABATEMENT MEASURES

6.1. Federal and State Abatement Guidance

MDOT's Noise Policy has established the criteria for determining where noise abatement must be provided. The policy is summarized as follows:

- Where adverse noise impacts are expected to occur, noise abatement will be considered and will be implemented if found feasible and reasonable for existing developments, and future developments that were approved before the date of public knowledge of the project. Approved means that a building permit has been received. After the date of public knowledge, MDOT is not responsible for providing noise abatement for new developments. The date of public knowledge is the date that the project's environmental analysis and documentation is approved (i.e. the date of approval of a CE, date of the issuance of the Finding of No Significant Impact for an EA, or the date of the Record Decision for an EIS). The date of the clearance of the Categorical Exclusion will be the date of public knowledge. The provision of noise abatement for new developments becomes the responsibility of local governments and private developers.

- Feasible - This refers to engineering considerations such as: constructability of a noise barrier on the existing topography; achievement of substantial noise reductions; the presence of other noise sources in the area; and the ability to maintain access, drainage, safety, utilities in the area. While every reasonable effort should be made to obtain a substantial noise reduction, a noise abatement measure is not feasible if it cannot achieve at least a 5 dB(A) noise reduction for 75% of impacted receivers during design year traffic noise.

- Reasonable - Noise mitigation will be considered reasonable if:
    - During the environmental clearance phase, the preliminary cost per benefiting unit is less than 3% above allowable per benefitting unit level ($49,907 in 2022 dollars or $51,404, based on a $45/square foot unit cost);
    - The public viewpoint reasonableness factor for the environmental clearance phase receives generally positive comments from the benefiting units; and
    - The noise barrier provides a design year traffic noise reduction of 10 dB(A) for at least one benefitted unit and at least a 7 dB(A) for 50% or more of the benefitted units.

Highway traffic noise abatement alternatives, which are listed in 23 CFR 772.15(c) include:

1) Construction of noise barriers including acquisition of property rights, either within or outside the highway right-of-way;
2) Traffic management measures;
3) Alteration of horizontal and vertical alignments;
4) Acquisition of real property or interests therein, to serve as a buffer zone to preempt development;
5) Noise insulation of Activity Category D land use facilities listed in Table 3

Review of the listed abatement alternatives has determined that reductions of speed limits, although acoustically beneficial, are seldom practical unless the design speed of the proposed roadway is also reduced. The restriction or prohibition of trucks is extremely undesirable because US-127 and I-496 are major freeways in Michigan. The MDOT design criteria, project limits, and the existing terrain preclude substantial horizontal and vertical alignment shifts that could potentially produce noticeable changes in some of the areas adjacent to the US-127 and I-496 corridors. Geometric improvements to the US-127/Dunckel Rd and the US-127/I-496 interchanges have been reviewed as a part of this project. These improvements could provide 1dB(A) of acoustic benefit to the adjacent properties. The cost restrictions typically prohibit the acquisition of property for any reason. The construction of noise berms is neither feasible nor reasonable because of the amount of space that would be required. Therefore, the construction of noise barriers within the existing Right-of-Way was the only mitigation measure that received in-depth evaluation.

6.2 Noise Barrier Analysis

Forty-eight (48) CNE areas were identified within the project limits. CNE areas B2, B3, D1, D2, E1, F1, F3, F4, I1, K, L, M3, M4, N1, N2, P2, Q1, T, V, W, X, Y, Z, AF, AH, and AI have no impacted receptors with the future conditions, and do not require abatement analysis. Impacted noise receptors were identified at the remaining CNE areas therefore, noise barriers were analyzed in accordance with the minimum requirement established by the MDOT: *Highway Noise Analysis and Abatement Handbook*. The alignment of the noise barriers that were analyzed are depicted in Appendix C. Line of sight was reviewed at all the evaluated barriers.

Based on the impacts that were seen behind the existing noise barriers, the effectiveness of the existing barriers (Noise barrier H [CNE H], Noise barrier U [CNEs U and AA], and Noise barrier Y [CNEs V, W, X, and Y]) were evaluated to determine if they meet current requirements.

The results of the evaluated barriers, including barrier location, future L_{eq}(1h) noise levels without and with a barrier, barrier length and height, and the noise reduction provided by the barrier are presented in Table 12. The receivers that are located behind the evaluated barriers are summarized in Appendix E. The remaining receivers will not receive any measurable reductions in noise levels and have been excluded from Appendix E.

The following information is presented for each of the barriers in Table 13:

- The number of substantial noise reduction locations.
- The number of locations with more than 7 dB(A) attenuation.
- The total estimated cost (based on $45.00 per square foot).
- The number of benefited receptors (i.e. residential, commercial, and equivalent).
- The cost per benefited receptor (maximum allowable $51,404).
- The feasibility determination.
- The reasonableness determination.

Table 12: Evaluated Noise Barriers

Noise Barrier ID	Locations	Existing L_{eq} (1hr) Noise Levels, dB(A)	Range of Future L_{eq}(1hr) Noise Levels, dB(A)		Noise Reduction (dB(A))	Barrier Characteristics	
			w/o Barrier	With Barrier		Length (ft)	Avg. Ht. (ft)
NB-C	Along the western Right-of-Way Line of I-496/US-127, between Jolly Rd and Dunckel Rd	57-72	59-74	55-65	1-14	2,400	17.4
NB-E	Along the western Right-of-Way Line of I-496/US-127, near the Beekman Center	64	66	62	4	900	30
NB-F1	Along WB I-496, on the north side of the Forest Rd overpass	66-69	66-69	62-66	3-6	600	16
NB-F2	Along the Dunckel Rd to WB I-496/US-127Ramp	64	67	63	4	600	30
NB-G	Along the EB I-496/US-127 shoulder, on the south side of the Forest Rd overpass	58-69	59-70	56-64	3-10	1,500	25.7
NB-H	Supplementary noise barrier in the NW quadrant of the US-127/I-496 over Forest Rd overpass	59-66*	62-76*	59-65*	1-3	300	20
NB-I	Along EB I-496/US-127, on the south side of the Mt Hope Ave overpass	67	69	65	4	500	30
NB-J	Along EB I-496/US-127, on the north side of the Mt Hope Ave overpass	64-67	66-68	64	2-4	1,200	30
NB-M1	Along the eastern Right-of-Way Line of US-127/I-496 interchange	60-70	59-68	58-64	0-12	1,400	19.5
NB-M2	Along the WB Trowbridge Rd to NB US-127 ramp shoulder	60-70	59-68	58-64	0-7	1,770	16
NB-O1	Along WB I-496, between Francis Ave and Hayford Ave	61-67	62-67	58-63	0-7	1,200	25
NB-O2	Along the SB US-127 to WB I-496 ramp, with the northern limits of the wall at the Kalamazoo St overpass approach	62-67	62-68	61-66	0-22	600	25

* Noise level behind the existing barrier.

Table 12: Evaluated Noise Barriers (Continued)

Noise Barrier ID	Locations	Existing L_{eq} (1hr) Noise Levels, dB(A)	Range of Future L_{eq}(1hr) Noise Levels, dB(A)		Noise Reduction (dB(A))	Barrier Characteristics	
			w/o Barrier	With Barrier		Length (ft)	Avg. Ht. (ft)
NB-P	Along SB US-127, between the Kalamazoo St overpass and the Michigan Ave overpass	67-70	67-70	62-69	1-5	1,100	30
NB-Q	Along NB US-127, between the Kalamazoo St overpass and the Michigan Ave overpass	67-71	66-70	62-68	2-4	1,100	30
NB-R	Along SB US-127, between the SB On Ramp and the Vine St overpass	63-72	63-72	59-69	2-5	1,300	30
NB-U (EX)	Existing noise barrier along the western Right-of-Way Line between Saginaw Ave and Lake Lansing Rd	56-69 *	60-79	56-69	0-15	5,580	20.1
NB-Y (EX)	Existing noise barrier along the eastern Right-of-Way Line between Saginaw Ave and Lake Lansing Rd	66-70 *	59-76	54-70	1-15	4,280	20.4
NB-AB	Along the western Right-of-Way Line of US-127, within the vicinity of the Fairfield Inn and Suites parking lot	72	73	63	10	500	14.6
NB-AC	Along the western Right-of-Way Line of US-127, south of the State Rd overpass	59-73	60-73	56-66	1-12	3,300	12.9
NB-AD	Along the eastern Right-of-Way Line of US-127, within the vicinity of First Assembly of God of Greater Lansing	60-72	60-72	58-63	2-13	600	15.5
NB-AE	Along the western Right-of-Way Line of US-127, north of the State Rd overpass	56-77	56-77	53-66	1-16	1,500	14
NB-AG	Along the western Right-of-Way Line of I-69, north of the Clark Rd overpass	65-71	66-71	59-61	5-12	550	30

* Noise level behind the existing barrier.

Table 13: Noise Barrier Feasibility and Reasonableness

Noise Barrier ID	# of Impacted Sites	Number of Attenuated Sites							Cost [1]	Cost / Benefited	Feasible	Reasonable
		# of Sites Benefited (≥ 5 dB(A))	# of Impacted Sites being Benefited	% of Impacted Sites being Benefited	# of Benefited Sites with ≥ 7 dB(A) Reduction	% of Benefited Sites with ≥ 7 dB(A) Reduction	# Benefited Sites with ≥ 10 dB(A) Reduction				(Y/N)	(Y/N)
NB-C	53	124	49	92%	72	58%	18		$1,876,500	$15,135	Y	Y
NB-E	1	0	0	0%	0	0%	0		$1,215,000	N/A	N	N
NB-F1	40	16	16	40%	0	0%	0		$432,000	$27,000	N	N
NB-F2	1	0	0	0%	0	0%	0		$810,000	N/A	N	N
NB-G	43	73	37	86%	37	51%	1		$1,737,000	$23,795	Y	Y
NB-H	2	0	0	0%	0	0%	0		$270,000	N/A	N	N
NB-I	1	0	0	0%	0	0%	0		$675,000	N/A	N	N
NB-J	3	0	0	0%	0	0%	0		$1,620,000	N/A	N	N
NB-M1	10	11	9	90%	7	63%	3		$1,228,500	$111,680	Y	N
NB-M2	10	8	8	80%	7	88%	0		$1,274,500	$159,300	Y	N
NB-O1	2	3	1	50%	1	33%	0		$1,350,000	$450,000	N	N
NB-O2	4	0	0	0%	0	0%	0		$675,000	N/A	N	N
NB-P	20	5	5	25%	0	0%	0		$1,485,000	$297,000	N	N
NB-Q	43	0	0	0%	0	0%	0		$1,485,000	N/A	N	N
NB-R	32	12	12	38%	0	0%	0		$1,755,000	$146,250	N	N
NB-U (EX) [2]	140	185	134	96%	98	53%	65		N/A	N/A	Y	Y
NB-Y (EX) [2]	190	341	181	95%	178	52%	74		N/A	N/A	Y	Y
NB-AB	1	1	1	100%	1	100%	1		$328,500	$328,500	Y	N
NB-AC	46	42	42	91%	41	98%	14		$1,858,500	$44,250	Y	Y
NB-AD	2	2	2	100%	2	100%	1		$418,500	$209,250	Y	N
NB-AE	14	24	14	100%	12	50%	9		$949,500	$39,560	Y	Y
NB-AG	2	2	2	100%	1	50%	1		$742,500	$371,250	Y	N

1) The construction cost of noise barriers is $45 per square feet
2) Values entered in the table are based a pre-existing noise barrier condition, evaluated per FHWA's "Consideration of Existing Noise Barrier in a Type I Noise Analysis" (FHWA-HEP-12-051)

The above table presents the modeled barrier analysis results to determine their feasibility and reasonableness. Noise barriers E, F1, F2, H, I, J, O1, O2, P, Q, and R have less than the required 75% of impacted receptors receiving a 5 dB(A) noise reduction and so did not meet the feasibility requirements. Noise barriers M1, M2, AB, AD, and AG exceed the $49,907 plus 3% ($51,404) allowable cost per benefitting unit and so did not meet the reasonableness requirement. The results show that noise barriers C, G, AC, and AE satisfy the MDOT's feasible and reasonableness criteria, and are recommended.

Three noise barrier alignments were evaluated at CNE G. The first alignment is primarily located along the edge of the Right-of-Way and would require wall heights of up to 35 ft high. The second alignment is in the green space halfway between the edge of the Right-of-Way and the edge of the proposed shoulder. This barrier would require a total abatement height of 38 ft, but could be constructed as a 22 ft high barrier placed on the top of a 16 ft earthen berm. The third alignment is primarily located along the edge of the proposed shoulder and would require wall heights of up to 28 ft. The third alignment was selected as the preferred alternative, because it is the most constructable, the least visually impactful, and the least environmentally impactful.

Existing noise barriers U and Y are functioning in a feasible and reasonable manner and do not need to be modified, despite having impacted receptors. Existing noise barrier H does not meet MDOTs current reasonableness requirement. Due to noise barrier H being constructed by the adjacent property owner, the existing barrier was evaluated as an existing feature and a supplemental barrier was evaluated to mitigate the impacted site in CNE H. The supplemental barrier could not be designed to meet MDOT reasonable and feasibleness criteria.

The limits of the noise barriers that were evaluated are depicted in Appendix C. The limits of the noise barriers that are being recommended because they satisfy MDOT's feasible and reasonableness criteria are depicted in Figure 2 through Figure 5.

All the recommended barriers are single run barriers and do not contain parallel communities, so absorptive noise barriers are not anticipated.

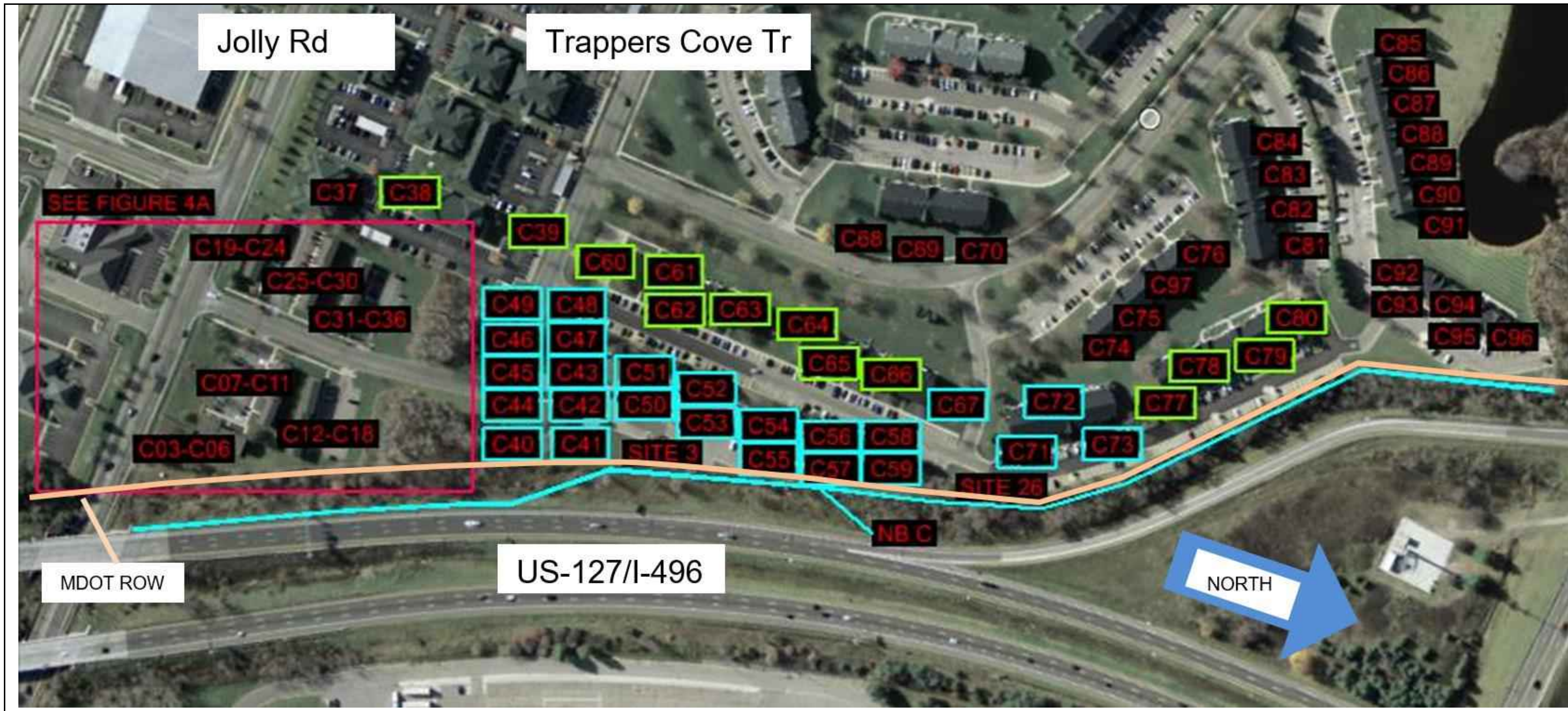


Figure 2: Recommended limits of noise barrier C

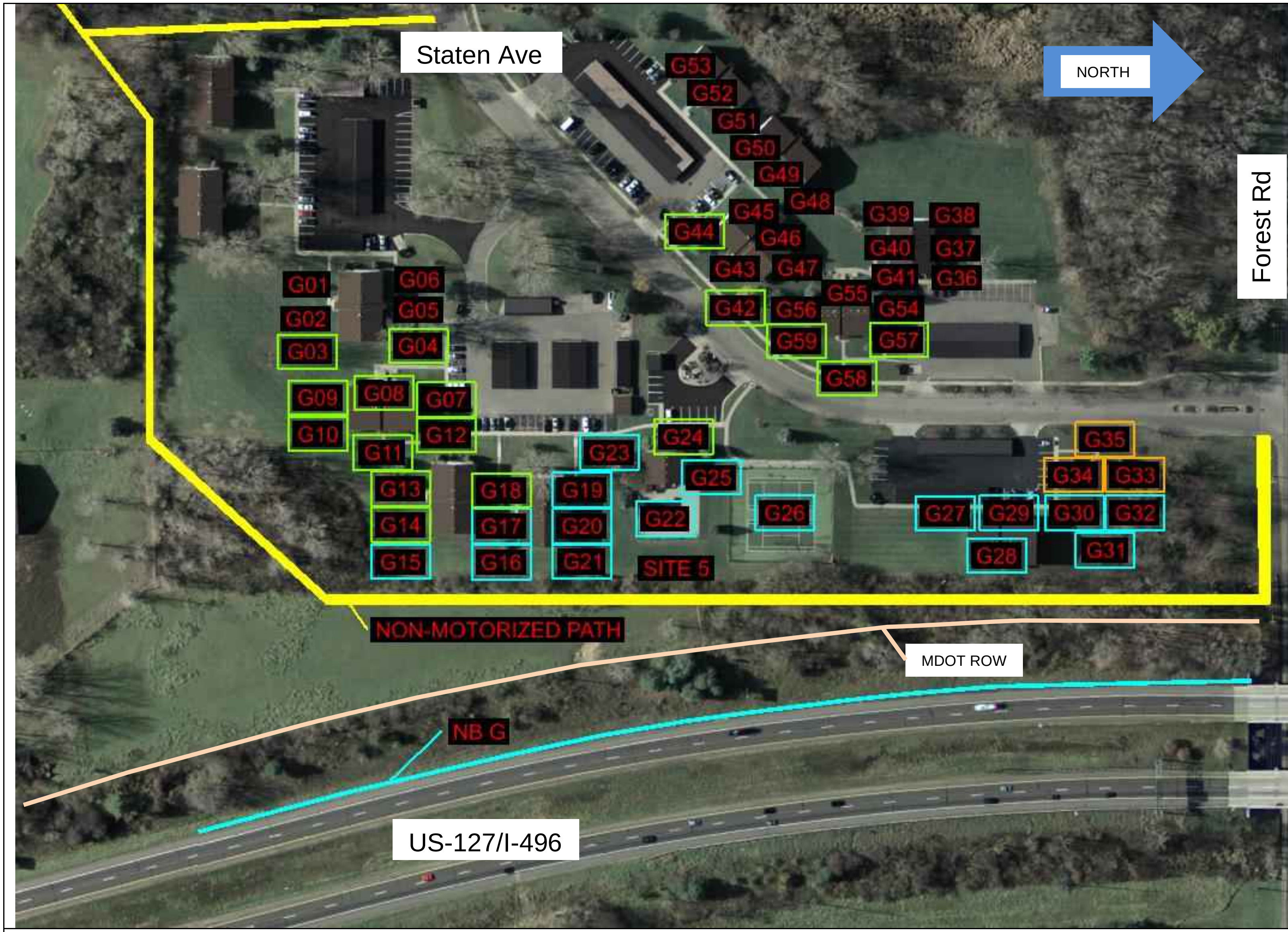


Figure 3: Recommended limits of noise barrier G

Figure 4: Recommended limits of noise barrier AC

Figure 5: Recommended limits of noise barrier AE

6.3 Noise Compatible Land Use Planning

Noise compatible land use planning along this corridor should be considered by local officials to avoid future highway noise impacts. To aid in this planning the future build (2045), 66 dB(A) noise contour (the noise level corresponding with MDOTs definition of "approaching" the NAC for Activity Categories B and C) has been evaluated as a part of this study. The 71 dB(A) contour line rarely extends beyond the existing Right-of-way and was excluded from the figures. The 66 dB(A) noise contour is depicted at the undeveloped parcels in Appendix C. The construction of noise sensitive properties within these limits should be avoided to prevent future highway noise impacts.

7. CONCLUSIONS AND RECOMMENDATIONS

MDOT's policy is to install noise abatement measures found to be feasible and reasonable that are associated with transportation improvements. Abatement of traffic noise impacts for the proposed I-496 and US-127 corridors appears to be feasible and reasonable for noise barriers C, G, AC, and AE (see Table 13).

An engineering level noise abatement analysis will be completed on the warranted abatement measure to ensure it meets final design phase feasibility and reasonableness criteria. Final design phase feasibility criteria are the same as in the environmental clearance phase and includes:

1) The approval of the abatement measure by a majority of the benefitting property owners and residents;

2) The cost benefit of the noise barrier is equal to or below the allowable per benefitting unit cost for the year of the final design; and

3) Noise attenuation level criteria that is the same as in the environmental clearance phase.

8. STATEMENT OF LIKELIHOOD

Based on the study thus far accomplished, the Michigan Department of Transportation intends to install highway traffic noise abatement in the form of noise barriers presented in Table 12 in this document. The preliminary indications of likely abatement measures are based on preliminary design for barrier cost(s) and noise abatement as illustrated in Table 13 in this document. If it subsequently develops during final design that these conditions have substantially changed, the abatement measures might not be provided. A final decision of the installation and aesthetics of the abatement measures(s) will be made upon completion of the project's final design and the Context Sensitive Design process.

9. CONSTRUCTION NOISE

The noise produced on highway construction sites originates from a variety of sources, which can be described by identifying those phases of construction applicable to the recommended project. Specifically, each phase of construction has its own scope, objective, mix of equipment, and therefore, its own noise characteristics. For most projects these phases will overlap due to time constraints and interdependency of activities.

The Michigan Department of Transportation is committed to abatement of construction noise at the locations identified in Table 13 and Appendix C contingent on the following considerations:

1. detailed construction noise analysis using the FWHA Roadway Noise Construction Model (RCNM) and design considerations during the PE Phase;
2. types of particularly noisy activities expected, like impact and vibratory pile driving, demolition using hoe ramming and other impact devices, pneumatic devices, rock coring auguring, concrete crusher plant operations, and concrete joint saw cutting;
3. efforts to mitigate noise during construction, like the early construction of noise barriers;
4. public outreach to adjacent residential communities to inform residents of upcoming construction activities, particularly those involving construction operations and nighttime construction;
5. site, path, and source control for noisy construction operations; and
6. safety and engineering aspects.

It is likely that construction noise abatement measures for the identified construction noise impacted areas will be carried out based on the contingencies listed above.

10. REFERENCES

Anderson, G. S., C.S.Y. Lee, G.G. Fleming and C. Menge, "FHWA Traffic Noise Model®, Version 1.0 User's Guide", Federal Highway Administration, January 1998, p. 60.

"Commission Policy", (Guidance Document 10136), Michigan Transportation Commission, Michigan Department of Transportation, July 31, 2003.

Lau, Michael C., Cynthia S. Y. Lee, Gregg G. Judith L. Rochat, Eric R. Boeker, and Gregg C. Fleming. FHWA Traffic Noise Model® Users Guide (Version 2.5 Addendum). Federal Highway Administration, April 2004.

"Highway Noise Analysis and Abatement Handbook" Michigan Department of Transportation, July 13, 2011.
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"Report to the President and Congress on Noise", National Service Center for Environmental Publications, February 1972.

Title 23 CFR Part 772, "Procedure for abatement of Highway Traffic Noise and Construction Noise", Code of Federal Regulations
http://www.fhwa.dot.gov/hep/23cfr772.htm

"Consideration of Existing Noise Barrier in a Type I Noise Analysis", FHWA-HEP-12-051
https://www.fhwa.dot.gov/environment/noise/noise_barriers/abatement/existing.cfm

Appendix A
Measurement Site Information:

Noise Measurements

SITE / LOCATION: **Site 3** DATE: **6/17/22**

AM Peak Measurement		Period	Measured	Calculated	Difference
Time Begin:	8:25 AM	15 minutes	Leq	Leq	Leq
			67	70	3
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
NB US-127	2556	44	128	0	0
SB US-127	1548	44	76	8	0

Off-Peak Measurement		Period		Calculated	Difference
Time Begin:	10:30 AM	15 minutes	Leq	Leq	Leq
			68	70	2
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
NB US-127	1732	32	152	4	4
SB US-127	1372	48	100	16	4

PM Peak Measurement		Period	Measured	Calculated	Difference
Time Begin:	4:55 PM	15 minutes	Leq	Leq	Leq
			68	71	3
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
NB US-127	2132	12	60	4	4
SB US-127	2268	8	76	0	8

LOCATION AERIAL:

Comments: ______

SITE PHOTOGRAPHS:

Looking E

Looking S

Looking W

Noise Measurements

SITE / LOCATION: **Site 4** DATE: **6/17/22**

AM Peak Measurement		Period	Measured	Calculated	Difference
Time Begin:	9:15 AM	15 minutes	Leq	Leq	Leq
			73	74	1
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
NB US-127	1596	52	108	4	0
SB US-127	1264	28	100	8	0

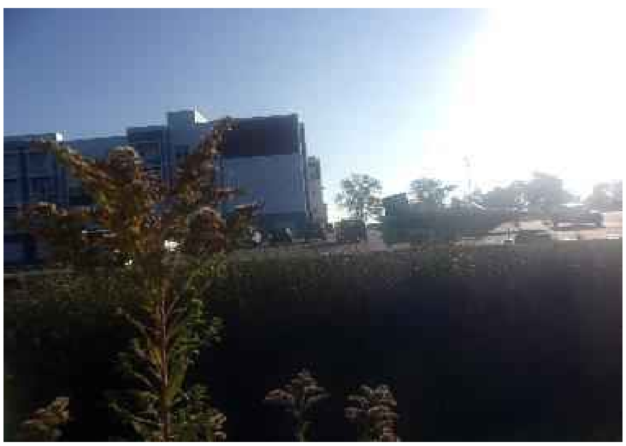
Off-Peak Measurement		Period		Calculated	Difference
Time Begin:	11:20 AM	15 minutes	Leq	Leq	Leq
			73	74	1
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
NB US-127	1500	44	104	8	0
SB US-127	1408	36	116	0	0

PM Peak Measurement		Period	Measured	Calculated	Difference
Time Begin:	4:30 PM	15 minutes	Leq	Leq	Leq
			74	75	1
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
NB US-127	2364	16	92	8	4
SB US-127	1936	32	52	4	4

LOCATION AERIAL:

Comments:

SITE PHOTOGRAPHS:



Looking E

Looking N

Looking S

Looking W

Noise Measurements

SITE / LOCATION: **Site 5**

DATE: **6/17/22**

AM Peak Measurement		Period	Measured	Calculated	Difference
Time Begin:	7:25 AM	15 minutes	Leq	Leq	Leq
			69	69	0
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
NB US-127	2708	24	88	16	0
SB US-127	2392	40	104	8	0

Off-Peak Measurement		Period		Calculated	Difference
Time Begin:	11:55 AM	15 minutes	Leq	Leq	Leq
			66	68	2
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
NB US-127	1840	28	116	0	4
SB US-127	1856	40	112	12	4

PM Peak Measurement		Period	Measured	Calculated	Difference
Time Begin:	5:50 PM	15 minutes	Leq	Leq	Leq
			67	68	1
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
NB US-127	1880	8	40	8	4
SB US-127	2592	12	100	4	0

LOCATION AERIAL:

Comments:

SITE PHOTOGRAPHS:

Noise Measurements

SITE / LOCATION: **Site 6**

DATE: **6/17/22**

AM Peak Measurement		Period	Measured	Calculated	Difference
Time Begin:	8:40 AM	15 minutes	Leq	Leq	Leq
			61	59	-2
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
NB US-127	2586	33	75	6	0
SB US-127	2223	66	87	27	0

Off-Peak Measurement		Period		Calculated	Difference
Time Begin:	2:30 PM	20 minutes	Leq	Leq	Leq
			59	58	-1
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
NB US-127	2238	57	90	15	0
SB US-127	2664	39	99	0	0

PM Peak Measurement		Period	Measured	Calculated	Difference
Time Begin:	4:05 PM	15 minutes	Leq	Leq	Leq
			58	59	1
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
NB US-127	2792	20	56	4	0
SB US-127	2892	32	56	36	0

LOCATION AERIAL:

Comments:

SITE PHOTOGRAPHS:

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Noise Measurements

SITE / LOCATION: **Site 7** DATE: **6/17/22**

AM Peak Measurement		Period	Measured	Calculated	Difference
Time Begin:	8:15 AM	15 minutes	Leq	Leq	Leq
			73	73	0
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
NB US-127	2640	72	68	4	0
SB US-127	2040	56	88	8	4

Off-Peak Measurement		Period		Calculated	Difference
Time Begin:	2:05 PM	15 minutes	Leq	Leq	Leq
			72	74	2
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
NB US-127	2468	40	112	32	4
SB US-127	2340	20	132	16	4

PM Peak Measurement		Period	Measured	Calculated	Difference
Time Begin:	4:35 PM	15 minutes	Leq	Leq	Leq
			75	75	0
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
NB US-127	2728	40	72	0	0
SB US-127	3688	8	80	20	0

LOCATION AERIAL:

Comments:

SITE PHOTOGRAPHS:

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Noise Measurements

SITE / LOCATION: **Site 8** DATE: **6/17/22**

AM Peak Measurement		Period	Measured	Calculated	Difference
Time Begin:	7:55 AM	15 minutes	Leq	Leq	Leq
			75	73	-2
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
NB US-127	2684	52	108	8	0
SB US-127	2168	16	92	12	0

Off-Peak Measurement		Period		Calculated	Difference
Time Begin:	1:40 PM	15 minutes	Leq	Leq	Leq
			72	73	1
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
NB US-127	2140	40	104	20	8
SB US-127	2184	32	92	8	0

PM Peak Measurement		Period	Measured	Calculated	Difference
Time Begin:	5:25 PM	15 minutes	Leq	Leq	Leq
			74	74	0
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
NB US-127	2512	44	60	4	0
SB US-127	2852	28	88	8	0

LOCATION AERIAL:

Comments:

SITE PHOTOGRAPHS:

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Noise Measurements

SITE / LOCATION: **Site 9** DATE: **6/17/22**

AM Peak Measurement		Period	Measured	Calculated	Difference
Time Begin:	9:30 AM	15 minutes	Leq	Leq	Leq
			64	64	0
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
NB US-127	1272	64	88	8	0
NB Ramp	56	4	0	0	0

Off-Peak Measurement		Period		Calculated	Difference
Time Begin:	10:45 AM	15 minutes	Leq	Leq	Leq
			63	64	1
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
NB US-127	1388	8	108	12	0
NB Ramp	92	0	0	0	0

PM Peak Measurement		Period	Measured	Calculated	Difference
Time Begin:	5:25 PM	15 minutes	Leq	Leq	Leq
			64	64	0
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
NB US-127	1680	8	88	8	0
NB Ramp	172	0	0	0	0

LOCATION AERIAL:

Comments:

SITE PHOTOGRAPHS:

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Noise Measurements

SITE / LOCATION: **Site10** DATE: **6/17/22**

AM Peak Measurement		Period	Measured	Calculated	Difference
Time Begin:	8:25 AM	15 minutes	Leq	Leq	Leq
			69	67	-2
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
EB Trowbrigde	1048	8	0	4	0
WB Trowbridge	268	4	0	4	4

Off-Peak Measurement		Period		Calculated	Difference
Time Begin:	3:45 PM	15 minutes	Leq	Leq	Leq
			69	68	-1
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
EB Trowbrigde	588	4	0	0	0
WB Trowbridge	684	4	0	0	0

PM Peak Measurement		Period	Measured	Calculated	Difference
Time Begin:	4:50 PM	15 minutes	Leq	Leq	Leq
			69	70	1
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
EB Trowbrigde	664	8	0	0	0
WB Trowbridge	860	4	4	8	0

LOCATION AERIAL:

Comments:

SITE PHOTOGRAPHS:

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Noise Measurements

SITE / LOCATION: **Site 12** DATE: **6/17/22**

AM Peak Measurement		Period	Measured	Calculated	Difference
Time Begin:	7:45 AM	15 minutes	Leq	Leq	Leq
			76	74	-2
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
Howard St	1588	4	12	0	0
SB US-127	2868	0	168	0	4

Off-Peak Measurement		Period		Calculated	Difference
Time Begin:	11:05 AM	15 minutes	Leq	Leq	Leq
			74	72	-2
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
Howard St	896	8	20	20	0
SB US-127	2036	56	100	0	0

PM Peak Measurement		Period	Measured	Calculated	Difference
Time Begin:	5:15 PM	15 minutes	Leq	Leq	Leq
			73	72	-1
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
Howard St	808	4	0	0	0
SB US-127	3360	20	88	8	4

LOCATION AERIAL:

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SITE PHOTOGRAPHS:

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Noise Measurements

SITE / LOCATION: **Site 13** DATE: **6/17/22**

AM Peak Measurement		Period	Measured	Calculated	Difference
Time Begin:	7:20 AM	15 minutes	Leq	Leq	Leq
			74	72	-2
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
NB US-127	928	20	44	8	0
Homer St	984	20	44	0	0

Off-Peak Measurement		Period		Calculated	Difference
Time Begin:	10:35 AM	20 minutes	Leq	Leq	Leq
			74	72	-2
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
NB US-127	960	12	87	27	0
Homer St	909	9	42	3	0

PM Peak Measurement		Period	Measured	Calculated	Difference
Time Begin:	5:40 PM	15 minutes	Leq	Leq	Leq
			73	70	-3
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
NB US-127	1336	60	96	4	0
Homer St	780	0	0	8	0

LOCATION AERIAL:

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Noise Measurements

SITE / LOCATION: **Site 14** DATE: **6/17/22**

AM Peak Measurement		Period	Measured	Calculated	Difference
Time Begin:	8:35 AM	15 minutes	Leq	Leq	Leq
			78	75	-3
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
NB US-127	1236	32	52	4	0
SB US-127	1816	32	132	12	0
Howard St	1100	40	12	16	0

Off-Peak Measurement		Period		Calculated	Difference
Time Begin:	12:30 PM	15 minutes	Leq	Leq	Leq
			77	75	-2
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
NB US-127	1244	12	64	0	0
SB US-127	1604	12	160	12	4
Howard St	1096	28	4	24	0

PM Peak Measurement		Period	Measured	Calculated	Difference
Time Begin:	5:30 PM	15 minutes	Leq	Leq	Leq
			77	75	-2
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
NB US-127	1792	4	28	0	0
SB US-127	1720	40	128	0	8
Howard St	1080	24	4	0	16

LOCATION AERIAL:

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Noise Measurements

SITE / LOCATION: **Site 15**　　　　DATE: **6/17/22**

AM Peak Measurement		Period	Measured	Calculated	Difference
Time Begin:	8:15 AM	15 minutes	Leq	Leq	Leq
			80	77	-3
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
NB US-127	1632	116	100	4	0
SB US-127	2536	20	188	8	0

Off-Peak Measurement		Period		Calculated	Difference
Time Begin:	1:15 PM	15 minutes	Leq	Leq	Leq
			78	76	-2
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
NB US-127	1516	28	88	4	0
SB US-127	1784	40	116	8	0

PM Peak Measurement		Period	Measured	Calculated	Difference
Time Begin:	5:10 PM	15 minutes	Leq	Leq	Leq
			79	77	-2
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
NB US-127	3076	12	84	4	0
SB US-127	2644	20	136	8	4

LOCATION AERIAL:

Comments:

SITE PHOTOGRAPHS:

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Noise Measurements

SITE / LOCATION: **Site 16** DATE: **6/17/22**

AM Peak Measurement		Period	Measured	Calculated	Difference
Time Begin:	8:40 AM	15 minutes	Leq	Leq	Leq
			60	57	-3
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
NB US-127	1636	56	88	4	0
SB US-127	2048	44	88	24	4

Off-Peak Measurement		Period		Calculated	Difference
Time Begin:	11:10 AM	15 minutes	Leq	Leq	Leq
			60	57	-3
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
NB US-127	1452	32	120	4	0
SB US-127	1588	12	80	4	8

PM Peak Measurement		Period	Measured	Calculated	Difference
Time Begin:	4:35 PM	15 minutes	Leq	Leq	Leq
			61	58	-3
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
NB US-127	3240	12	48	4	12
SB US-127	2128	24	84	4	4

LOCATION AERIAL:

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Noise Measurements

SITE / LOCATION: **Site 17** DATE: **6/17/22**

AM Peak Measurement		Period	Measured	Calculated	Difference
Time Begin:	8:30 AM	15 minutes	Leq	Leq	Leq
			62	60	-2

Traffic Counts (Veh/Hr):

	Auto	Med. Truck	Hvy Truck	Bus	Moto.
NB US-127	864	28	104	0	0
SB US-127	2428	16	180	8	0

Off-Peak Measurement		Period		Calculated	Difference
Time Begin:	11:50 AM	20 minutes	Leq	Leq	Leq
			60	59	-1

Traffic Counts (Veh/Hr):

	Auto	Med. Truck	Hvy Truck	Bus	Moto.
NB US-127	966	24	108	0	3
SB US-127	1182	15	150	3	0

PM Peak Measurement		Period	Measured	Calculated	Difference
Time Begin:	4:00 PM	15 minutes	Leq	Leq	Leq
			62	60	-2

Traffic Counts (Veh/Hr):

	Auto	Med. Truck	Hvy Truck	Bus	Moto.
NB US-127	1948	12	84	0	0
SB US-127	2340	24	176	4	4

LOCATION AERIAL:

Comments:

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Noise Measurements

SITE / LOCATION: **Site 18** DATE: **6/17/22**

AM Peak Measurement		Period	Measured	Calculated	Difference
Time Begin:	8:50 AM	15 minutes	Leq	Leq	Leq
			71	68	-3
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
NB US-127	800	24	76	0	0
SB US-127	1592	16	160	8	0
SB Ramp	304	20	32	0	0

Off-Peak Measurement		Period		Calculated	Difference
Time Begin:	11:20 AM	15 minutes	Leq	Leq	Leq
			68	68	0
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
NB US-127	884	32	68	0	0
SB US-127	1308	28	156	0	8
SB Ramp	488	28	16	0	4

PM Peak Measurement		Period	Measured	Calculated	Difference
Time Begin:	4:20 PM	15 minutes	Leq	Leq	Leq
			71	68	-3
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
NB US-127	1704	4	44	0	4
SB US-127	1828	40	156	0	0
SB Ramp	460	44	4	0	0

LOCATION AERIAL:

Comments:

SITE PHOTOGRAPHS:

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Noise Measurements

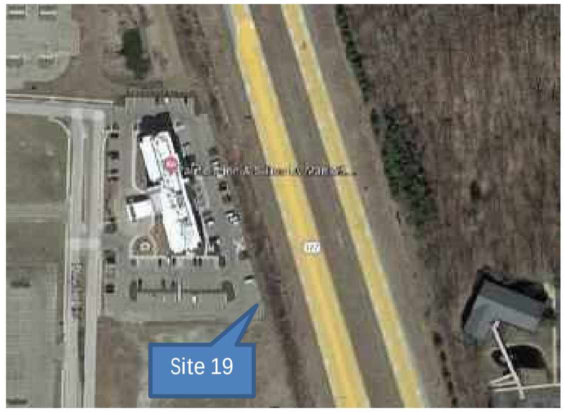
SITE / LOCATION: **Site 19** DATE: **6/17/22**

AM Peak Measurement		Period	Measured	Calculated	Difference
Time Begin:	7:20 AM	15 minutes	Leq	Leq	Leq
			77	74	-3
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
NB US-127	796	20	60	0	0
SB US-127	1924	8	88	0	0

Off-Peak Measurement		Period		Calculated	Difference
Time Begin:	10:55 AM	15 minutes	Leq	Leq	Leq
			75	73	-2
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
NB US-127	964	24	80	0	4
SB US-127	936	8	140	4	4

PM Peak Measurement		Period	Measured	Calculated	Difference
Time Begin:	3:35 PM	15 minutes	Leq	Leq	Leq
			76	74	-2
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
NB US-127	2152	12	68	0	4
SB US-127	1468	24	152	8	4

LOCATION AERIAL:



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Noise Measurements

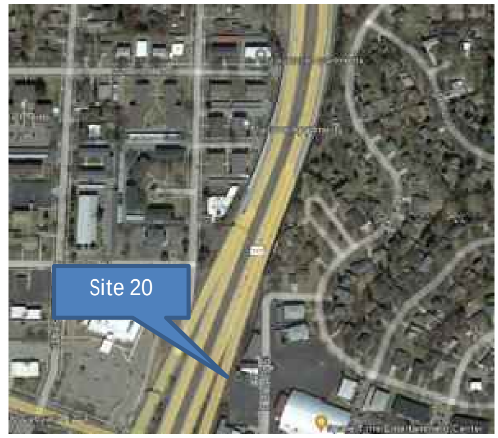
SITE / LOCATION: **Site 20**   DATE: **6/17/22**

AM Peak Measurement		Period	Measured	Calculated	Difference
Time Begin:	9:30 AM	15 minutes	Leq	Leq	Leq
			76	75	-1
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
NB US-127	1300	60	112	4	0
SB US-127	1704	48	156	0	12

Off-Peak Measurement		Period		Calculated	Difference
Time Begin:	1:05 PM	15 minutes	Leq	Leq	Leq
			76	75	-1
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
NB US-127	1804	40	60	0	0
SB US-127	1516	24	116	8	0

PM Peak Measurement		Period	Measured	Calculated	Difference
Time Begin:	3:55 PM	15 minutes	Leq	Leq	Leq
			77	76	-1
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
NB US-127	2496	40	76	0	0
SB US-127	2480	16	192	12	4

LOCATION AERIAL:



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SITE / LOCATION: **Site 21** DATE: **6/17/22**

AM Peak Measurement		Period	Measured	Calculated	Difference
Time Begin:	9:10 AM	15 minutes	Leq	Leq	Leq
			62	60	-2
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
NB US-127	1064	128	68	4	0
SB US-127	1600	36	176	20	0

Off-Peak Measurement		Period		Calculated	Difference
Time Begin:	1:30 PM	15 minutes	Leq	Leq	Leq
			62	60	-2
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
NB US-127	1120	4	60	0	0
SB US-127	1760	24	168	0	0

PM Peak Measurement		Period	Measured	Calculated	Difference
Time Begin:	4:15 PM	15 minutes	Leq	Leq	Leq
			63	61	-2
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
NB US-127	2728	20	32	0	0
SB US-127	2548	12	152	16	0

LOCATION AERIAL:

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Noise Measurements

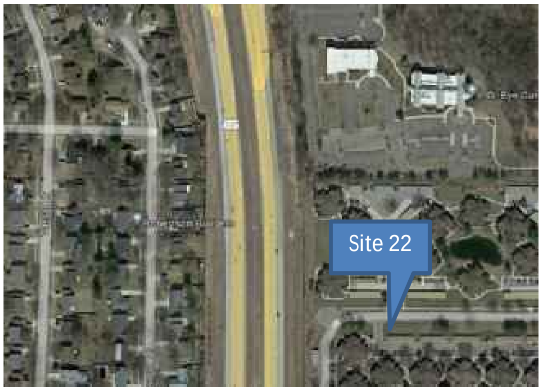
SITE / LOCATION: **Site 22** DATE: **6/17/22**

AM Peak Measurement		Period	Measured	Calculated	Difference
Time Begin:	8:10 AM	15 minutes	Leq	Leq	Leq
			60	58	-2
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
NB US-127	1548	64	88	4	0
SB US-127	2248	44	64	4	0

Off-Peak Measurement		Period		Calculated	Difference
Time Begin: 10:540:00 AM		15 minutes	Leq	Leq	Leq
			59	58	-1
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
NB US-127	1312	68	88	4	4
SB US-127	1640	8	80	0	8

PM Peak Measurement		Period	Measured	Calculated	Difference
Time Begin:	4:05 PM	15 minutes	Leq	Leq	Leq
			62	60	-2
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
NB US-127	3164	44	60	8	4
SB US-127	2248	16	68	12	8

LOCATION AERIAL:



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Noise Measurements

SITE / LOCATION: **Site 23** DATE: **6/17/22**

AM Peak Measurement		Period	Measured	Calculated	Difference
Time Begin:	7:40 AM	15 minutes	Leq	Leq	Leq
			73	73	0
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
NB US-127	1836	44	88	4	0
SB US-127	3492	28	196	0	0

Off-Peak Measurement		Period		Calculated	Difference
Time Begin:	2:30 PM	15 minutes	Leq	Leq	Leq
			72	72	0
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
NB US-127	2092	8	68	0	4
SB US-127	1932	28	132	20	0

PM Peak Measurement		Period	Measured	Calculated	Difference
Time Begin:	4:35 PM	15 minutes	Leq	Leq	Leq
			74	74	0
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
NB US-127	3748	8	24	4	0
SB US-127	2364	20	116	0	0

LOCATION AERIAL:

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Noise Measurements

SITE / LOCATION: **Site 24** DATE: **6/17/22**

AM Peak Measurement		Period	Measured	Calculated	Difference
Time Begin:	7:45 AM	15 minutes	Leq	Leq	Leq
			72	73	1
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
NB US-127	796	36	100	8	0
SB US-127	2920	12	148	0	0

Off-Peak Measurement		Period		Calculated	Difference
Time Begin:	1:55 PM	15 minutes	Leq	Leq	Leq
			69	70	1
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
NB US-127	1236	12	80	0	0
SB US-127	1104	24	136	8	0

PM Peak Measurement		Period	Measured	Calculated	Difference
Time Begin:	3:50 PM	15 minutes	Leq	Leq	Leq
			71	71	0
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
NB US-127	1988	12	64	12	0
SB US-127	1504	16	128	4	0

LOCATION AERIAL:

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Noise Measurements

SITE / LOCATION: **Site 25** DATE: **6/17/22**

AM Peak Measurement		Period	Measured	Calculated	Difference
Time Begin:	8:10 AM	15 minutes	Leq	Leq	Leq
			79	76	-3
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
NB US-127	832	20	96	0	0
SB US-127	2076	32	136	0	0

Off-Peak Measurement		Period		Calculated	Difference
Time Begin:	2:20 PM	15 minutes	Leq	Leq	Leq
			78	76	-2
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
NB US-127	1228	16	60	0	8
SB US-127	1328	24	152	0	4

PM Peak Measurement		Period	Measured	Calculated	Difference
Time Begin:	4:10 PM	15 minutes	Leq	Leq	Leq
			78	76	-2
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
NB US-127	2100	8	56	4	0
SB US-127	1360	24	140	0	0

LOCATION AERIAL:

Comments:

SITE PHOTOGRAPHS:

Looking E

Looking N

Looking S

Noise Measurements

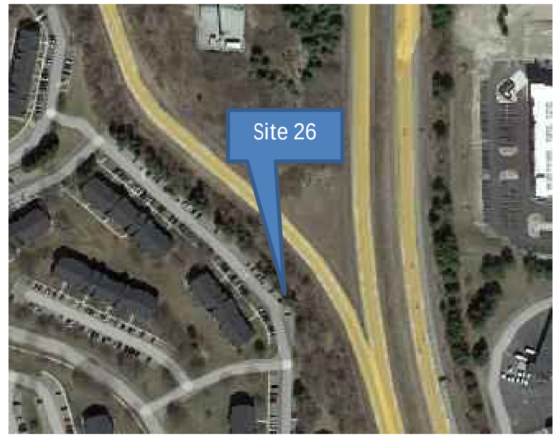
SITE / LOCATION: **Site 26** DATE: **6/17/22**

AM Peak Measurement		Period	Measured	Calculated	Difference
Time Begin:	8:50 AM	15 minutes	Leq	Leq	Leq
			70	69	-1
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
NB US-127	2228	44	88	8	0
SB US-127	1576	32	116	20	0

Off-Peak Measurement		Period		Calculated	Difference
Time Begin:	10:50 AM	15 minutes	Leq	Leq	Leq
			69	69	0
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
NB US-127	1516	28	112	16	0
SB US-127	1348	28	76	16	0

PM Peak Measurement		Period	Measured	Calculated	Difference
Time Begin:	5:50 PM	15 minutes	Leq	Leq	Leq
			72	69	-3
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
NB US-127	2072	16	32	4	8
SB US-127	2076	8	52	0	0

LOCATION AERIAL:



Comments:

SITE PHOTOGRAPHS:

Looking N

Looking S

Looking W

Noise Measurements

SITE / LOCATION: **Site 27** DATE: **6/17/22**

AM Peak Measurement		Period	Measured	Calculated	Difference
Time Begin:	7:50 AM	15 minutes	Leq	Leq	Leq
			63	63	0
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
NB US-127	3280	20	72	0	0
SB US-127	2880	24	100	20	0

Off-Peak Measurement		Period		Calculated	Difference
Time Begin:	9:50 AM	15 minutes	Leq	Leq	Leq
			64	62	-2
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
NB US-127	2232	56	128	16	0
SB US-127	1500	16	120	4	0

PM Peak Measurement		Period	Measured	Calculated	Difference
Time Begin:	3:50 PM	15 minutes	Leq	Leq	Leq
			62	62	0
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
NB US-127	2144	24	44	20	4
SB US-127	2892	16	64	12	0

LOCATION AERIAL:

Comments:

SITE PHOTOGRAPHS:

Looking E

Looking S

Looking W

Looking N

Noise Measurements

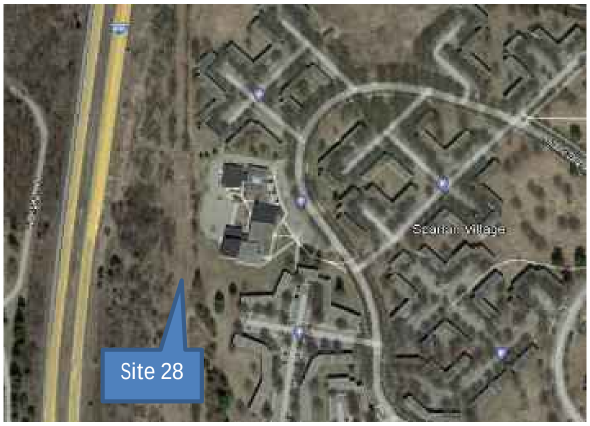
SITE / LOCATION: **Site 28** DATE: **6/17/22**

AM Peak Measurement		Period	Measured	Calculated	Difference
Time Begin:	9:20 AM	15 minutes	Leq	Leq	Leq
			62	62	0
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
NB US-127	1540	112	108	12	4
SB US-127	1260	28	116	8	0

Off-Peak Measurement		Period		Calculated	Difference
Time Begin:	3:15 PM	15 minutes	Leq	Leq	Leq
			60	62	2
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
NB US-127	1856	24	64	12	8
SB US-127	2208	20	64	16	0

PM Peak Measurement		Period	Measured	Calculated	Difference
Time Begin:	4:15 PM	15 minutes	Leq	Leq	Leq
			61	62	1
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
NB US-127	2208	28	68	4	4
SB US-127	2604	28	64	32	0

LOCATION AERIAL:



Comments:

SITE PHOTOGRAPHS:

Looking N

Looking W

Noise Measurements

SITE / LOCATION: **Site 29**

DATE: **6/17/22**

AM Peak Measurement		Period	Measured	Calculated	Difference
Time Begin:	9:15 AM	15 minutes	Leq	Leq	Leq
			73	71	-2
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
NB US-127	840	72	100	0	0
SB US-127	1264	24	120	0	0

Off-Peak Measurement		Period		Calculated	Difference
Time Begin:	10:30 PM	15 minutes	Leq	Leq	Leq
			73	71	-2
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
NB US-127	1008	36	76	0	0
SB US-127	1280	44	144	0	0

PM Peak Measurement		Period	Measured	Calculated	Difference
Time Begin:	5:25 PM	15 minutes	Leq	Leq	Leq
			75	73	-2
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
NB US-127	2344	4	44	4	0
SB US-127	1848	24	96	0	0

LOCATION AERIAL:

Comments:

SITE PHOTOGRAPHS:

Noise Measurements

SITE / LOCATION: **Site30** DATE: **6/17/22**

AM Peak Measurement		Period	Measured	Calculated	Difference
Time Begin:	8:55 AM	15 minutes	Leq	Leq	Leq
			58	57	-1
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
NB US-127	1148	40	136	4	0
NB Ramp	80	0	0	0	0

Off-Peak Measurement		Period		Calculated	Difference
Time Begin:	10:05 AM	15 minutes	Leq	Leq	Leq
			56	56	0
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
NB US-127	1020	28	84	12	0
NB Ramp	96	4	4	0	0

PM Peak Measurement		Period	Measured	Calculated	Difference
Time Begin:	5:00 PM	15 minutes	Leq	Leq	Leq
			58	55	-3
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
NB US-127	1480	12	32	0	0
NB Ramp	336	0	4	0	0

LOCATION AERIAL:

Comments:

SITE PHOTOGRAPHS:

Looking N

Looking S

Looking W

Noise Measurements

SITE / LOCATION: **Site 31** DATE: **6/17/22**

AM Peak Measurement		Period	Measured	Calculated	Difference
Time Begin:	9:15 AM	15 minutes	Leq	Leq	Leq
			63	61	-2
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
NB US-127	944	20	108	12	0
NB Ramp	452	16	100	0	0

Off-Peak Measurement		Period		Calculated	Difference
Time Begin:	9:35 AM	15 minutes	Leq	Leq	Leq
			63	60	-3
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
NB US-127	1000	16	68	12	0
NB Ramp	472	16	60	0	0

PM Peak Measurement		Period	Measured	Calculated	Difference
Time Begin:	5:10 PM	15 minutes	Leq	Leq	Leq
			64	61	-3
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
NB US-127	1516	12	56	4	12
NB Ramp	948	20	24	4	4

LOCATION AERIAL:

Comments:

SITE PHOTOGRAPHS:

Looking E

Looking N

Looking S

Looking W

Noise Measurements

SITE / LOCATION: **Site 32** DATE: **6/17/22**

AM Peak Measurement		Period	Measured	Calculated	Difference
Time Begin:	8:50 AM	15 minutes	Leq	Leq	Leq
			63	60	-3
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
EB I-69	916	44	168	0	0
WB I-69	732	4	100	0	0

Off-Peak Measurement		Period		Calculated	Difference
Time Begin:	9:55 AM	15 minutes	Leq	Leq	Leq
			57	60	3
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
EB I-69	928	12	112	0	0
WB I-69	880	24	192	4	4

PM Peak Measurement		Period	Measured	Calculated	Difference
Time Begin:	5:05 PM	15 minutes	Leq	Leq	Leq
			63	60	-3
Traffic Counts (Veh/Hr):					
	Auto	Med. Truck	Hvy Truck	Bus	Moto.
EB I-69	1696	12	116	0	0
WB I-69	1272	28	100	4	0

LOCATION AERIAL:

Comments:

SITE PHOTOGRAPHS:

Appendix B
Traffic Data

MEMO

TO: Alex Craigmile (MDOT)

FROM: Trevor Kirsch (WSP)

SUBJECT: US-127/I-496: Base Conditions Memo

DATE: November 24, 2021

PURPOSE

The intent of this memorandum is to summarize the performance of the base condition microsimulation models. The base condition models consist of the AM peak period (6:00 AM-9:00 AM) and the PM peak period (4:00 PM-7:00 PM) with traffic count data from a variety of years as described in the previously prepared ***US-127/I-496: Data Verification and Screening Memo*** dated October 22, 2021 by WSP. The models were prepared in VISSIM and were calibrated and validated per the ***US-127/I-496: Calibration and Validation Memo*** dated November 19, 2021. Figure 1 illustrates the modeled study area.

TRAFFIC VOLUMES

A balanced set of traffic volumes in 15-minute intervals were established for the study area for both the AM peak period and the PM peak period. VISSIM requires that all traffic be balanced within the model, as the software does not allow vehicles to enter or exit the network at internal junctions. In other words, all vehicles which are generated in the model must enter and exit the network appropriately. To develop the balanced volume set, the mainline counts on the freeway segments south of the Saginaw/Grand River Ave interchange (for US-127) and west of the Old US-27 interchange (for I-69) were considered as ground truth, as well as all the entry and exit ramp counts. Using this information, the subsequent mainline segment volumes were adjusted accordingly to balance with the entry and exit ramp counts. All surface street counts were also balanced with the entry and exit ramp counts. The volume exhibits in Figure 2 and Figure 3 reflect the established balanced volume set for the AM peak hour (7:15 AM-8:15 AM) and the PM peak hour (4:30 PM-5:30 PM) for the US-127/Dunckel Rd interchange and the US-127/I-496 interchange, respectively. Volume exhibits for all other locations within the study area are included in the Appendix. Balanced traffic volume sets for the full modeled network as well as the other time periods are provided in an Excel workbook as an addendum to this memo.

MEASURES OF EFFECTIVENESS

The base condition models were simulated 10 times for the AM period and 16 times for the PM period using different random number seeds, and the measures of effectiveness (MOEs) from these simulations were averaged together. Multiple simulations were utilized to capture all reasonable variability in MOE results when reporting the average of these runs.

Figure 1. Modeled Study Area

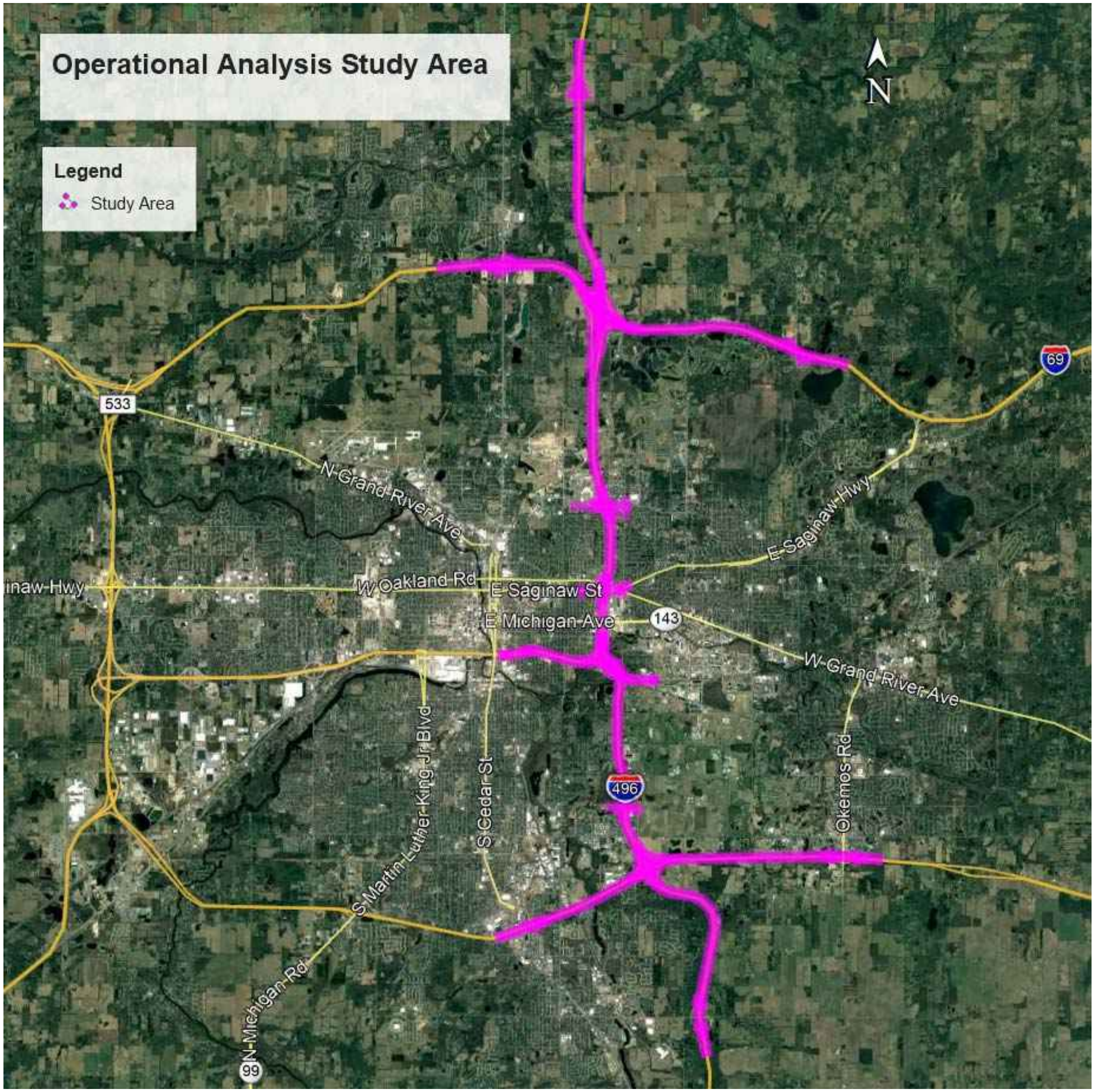


Figure 2. US-127 and Dunckel Rd Volume Exhibit

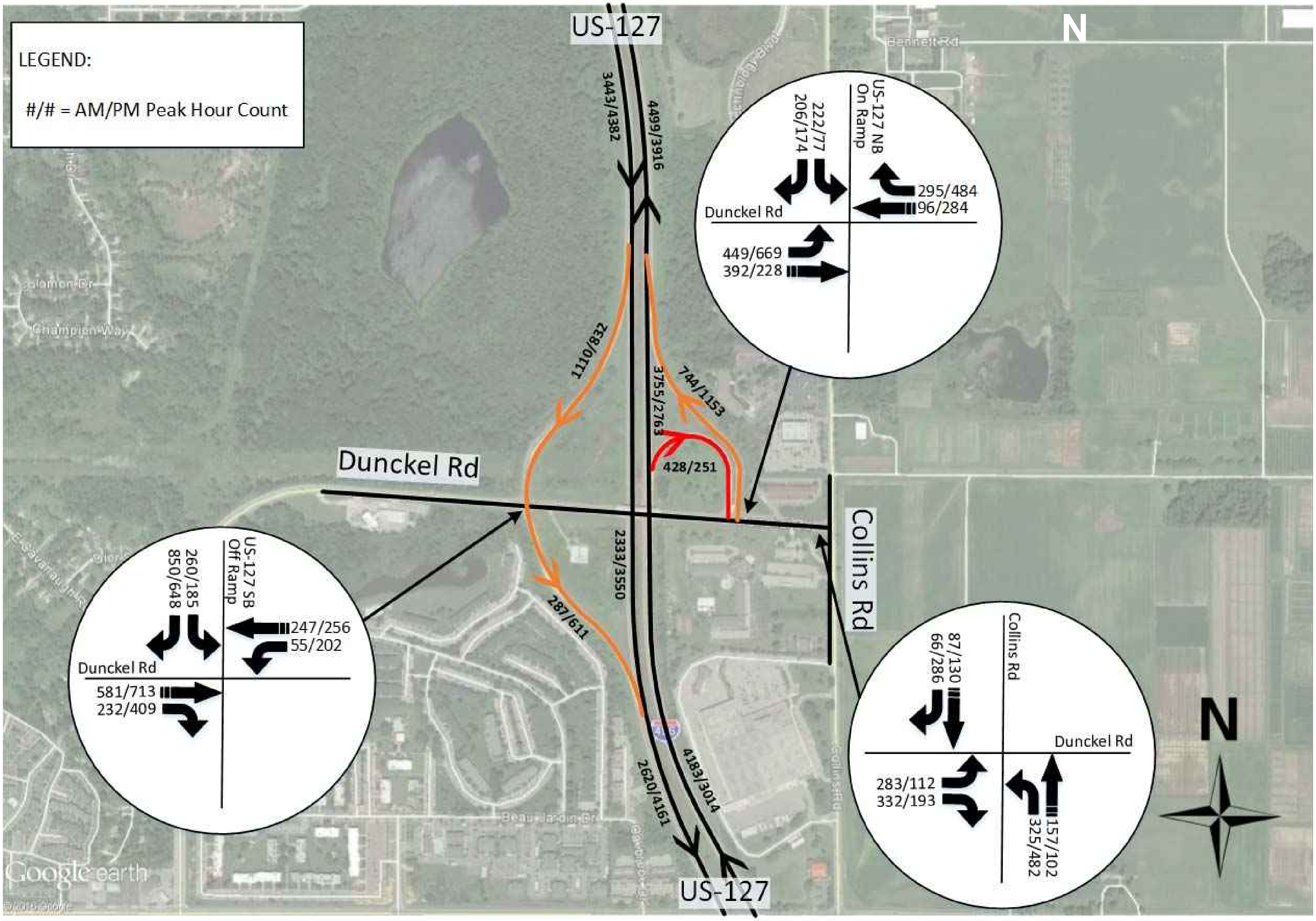
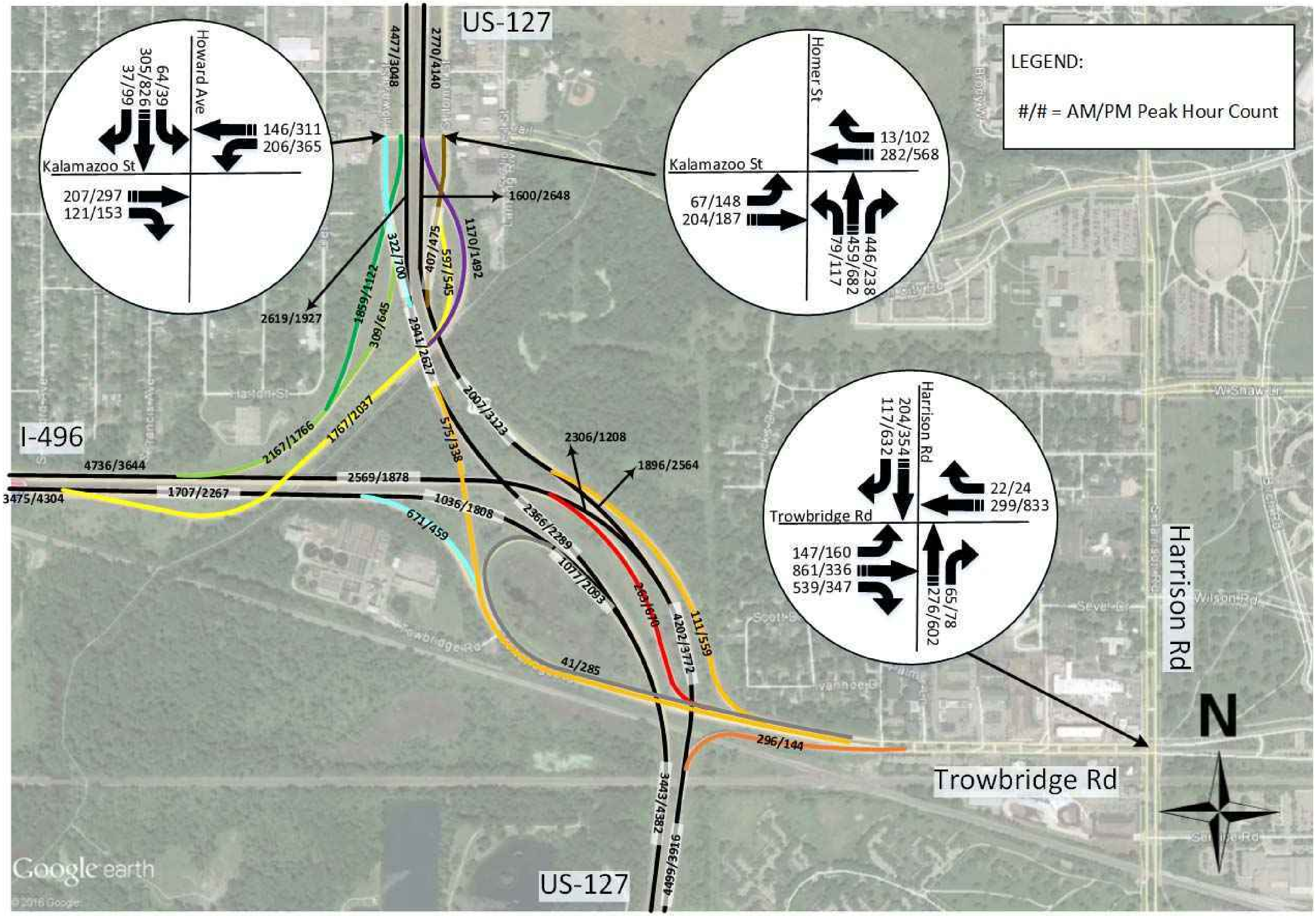


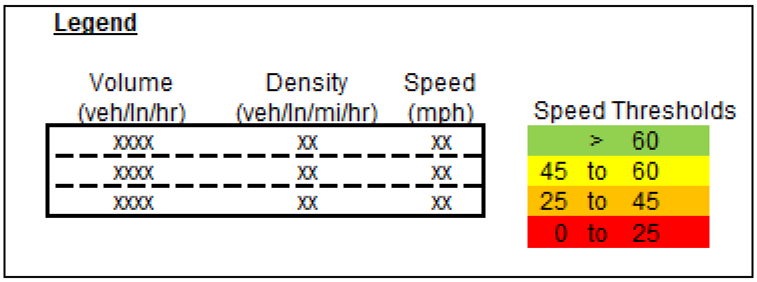
Figure 3. US-127 and I-496 Volume Exhibit



FREEWAY MOES

The freeway segments within the study area were analyzed to determine the existing operational performance of the interstate network. For the purposes of this analysis, the volume, density, and speed were reported for each basic freeway segment, ramp merge area, weave area, and ramp diverge area. This information is displayed through lane schematics. The lane schematics depict these MOEs per lane. Figure 3 contains a legend that depicts the layout of the MOEs for each lane segment, the units for each MOE, and how the segments are color coded:

Figure 3. Lane Schematic Legend



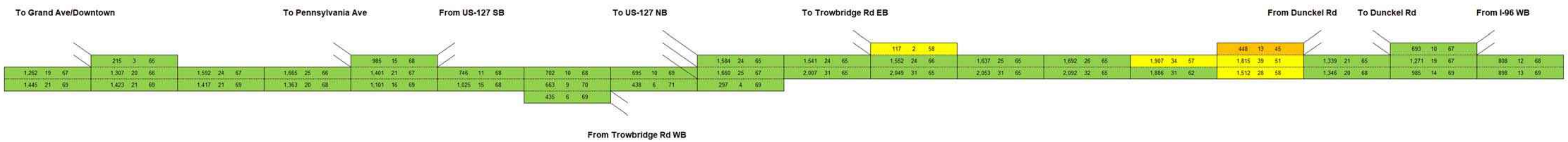
Note that the results displayed within the following schematics are averaged over all simulation runs and include MOEs during the AM peak hour and the PM peak hour.

Figure 4 and Figure 6 contain the lane schematics for I-496, while the lane schematics for the remainder of the study area are contained in the Appendix.

Figure 4. I-496/US-127 NB Lane Schematics

AM Peak

PM Peak



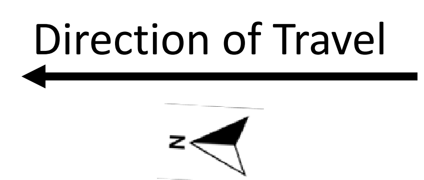


Figure 5. I-496/US-127 SB Lane Schematics

AM Peak

PM Peak

Direction of Travel

SURFACE STREET MOES

The intersections within the study area were also analyzed to determine the existing operational performance of the surface street network. The MOEs used to measure the performance of the intersections in this analysis were level of service (LOS) and queue length.

For intersections, the LOS can be computed for an individual movement, an entire approach, or a whole intersection. The thresholds are also different based on the type of signal control present. The LOS criteria utilized in this analysis are from the *Highway Capacity Manual (6th Edition)* and are displayed in Table 1. Table 1 contains the LOS thresholds for signalized intersections.

The other surface street MOE considered in this analysis is queue length. For the intersections within the study area, two queue related MOEs were collected: (1) average queue length and (2) maximum queue length.

The surface street MOEs are summarized in Table 2 and Table 3. Table 2 displays the LOS results, while Table 3 contains the queue length information. Note that the results in both tables are averaged over all simulation runs during the AM peak period and PM peak period.

Table 1. LOS Thresholds for Signalized Intersections

LOS	Description	Average Control Delay per Vehicle (s)
A	Operations with very low control delay occurring with favorable progression and/or short cycle lengths.	≤ 10.0
B	Operations with low control delay occurring with good progression and/or short cycle lengths.	> 10.0 and ≤ 20.0
C	Operations with average control delay occurring with fair progression and/or long cycle lengths. Individual cycle failures begin to appear.	> 20.0 and ≤ 35.0
D	Operations with longer control delay occurring with unfavorable progression, longer cycle lengths, and/or high volume-to-capacity ratios. Individual cycle failures are noticeable.	> 35.0 and ≤ 55.0
E	Operations with high control delay occurring with poor progression, longer cycle lengths, and/or high volume-to-capacity ratios. Individual cycle failures are frequent. This is considered the limit of acceptable delay.	> 55.0 and ≤ 80.0
F	Operations with unacceptable control delay occurring with poor progression, longer cycle lengths, and/or oversaturation.	> 80.0

Table 2. LOS Results

Peak	Intersection	Control	Northbound								Southbound								Eastbound								Westbound								Total	
			LT		TH		RT		Approach		LT		TH		RT		Approach		LT		TH		RT		Approach		LT		TH		RT		Approach			
			Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS
	Howard Ave and Kalamazoo St	Signal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	12.6	B	12.7	B	7.3	A	12.1	B	N/A	N/A	21.3	C	7.4	A	16.2	B	10.3	B	15.5	B	N/A	N/A	12.5	B	13.5	B
	Homer St and Kalamazoo St	Signal	25.1	C	18.4	B	15.0	B	17.3	B	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3.8	A	4.4	A	N/A	N/A	4.3	A	N/A	N/A	21.3	C	10.2	B	20.7	C	15.7	B
	Trowbridge Rd and Harrison Rd	Signal	N/A	N/A	13.8	B	5.6	A	12.3	B	N/A	N/A	12.2	B	3.1	A	8.9	A	34.7	C	25.9	C	31.0	C	28.5	C	N/A	N/A	22.9	C	17.1	B	22.5	C	22.9	C
	US-127 SB and Dunckel Rd	Signal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.9	B	N/A	N/A	20.8	C	20.6	C	N/A	N/A	24.5	C	20.5	C	23.3	C	26.7	C	29.7	C	N/A	N/A	29.0	C	22.7	C
	US-127 NB and Dunckel Rd	Signal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	27.3	C	N/A	N/A	20.6	C	24.3	C	13.0	B	11.2	B	N/A	N/A	12.2	B	N/A	N/A	16.7	B	6.4	A	8.9	A	14.4	B
	Dunckel Rd and Collins Rd	Signal	9.2	A	5.6	A	N/A	N/A	8.0	A	N/A	N/A	5.0	A	1.6	A	3.5	A	30.5	C	N/A	N/A	12.2	B	20.6	C	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	13.6	B
	Howard Ave and Michigan Ave	Signal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	15.5	B	15.4	B	11.1	B	13.7	B	N/A	N/A	14.7	B	4.1	A	9.3	A	N/A	N/A	6.9	A	N/A	N/A	6.9	A	9.8	A
	Homer St and Michigan Ave	Signal	9.3	A	9.1	A	5.7	A	8.1	A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	21.4	C	11.1	B	N/A	N/A	13.0	B	N/A	N/A	15.3	B	4.5	A	14.9	B	11.7	B
	Saginaw St and Foster Ave	Signal	N/A	N/A	18.0	B	6.7	A	12.8	B	8.2	A	19.0	B	N/A	N/A	10.2	B	9.1	A	9.4	A	7.7	A	9.4	A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	9.5	A
	Saginaw St and Howard Ave	Signal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	9.1	A	34.1	C	N/A	N/A	29.4	C	N/A	N/A	21.3	C	17.1	B	20.2	C	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	25.0	C
AM	Saginaw St and Homer St	Signal	N/A	N/A	35.0	D	28.3	C	30.2	C	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	2.4	A	5.4	A	N/A	N/A	5.1	A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	16.7	B
	Saginaw St and Clippert St	Signal	N/A	N/A	55.8	E	11.3	B	22.6	C	14.7	B	57.6	E	N/A	N/A	37.4	D	4.3	A	1.9	A	2.2	A	1.9	A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	4.3	A
	Saginaw St and Grand River Ave	Signal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	11.3	B	N/A	N/A	11.3	B	N/A	N/A	15.7	B	N/A	N/A	15.7	B	12.5	B
	Grand River Ave and Coolidge Rd	Signal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	45.4	D	N/A	N/A	5.8	A	39.2	D	19.8	B	5.7	A	N/A	N/A	10.1	B	N/A	N/A	16.5	B	15.2	B	16.3	B	14.9	B
	Saginaw St and Coolidge Rd	Signal	19.8	B	18.7	B	11.7	B	18.5	B	52.9	D	36.3	D	12.2	B	26.0	C	N/A	N/A	1.1	A	1.5	A	1.1	A	N/A	N/A	14.5	B	13.3	B	14.5	B	11.6	B
	Grand River Ave and Homer St	Signal	22.5	C	28.1	C	N/A	N/A	24.7	C	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	8.9	A	4.3	A	8.7	A	11.3	B
	Grand River Ave and Howard Ave	Signal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	57.7	E	49.6	D	55.4	E	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	11.3	B	6.8	A	N/A	N/A	8.5	A	21.6	C
	Lake Lansing Rd and Preyde Blvd	Signal	49.8	D	N/A	N/A	10.2	B	21.6	C	37.5	D	N/A	N/A	23.1	C	32.9	C	23.5	C	7.4	A	7.6	A	8.3	A	13.1	B	4.0	A	4.6	A	4.4	A	8.2	A
	US-127 SB and Lake Lansing Rd	Signal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	34.4	C	N/A	N/A	16.5	B	24.8	C	N/A	N/A	3.1	A	N/A	N/A	3.1	A	N/A	N/A	8.8	A	N/A	N/A	8.8	A	11.1	B
	US-127 NB and Lake Lansing Rd	Signal	31.8	C	N/A	N/A	22.1	C	27.1	C	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	28.4	C	N/A	N/A	28.4	C	N/A	N/A	5.9	A	N/A	N/A	5.9	A	19.7	B
	Lake Lansing Rd and Coolidge Rd	Signal	18.7	B	35.9	D	23.1	C	24.5	C	17.7	B	33.7	C	22.3	C	23.8	C	43.0	D	39.3	D	33.6	C	39.3	D	41.6	D	32.9	C	14.6	B	29.6	C	32.1	C
	Howard Ave and Kalamazoo St	Signal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	12.7	B	15.5	B	12.9	B	15.1	B	N/A	N/A	23.6	C	13.1	B	20.0	B	16.6	B	11.5	B	N/A	N/A	14.2	B	15.9	B
	Homer St and Kalamazoo St	Signal	26.1	C	19.0	B	8.6	A	17.3	B	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	9.1	A	3.5	A	N/A	N/A	6.0	A	N/A	N/A	34.2	C	26.9	C	33.1	C	20.7	C
	Trowbridge Rd and Harrison Rd	Signal	N/A	N/A	15.7	B	7.5	A	14.7	B	N/A	N/A	14.2	B	13.5	B	13.8	B	46.4	D	20.3	C	18.7	B	24.5	C	N/A	N/A	42.4	D	37.2	D	42.2	D	24.0	C
	US-127 SB and Dunckel Rd	Signal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	26.9	C	N/A	N/A	9.2	A	13.1	B	N/A	N/A	49.1	D	50.3	D	49.5	D	19.2	B	22.0	C	N/A	N/A	20.7	C	31.6	C
	US-127 NB and Dunckel Rd	Signal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	42.1	D	N/A	N/A	26.1	C	31.0	C	9.2	A	3.1	A	N/A	N/A	7.7	A	N/A	N/A	19.2	B	12.6	B	15.0	B	13.7	B
	Dunckel Rd and Collins Rd	Signal	58.7	E	46.8	D	N/A	N/A	56.7	E	N/A	N/A	4.5	A	2.0	A	2.8	A	17.9	B	N/A	N/A	7.2	A	11.2	B	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	28.3	C
	Howard Ave and Michigan Ave	Signal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	14.5	B	15.0	B	11.4	B	14.1	B	N/A	N/A	16.5	B	7.5	A	12.8	B	N/A	N/A	6.5	A	N/A	N/A	6.5	A	11.3	B
	Homer St and Michigan Ave	Signal	10.3	B	10.0	A	8.4	A	9.7	A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	45.3	D	6.4	A	N/A	N/A	16.6	B	N/A	N/A	15.9	B	7.1	A	14.5	B	13.4	B
	Saginaw St and Foster Ave	Signal	N/A	N/A	38.6	D	21.4	C	33.8	C	19.9	B	38.5	D	N/A	N/A	26.9	C	10.3	B	9.5	A	9.0	A	9.5	A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	11.1	B
	Saginaw St and Howard Ave	Signal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	21.8	C	36.2	D	N/A	N/A	32.9	C	N/A	N/A	18.3	B	13.1	B	17.5	B	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	22.8	C
PM	Saginaw St and Homer St	Signal	N/A	N/A	53.6	D	48.2	D	51.1	D	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	9.4	A	11.0	B	N/A	N/A	10.8	B	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	26.4	C
	Saginaw St and Clippert St	Signal	N/A	N/A	53.1	D	31.7	C	38.3	D	23.6	C	45.3	D	N/A	N/A	39.0	D	5.0	A	5.1	A	5.6	A	5.1	A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	11.3	B
	Saginaw St and Grand River Ave	Signal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	4.6	A	N/A	N/A	4.6	A	N/A	N/A	17.1	B	N/A	N/A	17.1	B	8.0	A
	Grand River Ave and Coolidge Rd	Signal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	2.2	A	N/A	N/A	1.2	A	2.0	A	42.8	D	11.5	B	N/A	N/A	20.4	C	N/A	N/A	33.5	C	32.2	C	33.3	C	23.7	C
	Saginaw St and Coolidge Rd	Signal	20.0	B	18.4	B	17.6	B	18.6	B	110.1	F	50.1	D	23.5	C	43.4	D	N/A	N/A	1.4	A	1.7	A	1.4	A	N/A	N/A	14.8	B	13.1	B	14.7	B	14.0	B
	Grand River Ave and Homer St	Signal	19.7	B	21.7	C	N/A	N/A	20.9	C	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.6	B	11.2	B	18.4	B	19.2	B
	Grand River Ave and Howard Ave	Signal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	42.9	D	21.2	C	39.3	D	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3.1	A	5.4	A	N/A	N/A	4.5	A	10.4	B
	Lake Lansing Rd and Preyde Blvd	Signal	53.4	D	N/A	N/A	15.8	B	23.2	C	43.6	D	N/A	N/A	42.9	D	43.3	D	45.8	D	28.3	C	26.0	C	30.4	C	46.6	D	15.5	B	17.5	B	17.1	B	27.9	C
	US-127 SB and Lake Lansing Rd	Signal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	40.9	D	N/A	N/A	30.1	C	36.3	D	N/A	N/A	7.0	A	N/A	N/A	7.0	A	N/A	N/A	74.7	E	N/A	N/A	74.7	E	40.1	D
	US-127 NB and Lake Lansing Rd	Signal	64.7	E	N/A	N/A	24.6	C	46.4	D	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	21.1	C	N/A	N/A	21.1	C	N/A	N/A	41.2	D	N/A	N/A	41.2	D	37.4	D
	Lake Lansing Rd and Coolidge Rd	Signal	52.9	D	29.5	C	22.6	C	34.8	C	45.9	D	60.4	E	110.8	F	72.0	E	44.2	D	29.1	C	28.7	C	30.4	C	74.8	E	81.3	F	39.5	D	74.7	E	53.1	D

Table 3. Queue Results

Peak	Intersection	Control	Northbound		Southbound		Eastbound		Westbound	
			Avg (ft)	Max (ft)	Avg (ft)	Max (ft)	Avg (ft)	Max (ft)	Avg (ft)	Max (ft)
AM	Howard Ave and Kalamazoo St	Signal	N/A	N/A	14	142	26	251	12	200
	Homer St and Kalamazoo St	Signal	40	376	N/A	N/A	4	100	21	219
	Trowbridge Rd and Harrison Rd	Signal	13	154	9	106	241	876	26	211
	US-127 SB and Dunckel Rd	Signal	N/A	N/A	328	2225	61	425	29	193
	US-127 NB and Dunckel Rd	Signal	N/A	N/A	70	444	36	383	9	184
	Dunckel Rd and Collins Rd	Signal	14	175	3	96	81	359	N/A	N/A
	Howard Ave and Michigan Ave	Signal	N/A	N/A	30	242	12	109	15	122
	Homer St and Michigan Ave	Signal	24	151	N/A	N/A	11	102	35	168
	Saginaw St and Foster Ave	Signal	4	77	6	105	30	191	N/A	N/A
	Saginaw St and Howard Ave	Signal	N/A	N/A	202	606	47	350	N/A	N/A
	Saginaw St and Homer St	Signal	100	393	N/A	N/A	30	191	N/A	N/A
	Saginaw St and Clippert St	Signal	9	118	19	122	8	155	N/A	N/A
	Saginaw St and Grand River Ave	Signal	N/A	N/A	N/A	N/A	48	349	27	227
	Grand River Ave and Coolidge Rd	Signal	N/A	N/A	34	208	30	293	28	239
	Saginaw St and Coolidge Rd	Signal	50	366	25	194	0	28	90	609
	Grand River Ave and Homer St	Signal	42	224	N/A	N/A	N/A	N/A	35	279
	Grand River Ave and Howard Ave	Signal	N/A	N/A	185	653	N/A	N/A	81	291
	Lake Lansing Rd and Preyde Blvd	Signal	6	78	44	193	41	363	24	307
	US-127 SB and Lake Lansing Rd	Signal	N/A	N/A	63	237	6	221	31	469
	US-127 NB and Lake Lansing Rd	Signal	126	1250	N/A	N/A	113	632	21	231
	Lake Lansing Rd and Coolidge Rd	Signal	47	225	48	231	269	947	102	604
PM	Howard Ave and Kalamazoo St	Signal	N/A	N/A	48	203	46	355	31	340
	Homer St and Kalamazoo St	Signal	38	192	N/A	N/A	5	135	130	694
	Trowbridge Rd and Harrison Rd	Signal	31	229	45	490	66	424	132	570
	US-127 SB and Dunckel Rd	Signal	N/A	N/A	32	412	291	798	34	258
	US-127 NB and Dunckel Rd	Signal	N/A	N/A	61	335	27	449	32	304
	Dunckel Rd and Collins Rd	Signal	162	609	6	112	25	187	N/A	N/A
	Howard Ave and Michigan Ave	Signal	N/A	N/A	41	240	39	232	18	110
	Homer St and Michigan Ave	Signal	40	189	N/A	N/A	48	265	49	225
	Saginaw St and Foster Ave	Signal	27	177	25	180	44	342	N/A	N/A
	Saginaw St and Howard Ave	Signal	N/A	N/A	184	620	84	537	N/A	N/A
	Saginaw St and Homer St	Signal	228	1050	N/A	N/A	92	401	N/A	N/A
	Saginaw St and Clippert St	Signal	90	348	58	302	34	290	N/A	N/A
	Saginaw St and Grand River Ave	Signal	N/A	N/A	N/A	N/A	24	423	51	420
	Grand River Ave and Coolidge Rd	Signal	N/A	N/A	1	31	100	446	84	429
	Saginaw St and Coolidge Rd	Signal	72	390	104	452	17	123	74	458
	Grand River Ave and Homer St	Signal	83	328	N/A	N/A	N/A	N/A	74	526
	Grand River Ave and Howard Ave	Signal	N/A	N/A	73	244	N/A	N/A	50	263
	Lake Lansing Rd and Preyde Blvd	Signal	8	91	168	645	188	897	156	343
	US-127 SB and Lake Lansing Rd	Signal	N/A	N/A	65	214	40	366	703	1442
	US-127 NB and Lake Lansing Rd	Signal	604	3520	N/A	N/A	70	418	318	974
	Lake Lansing Rd and Coolidge Rd	Signal	53	222	409	1702	195	816	300	729

SUMMARY

US-127/I-496 NB

As shown in Figure 5, the US-127/I-496 NB corridor within the study area experiences heavy congestion during the AM peak period and minimal congestion during the PM peak period.

During the AM peak period, the congestion starts where the Dunckel Rd on ramp merges with the heavy volume mainline traffic. This congestion regularly spills back into the I-96/US-127/I-496 system interchange. This can also impact operations along WB I-96 where the exit ramp to NB I-496/127 will back up between the system interchange and Okemos Road. The congestion starts to break free north of Dunckel Rd approaching the Trowbridge Rd interchange, but this segment still experiences reduced speeds. The minimal congestion during the PM peak period is also created by the Dunckel Rd on ramp. The effects of this congestion are localized to the Dunckel Rd on ramp, and the corridor begins to recover immediately after the merge point.

US-127/I-496 SB

As shown in Figure 6, the US-127/I-496 SB corridor within the study area experiences no congestion during the AM peak period and significant congestion during the PM peak period.

The significant congestion during the PM peak period is created by the heavy volume of SB 127 and EB I-496 traffic coming together and then having a left-hand lane drop immediately downstream from the confluence of these two roadways. This leads to a lot of traffic changing lanes in this short segment and trying to position for downstream movements. The effects of this congestion spills back from this location to approximately the Pennsylvania and Cedar Street interchanges along EB I-496 and also spills back along SB US-127 into the US-127/I-496 system interchange. The corridor does not begin to recover until after the US-127/I-496 SB left-hand lane drop north of Mt Hope Ave.

US-127/I-496 SB and Dunckel Rd

Based on the results in Table 2, most of the individual movements at the intersection of US-127 SB and Dunckel Rd have a LOS A, LOS B, or LOS C during the AM and PM peak periods. At the eastbound approach, the through and right-turn movements have a LOS D during the PM peak period. Additionally, most of the approaches have a LOS B or LOS C during these time periods. The eastbound approach has a LOS D during the PM peak period. Lastly, the overall intersection has a LOS C during both the AM and PM peak periods. The greatest average queue for all approaches at this intersection is 328 ft., as shown in Table 3. This queue occurs on the southbound approach during the AM peak period. This approach also has the greatest maximum queue of 2,225 ft., which also occurs during the AM peak period.

US-127/I-496 NB and Dunckel Rd

Based on the results in Table 2, most of the individual movements at the intersection of US-127 NB and Dunckel Rd have a LOS A, LOS B, or LOS C during the AM and PM peak periods. At the southbound approach, the left-turn movement has a LOS D during the PM peak period. Additionally, all the approaches have a LOS A, LOS B, or LOS C during these time periods. Lastly, the overall intersection has a LOS B during both the AM and PM peak periods. The greatest average queue for all approaches at this intersection is 70 ft., as shown in Table 3. This queue occurs on the southbound approach during the AM peak period. The greatest maximum queue for all approaches at this intersection is 449 ft., which occurs on the eastbound approach during the PM peak period.

Dunckel Rd and Collins Rd

Based on the results in Table 2, most of the individual movements at the intersection of Dunckel Rd and Collins Rd have a LOS A, LOS B, or LOS C during the AM and PM peak periods. At the northbound approach, the left-turn and through movements have a LOS E and LOS D during the PM peak period, respectively. Additionally, most of the approaches have a LOS A, LOS B, or LOS C during these time periods. The northbound approach has a LOS E during the PM peak period. Lastly, the overall intersection has a LOS B during the AM peak period and a LOS C during the PM peak period. The greatest average queue for all approaches at this intersection is 162 ft., as shown in Table 3. This queue occurs on the northbound approach during the PM peak period. This approach also has the greatest maximum queue of 609 ft., which also occurs during the PM peak period.

Trowbridge Rd and Harrison Rd

Based on the results in Table 2, some of the individual movements at the intersection of Trowbridge Rd and Harrison Rd have a LOS A, LOS B, or LOS C during the AM and PM peak periods. At the eastbound approach, the left-turn movement has a LOS D during the PM peak period. At the westbound approach, the through and right-turn movements also have a LOS D during the PM peak period. Additionally, most of the approaches have a LOS A, LOS B, or LOS C during these time periods. The westbound approach has a LOS D during the PM peak period. Lastly, the overall intersection has a LOS C during both the AM and PM peak periods. The greatest average queue for all approaches at this intersection is 241 ft., as shown in Table 3. This queue occurs on the eastbound approach during the AM peak period. This approach also has the greatest maximum queue of 876 ft., which also occurs during the AM peak period.

Howard Ave and Kalamazoo St

Based on the results in Table 2, all the individual movements at the intersection of Howard Ave and Kalamazoo St have a LOS A, LOS B, or LOS C during the AM and PM peak periods. Additionally, all the approaches have a LOS B during these time periods. Lastly, the overall intersection has a LOS B during both the AM and PM peak periods. The greatest average queue for all approaches at this intersection is 48 ft., as shown in Table 3. This queue occurs on the southbound approach during the PM peak period. The greatest maximum queue for all approaches at this intersection is 355 ft., which occurs on the eastbound approach during the PM peak period.

Homer St and Kalamazoo St

Based on the results in Table 2, all the individual movements at the intersection of Homer St and Kalamazoo St have a LOS A, LOS B, or LOS C during the AM and PM peak periods. Additionally, all the approaches have a LOS A, LOS B, or LOS C during these time periods. Lastly, the overall intersection has a LOS B during the AM peak period and a LOS C during the PM peak period. The greatest average queue for all approaches at this intersection is 130 ft., as shown in Table 3. This queue occurs on the westbound approach during the PM peak period. This approach also has the greatest maximum queue of 694 ft., which also occurs during the PM peak period.

Howard Ave and Michigan Ave

Based on the results in Table 2, all the individual movements at the intersection of Howard Ave and Michigan Ave have a LOS A or LOS B during the AM and PM peak periods. Additionally, all the approaches have a LOS A or LOS B during these time periods. Lastly, the overall intersection has a LOS A during the AM peak period and a LOS B during the PM peak period. The greatest average queue for all approaches at this intersection is 41 ft., as shown in Table 3. This queue occurs on the southbound approach during the PM peak period. This approach also has the greatest maximum queue of 242 ft.; however, this occurs during the AM peak period.

Homer St and Michigan Ave

Based on the results in Table 2, most of the individual movements at the intersection of Homer St and Michigan Ave have a LOS A, LOS B, or LOS C during the AM and PM peak periods. At the eastbound approach, the left-turn movement has a LOS D during the PM peak period. Additionally, all the approaches have a LOS A or LOS B during these time periods. Lastly, the overall intersection has a LOS B during both the AM and PM peak periods. The greatest average queue for all approaches at this intersection is 49 ft., as shown in Table 3. This queue occurs on the westbound approach during the PM peak period. The greatest maximum queue for all approaches at this intersection is 265 ft., which occurs on the eastbound approach during the PM peak period.

Saginaw St and Foster Ave

Based on the results in Table 2, most of the individual movements at the intersection of Saginaw St and Foster Ave have a LOS A, LOS B, or LOS C during the AM and PM peak periods. At the northbound and southbound approaches, the through movements have a LOS D during the PM peak period. Additionally, all the approaches have a LOS A, LOS B, or LOS C during these time periods. Lastly, the overall intersection has a LOS A during the AM peak period and a LOS B during the PM peak period. The greatest average queue for all approaches at this intersection is 44 ft., as shown in Table 3. This queue occurs on the eastbound approach during the PM peak period. This approach also has the greatest maximum queue of 342 ft., which also occurs during the PM peak period.

Saginaw St and Howard Ave

Based on the results in Table 2, most of the individual movements at the intersection of Saginaw St and Howard Ave have a LOS A, LOS B, or LOS C during the AM and PM peak periods. At the southbound approach, the through movement has a LOS D during the PM peak period. Additionally, all the approaches have a LOS B or LOS C during these time periods. Lastly, the overall intersection has a LOS C during both the AM and PM peak periods. The greatest average queue for all approaches at this intersection is 202 ft., as shown in Table 3. This queue occurs on the southbound approach during the AM peak period. This approach also has the greatest maximum queue of 620 ft.; however, this occurs during the PM peak period.

Saginaw St and Homer St

Based on the results in Table 2, some of the individual movements at the intersection of Saginaw St and Homer St have a LOS A, LOS B, or LOS C during the AM and PM peak periods. At the northbound approach, the through movement has a LOS D during the AM and PM peak periods. Also, the right-turn movement has a LOS D during the PM peak period. Additionally, most of the approaches have a LOS A, LOS B, or LOS C during these time periods. The northbound approach has a LOS D during the PM peak period. Lastly, the overall intersection has a LOS B during the AM peak period and a LOS C during the PM peak period. The greatest average queue for all approaches at this intersection is 228 ft., as shown in Table 3. This queue occurs on the northbound approach during the PM peak period. This approach also has the greatest maximum queue of 1,050 ft., which also occurs during the PM peak period.

Saginaw St and Clippert St

Based on the results in Table 2, some of the individual movements at the intersection of Saginaw St and Clippert St have a LOS A, LOS B, or LOS C during the AM and PM peak periods. At the northbound and southbound approaches, the through movements have a LOS E and LOS D during the AM and PM peak periods, respectively. Additionally, some of the approaches have a LOS A or LOS C during these time periods. The southbound approach has a LOS D during the AM and PM peak periods. The northbound approach has a LOS D during the PM peak period. Lastly, the overall intersection has a LOS A during the AM peak period and a LOS B during the PM peak period. The greatest average queue for all approaches at this intersection is 90 ft., as shown in Table 3. This queue occurs on the northbound approach during the PM peak period. This approach also has the greatest maximum queue of 348 ft., which also occurs during the PM peak period.

Saginaw St and Grand River Ave

Based on the results in Table 2, all the individual movements at the intersection of Saginaw St and Grand River Ave have a LOS A or LOS B during the AM and PM peak periods. Additionally, all the approaches have a LOS A or LOS B during these time periods. Lastly, the overall intersection has a LOS B during the AM peak period and a LOS A during the PM peak period. The greatest average queue for all approaches at this intersection is 51 ft., as shown in Table 3. This queue occurs on the westbound approach during the PM peak period. The greatest maximum queue for all approaches at this intersection is 423 ft., which occurs on the eastbound approach during the PM peak period.

Grand River Ave and Coolidge Rd

Based on the results in Table 2, most of the individual movements at the intersection of Grand River Ave and Coolidge Rd have a LOS A, LOS B, or LOS C during the AM and PM peak periods. At the southbound approach, the left-turn movement has a LOS D during the AM peak period. At the eastbound approach, the left-turn movement has a LOS D during the PM peak period. Additionally, most of the approaches have a LOS A, LOS B, or LOS C during these time periods. The southbound approach has a LOS D during the AM peak period. Lastly, the overall intersection has a LOS B during the AM peak period and a LOS C during the PM peak period. The greatest average queue for all approaches at this intersection is 100 ft., as shown in Table 3. This queue occurs on the eastbound approach during the PM peak period. This approach also has the greatest maximum queue of 446 ft., which also occurs during the PM peak period.

Saginaw St and Coolidge Rd

Based on the results in Table 2, some of the individual movements at the intersection of Saginaw St and Coolidge Rd have a LOS A, LOS B, or LOS C during the AM and PM peak periods. At the southbound approach, the left-turn movement has a LOS D and a LOS F during the AM and PM peak periods, respectively. Also, the through movement has a LOS D during the AM and PM peak periods. Additionally, most of the approaches have a LOS A, LOS B, or LOS C during these time periods. The southbound approach has a LOS D during the PM peak period. Lastly, the overall intersection has a LOS B during both the AM and PM peak periods. The greatest average queue for all approaches at this intersection is 104 ft., as shown in Table 3. This queue occurs on the southbound approach during the PM peak period. The greatest maximum queue for all approaches at this intersection is 609 ft., which occurs on the westbound approach during the AM peak period.

Grand River Ave and Homer St

Based on the results in Table 2, all the individual movements at the intersection of Grand River Ave and Homer St have a LOS A, LOS B, or LOS C during the AM and PM peak periods. Additionally, all the approaches have a LOS A, LOS B, or LOS C during these time periods. Lastly, the overall intersection has a LOS B during both the AM and PM peak periods. The greatest average queue for all approaches at this intersection is 83 ft., as shown in Table 3. This queue occurs on the northbound approach during the PM peak period. The greatest maximum queue for all approaches at this intersection is 526 ft., which occurs on the westbound approach during the PM peak period.

Grand River Ave and Howard Ave

Based on the results in Table 2, some of the individual movements at the intersection of Grand River Ave and Howard Ave have a LOS A, LOS B, or LOS C during the AM and PM peak periods. At the southbound approach, the through movement has a LOS E and a LOS D during the AM and PM peak periods, respectively. Also, the right-turn movement has a LOS D during the AM peak period. Additionally, some of the approaches have a LOS A during these time periods. The southbound approach has a LOS E and LOS D during the AM and PM peak periods, respectively. Lastly, the overall intersection has a LOS C during the AM peak period and a LOS B during the PM peak period. The greatest average queue for all approaches at this intersection is 185 ft., as shown in Table 3. This queue occurs on the southbound approach during the AM peak period. This approach also has the greatest maximum queue of 653 ft., which also occurs during the AM peak period.

Lake Lansing Rd and Preyde Blvd

Based on the results in Table 2, some of the individual movements at the intersection of Lake Lansing Rd and Preyde Blvd have a LOS A, LOS B, or LOS C during the AM and PM peak periods. At the northbound approach, the left-turn movement has a LOS D during the AM and PM peak periods. At the southbound approach, the left-turn movement has a LOS D during the AM and PM peak periods. Also, the right-turn movement has a LOS D during the PM peak period. At the eastbound and westbound approaches, the left-turn movements have a LOS D during the AM and PM peak periods. Additionally, most of the approaches have a LOS A, LOS B, or LOS C during these time periods. The southbound approach has a LOS D during the PM peak period. Lastly, the overall intersection has a LOS A during the AM peak period and a LOS C during the PM peak period. The greatest average queue for all approaches at this intersection is 188 ft., as shown in Table 3. This queue occurs on the eastbound approach during the PM peak period. This approach also has the greatest maximum queue of 897 ft., which also occurs during the PM peak period.

US-127 SB and Lake Lansing Rd

Based on the results in Table 2, most of the individual movements at the intersection of US-127 SB and Lake Lansing Rd have a LOS A, LOS B, or LOS C during the AM and PM peak periods. At the southbound approach, the left-turn movement has a LOS D during the PM peak period. At the westbound approach, the through movement has a LOS E during the PM peak period. Additionally, most of the approaches have a LOS A or LOS C during these time periods. The southbound approach has a LOS D during the PM peak period. The westbound approach has a LOS E during the PM peak period. Lastly, the overall intersection has a LOS B during the AM peak period and a LOS D during the PM peak period. The greatest average queue for all approaches at this intersection is 703 ft., as shown in Table 3. This queue occurs on the westbound approach during the PM peak period. This approach also has the greatest maximum queue of 1,442 ft., which also occurs during the PM peak period.

US-127 NB and Lake Lansing Rd

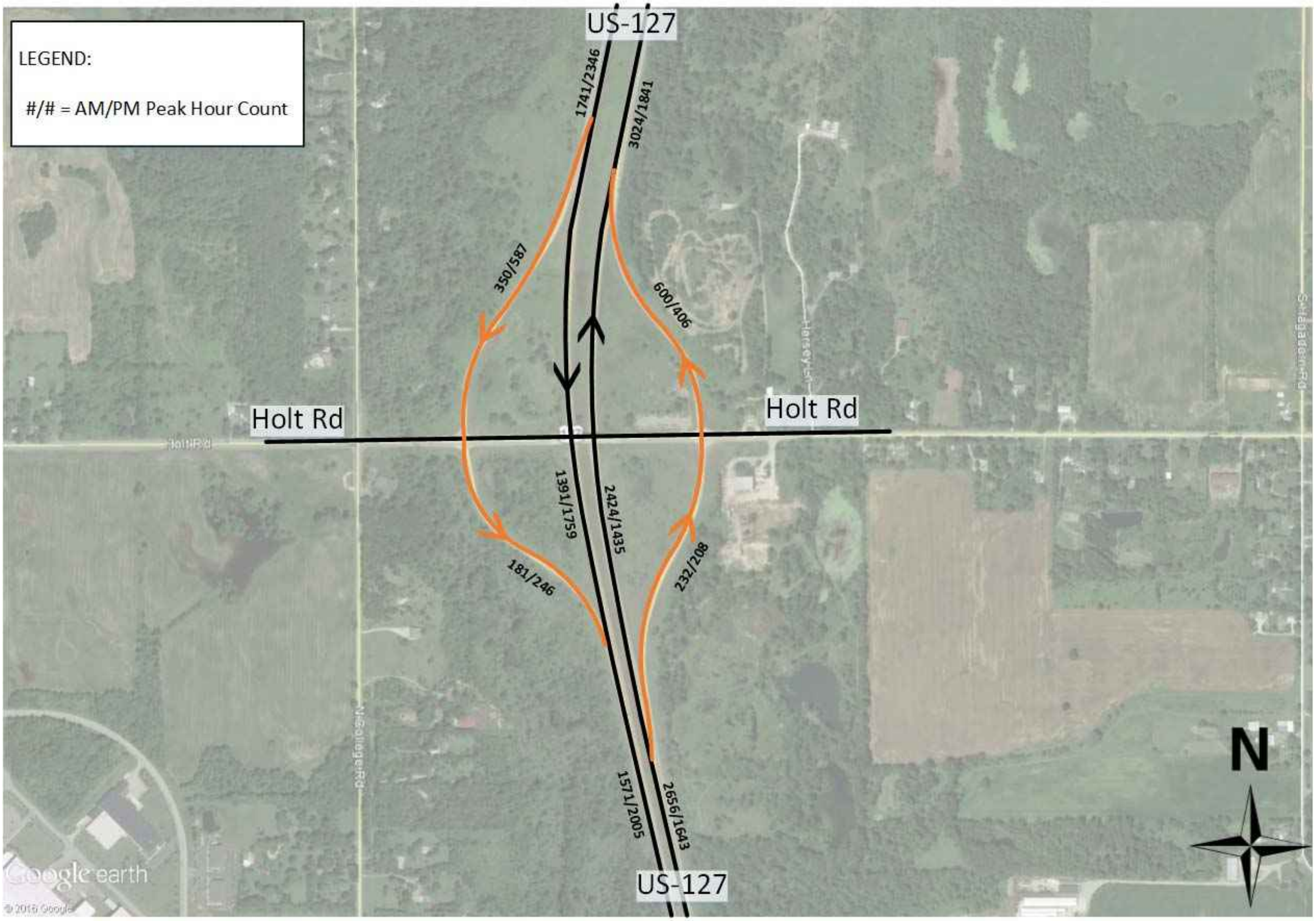
Based on the results in Table 2, most of the individual movements at the intersection of US-127 NB and Lake Lansing Rd have a LOS A or LOS C during the AM and PM peak periods. At the northbound approach, the left-turn movement has a LOS E during the PM peak period. At the westbound approach, the through movement has a LOS D during the PM peak period. Additionally, most of the approaches have a LOS A or LOS C during these time periods. The northbound and westbound approaches have a LOS D during the PM peak period. Lastly, the overall intersection has a LOS B during the AM peak period and a LOS D during the PM peak period. The greatest average queue for all approaches at this intersection is 604 ft., as shown in Table 3. This queue occurs on the northbound approach during the PM peak period. This approach also has the greatest maximum queue of 3,520 ft., which also occurs during the PM peak period.

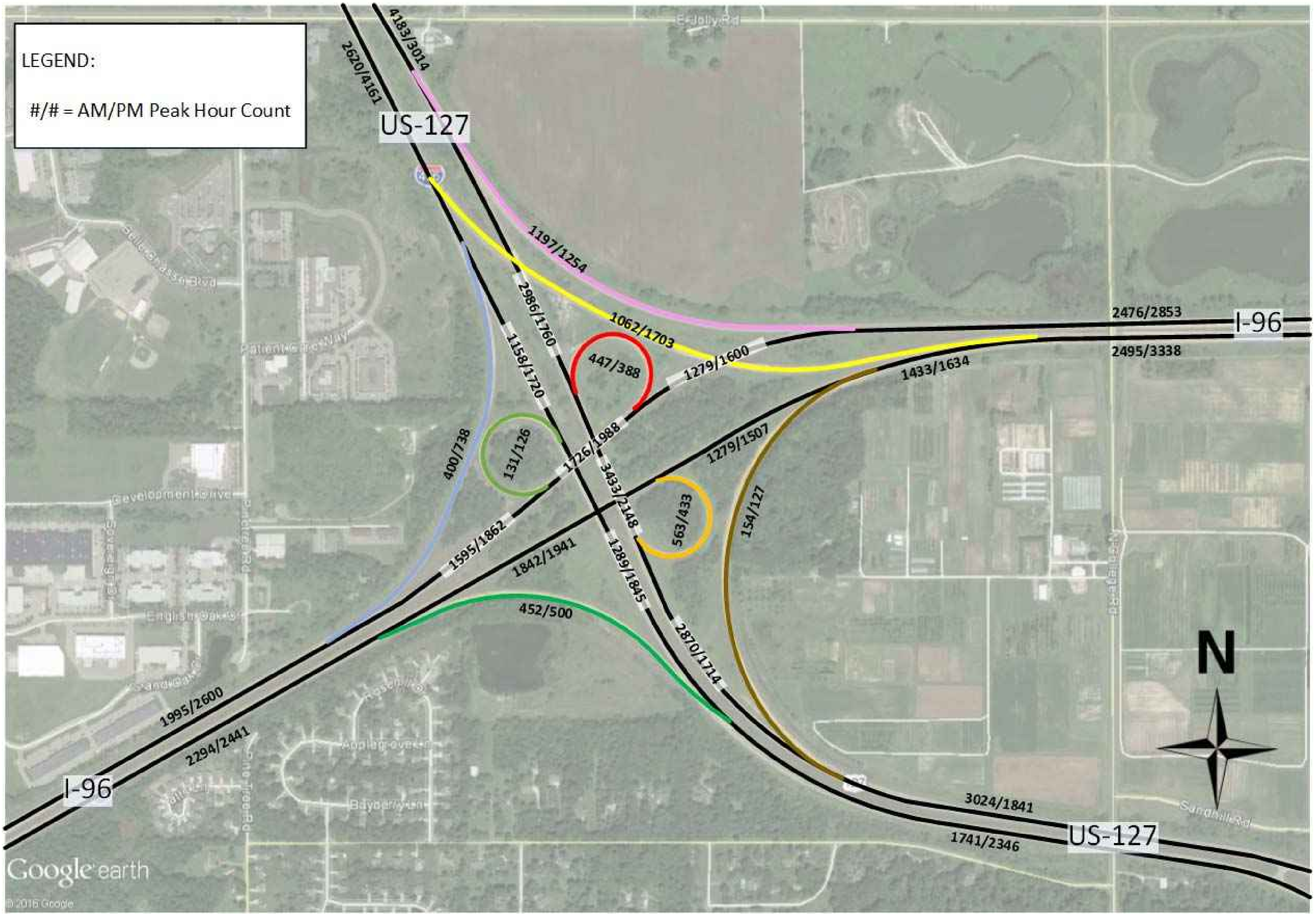
Lake Lansing Rd and Coolidge Rd

Based on the results in Table 2, some of the individual movements at the intersection of Lake Lansing Rd and Coolidge Rd have a LOS B or LOS C during the AM and PM peak periods. At the northbound approach, the left-turn movement has a LOD D during the PM peak period. Also, the through movement has a LOS D during the AM peak period. At the southbound approach, the left-turn movement has a LOS D during the PM peak period. Also, the through and right-turn movement have a LOS E and LOS F during the PM peak period, respectively. At the eastbound approach, the left-turn movement has a LOS D during the AM and PM peak period. Also, the through movement has a LOS D during the AM peak period. At the westbound approach, the left-turn movement has a LOS D and LOS E during the AM and PM peak periods, respectively. Also, the through and right-turn movements have a LOS F and LOS D during the PM peak period, respectively. Additionally, some of the approaches have a LOS C during these time periods. The southbound and westbound approaches have a LOS E during the PM peak period. The eastbound approach has a LOS D during the AM peak period. Lastly, the overall intersection has a LOS C during the AM peak period and a LOS D during the PM peak period. The greatest average queue for all approaches at this intersection is 409 ft., as shown in Table 3. This queue occurs on the southbound approach during the PM peak period. This approach also has the greatest maximum queue of 1,702 ft., which also occurs during the PM peak period.

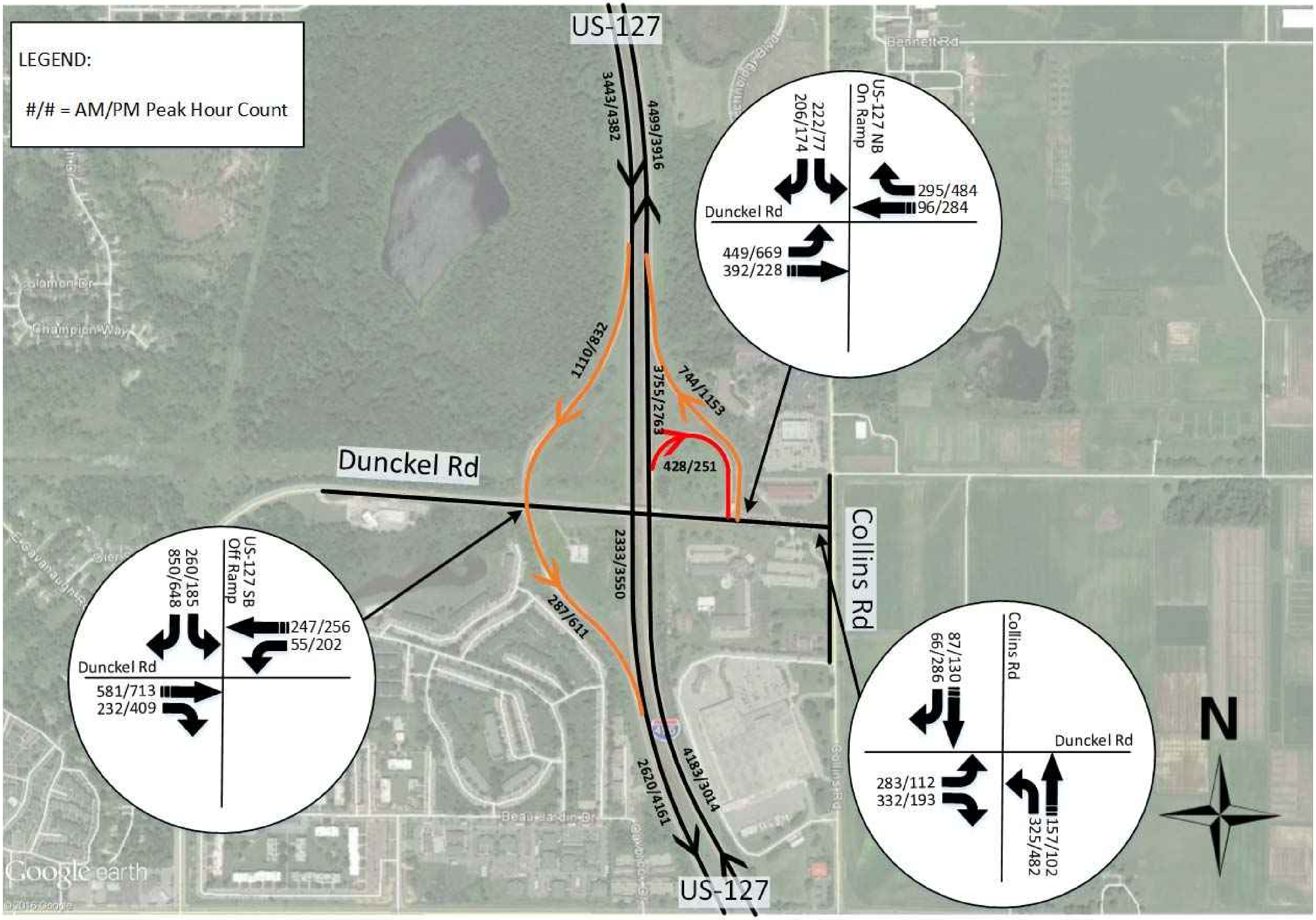
APPENDIX

US-127 and Holt Rd Volume Exhibit

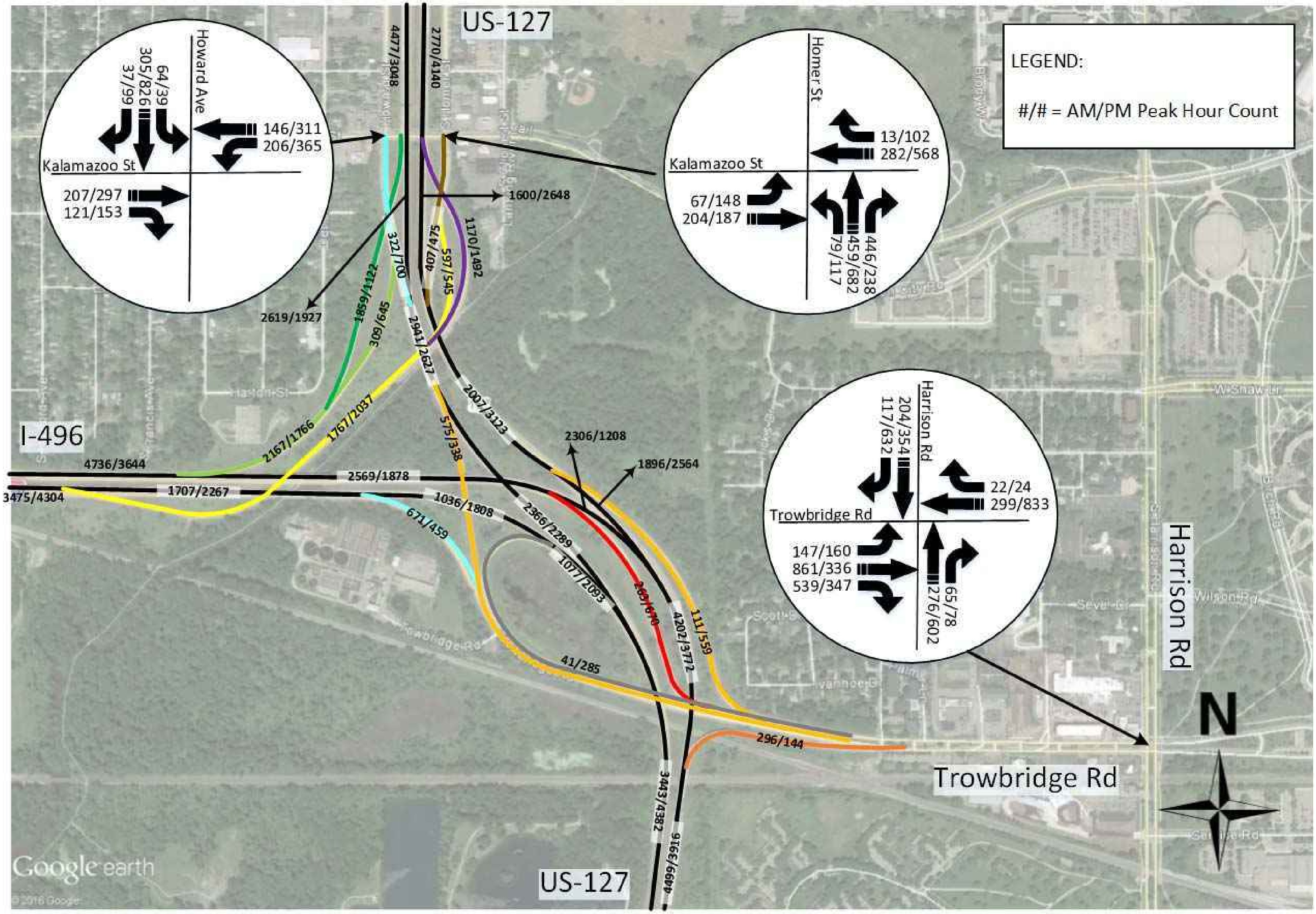



LEGEND:
#/# = AM/PM Peak Hour Count
US-127
I-96
2620/4161
4183/3014
1197/1254
2986/1760
1062/1703
1158/1720
447/388
1279/1600
2476/2853
2495/3338
1433/1634
400/738
131/126
1726/1988
3433/2148
1279/1507
563/433
154/127
1595/1862
1842/1941
1289/1845
452/500
2870/1714
1995/2600
2294/2441
3024/1841
1741/2346
N
Google earth

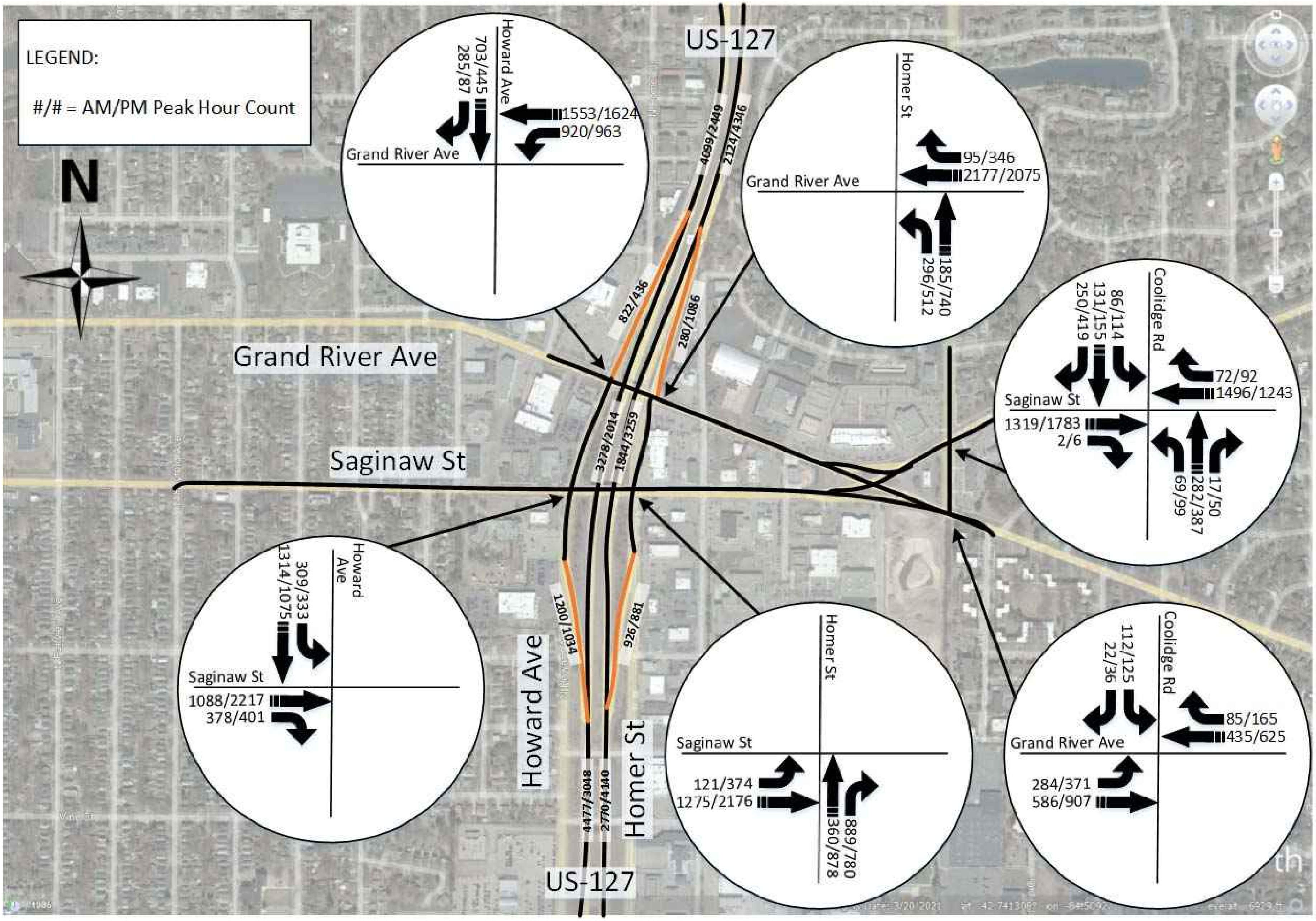
US-127 and Dunckel Rd Volume Exhibit

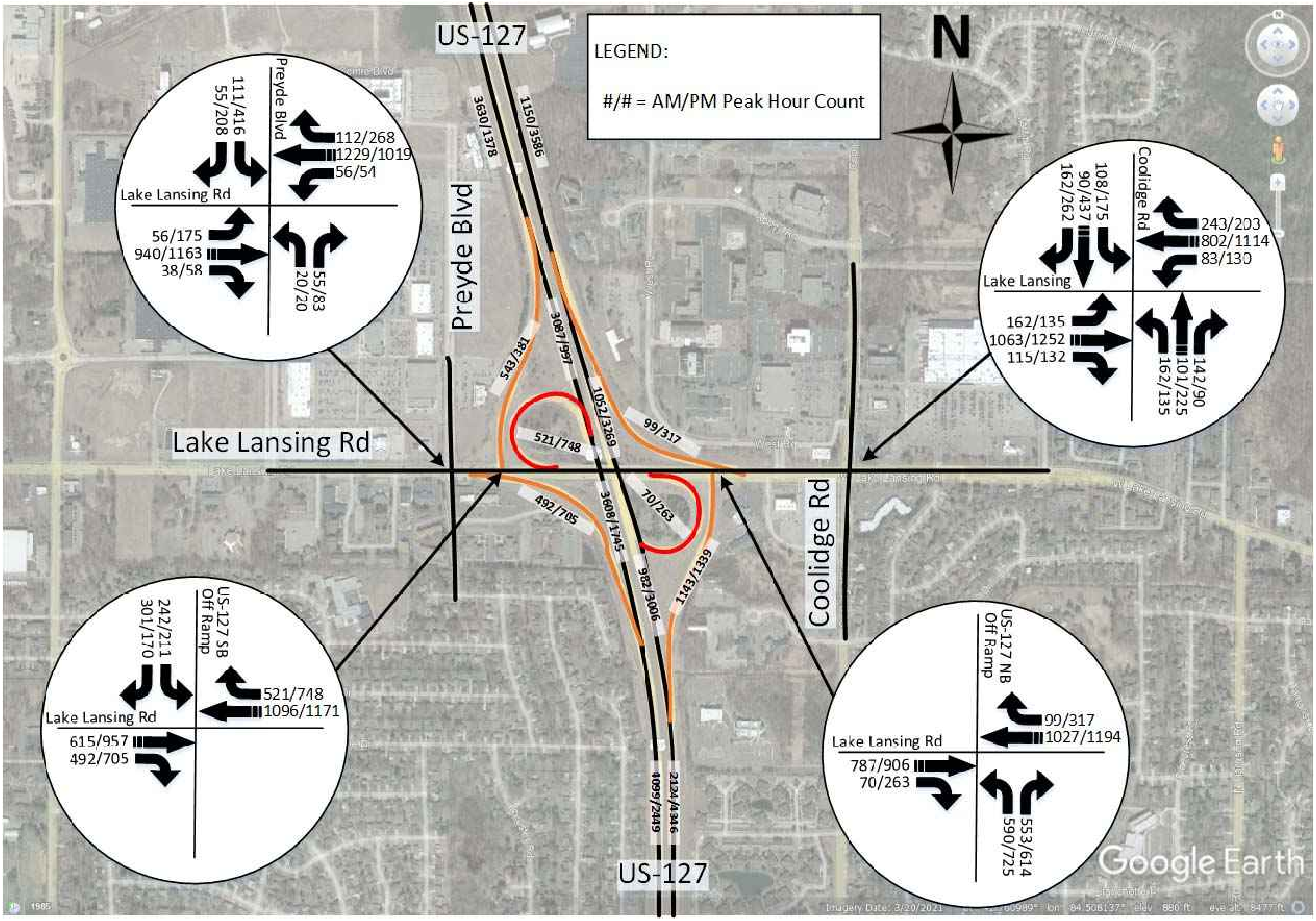


US-127 and I-496 Volume Exhibit



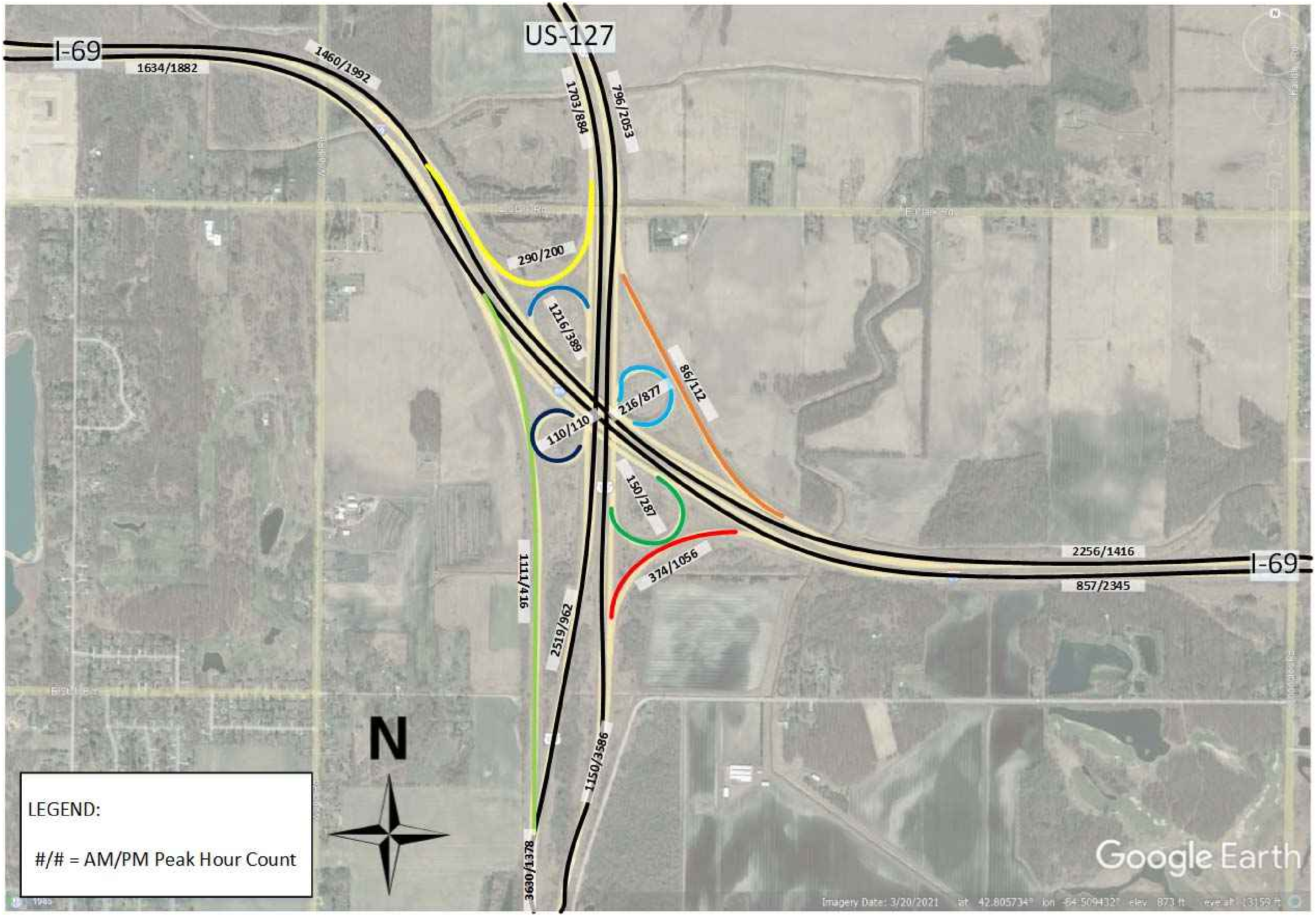
US-127 and Saginaw St Volume Exhibit



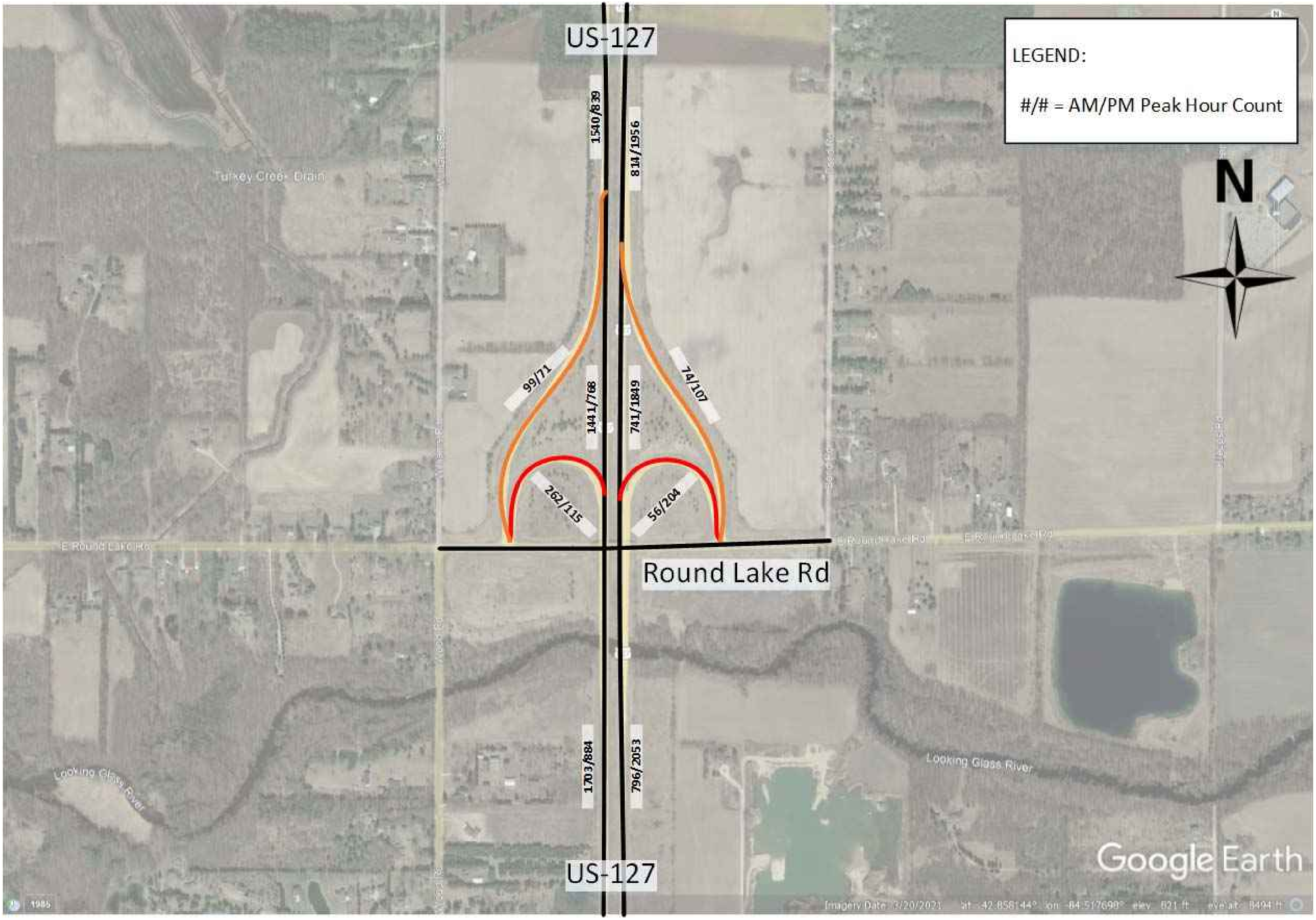


US-127
LEGEND:
#/# = AM/PM Peak Hour Count
N
Preyde Blvd
Lake Lansing Rd
Coolidge Rd
111/416
55/208
112/268
1229/1019
56/54
56/175
940/1163
38/58
20/20
55/83
3630/1378
1150/3586
543/381
3087/997
1052/3269
99/317
521/748
492/705
3608/1745
70/263
1143/1339
982/3006
4099/2449
2124/4346
108/175
90/437
162/262
243/203
802/1114
83/130
Lake Lansing
162/135
1063/1252
115/132
162/135
101/225
142/90
US-127 SB
Off Ramp
242/211
301/170
521/748
1096/1171
615/957
492/705
US-127 NB
Off Ramp
99/317
1027/1194
787/906
70/263
590/725
553/614
Google Earth

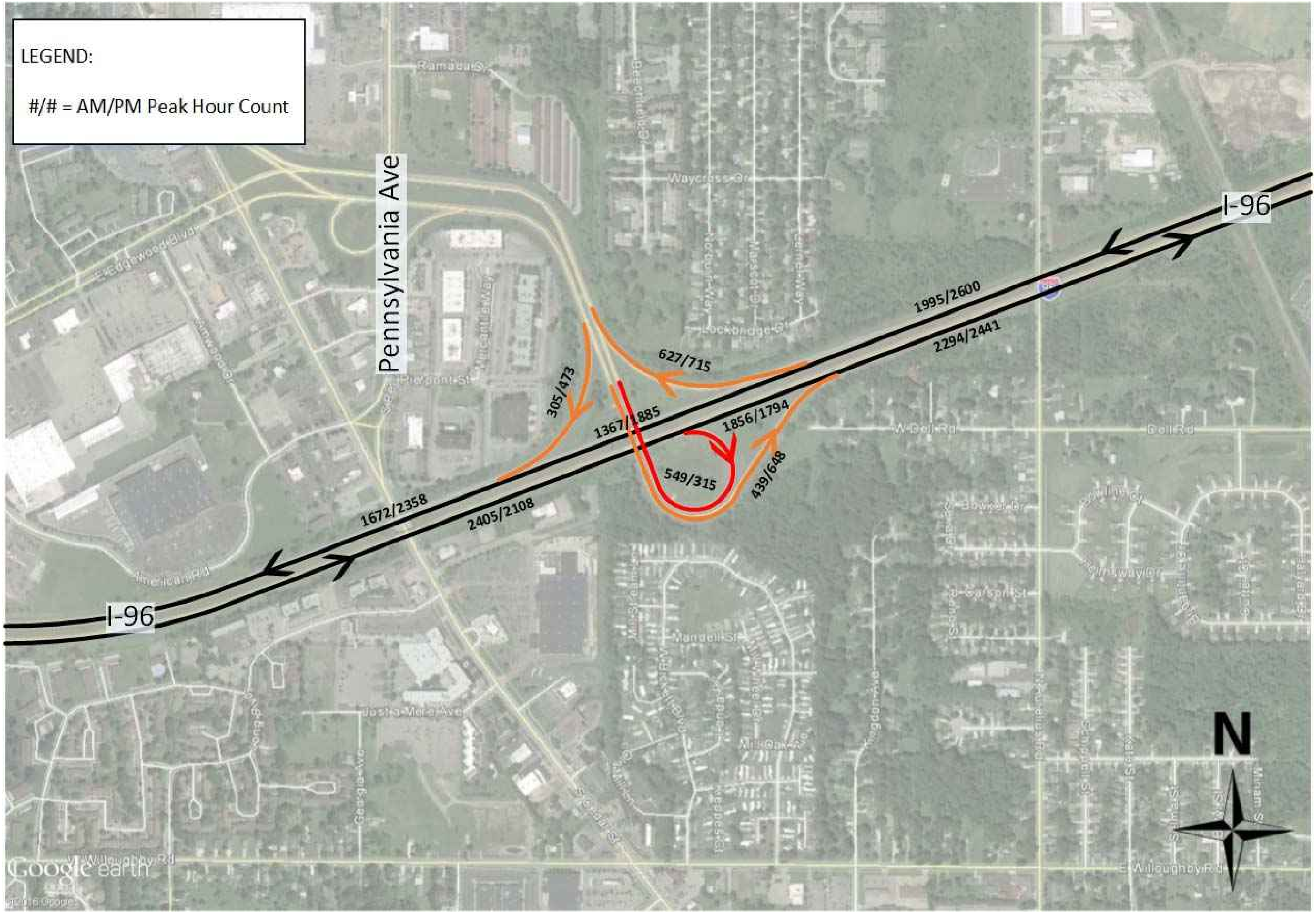
US-127 and I-69 Volume Exhibit



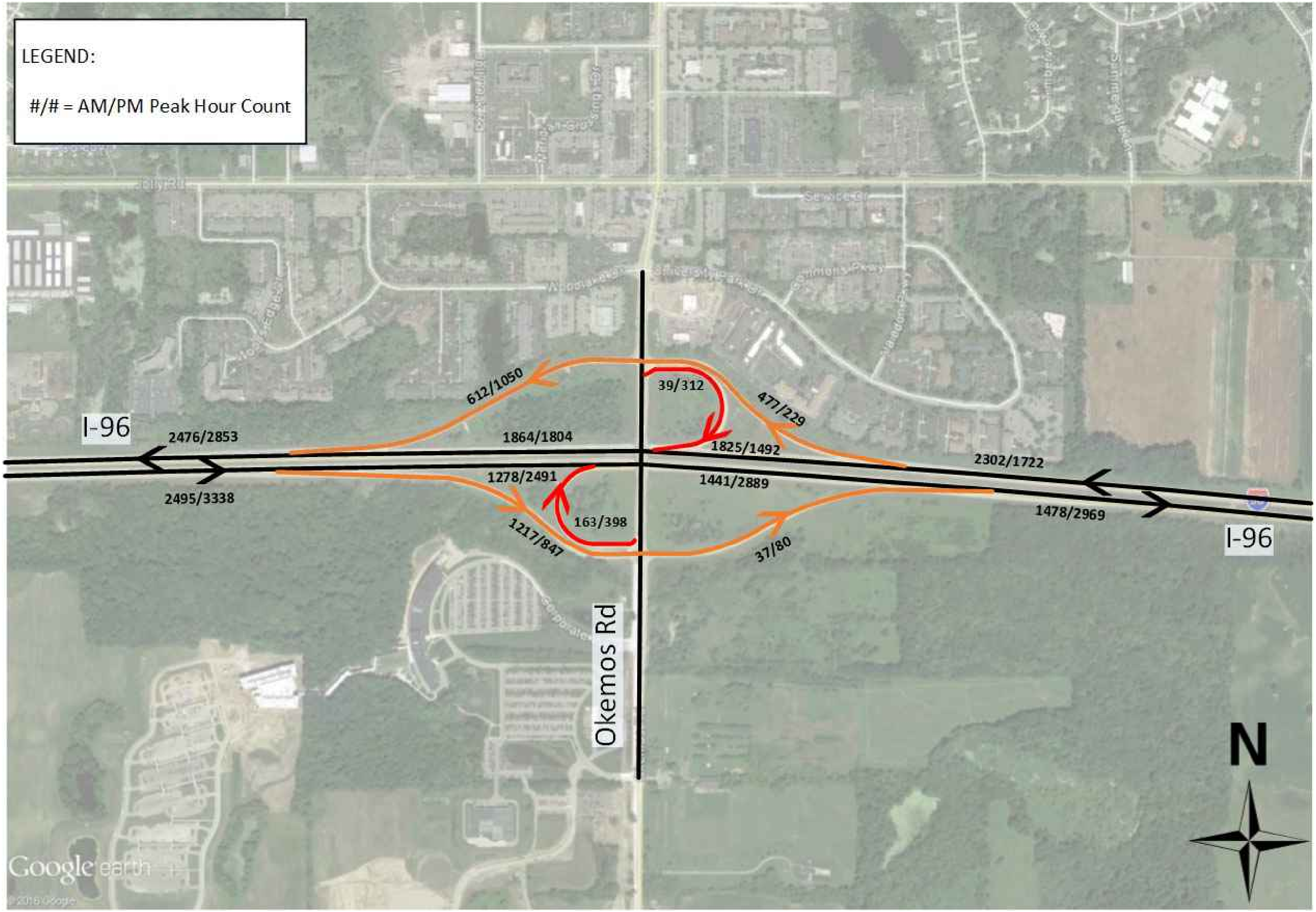
US-127 and Round Lake Rd Volume Exhibit



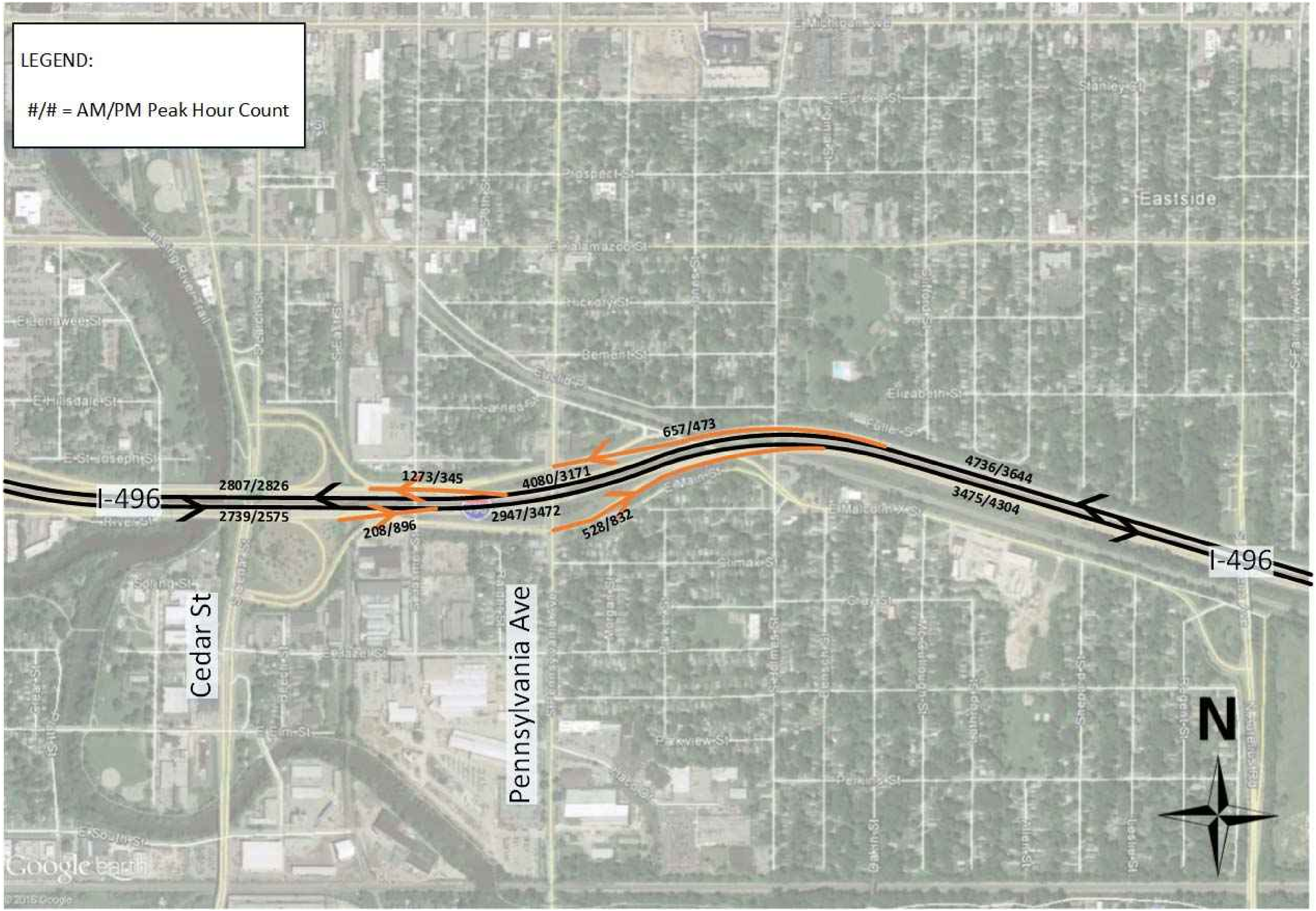
I-96 and Pennsylvania Ave Volume Exhibit



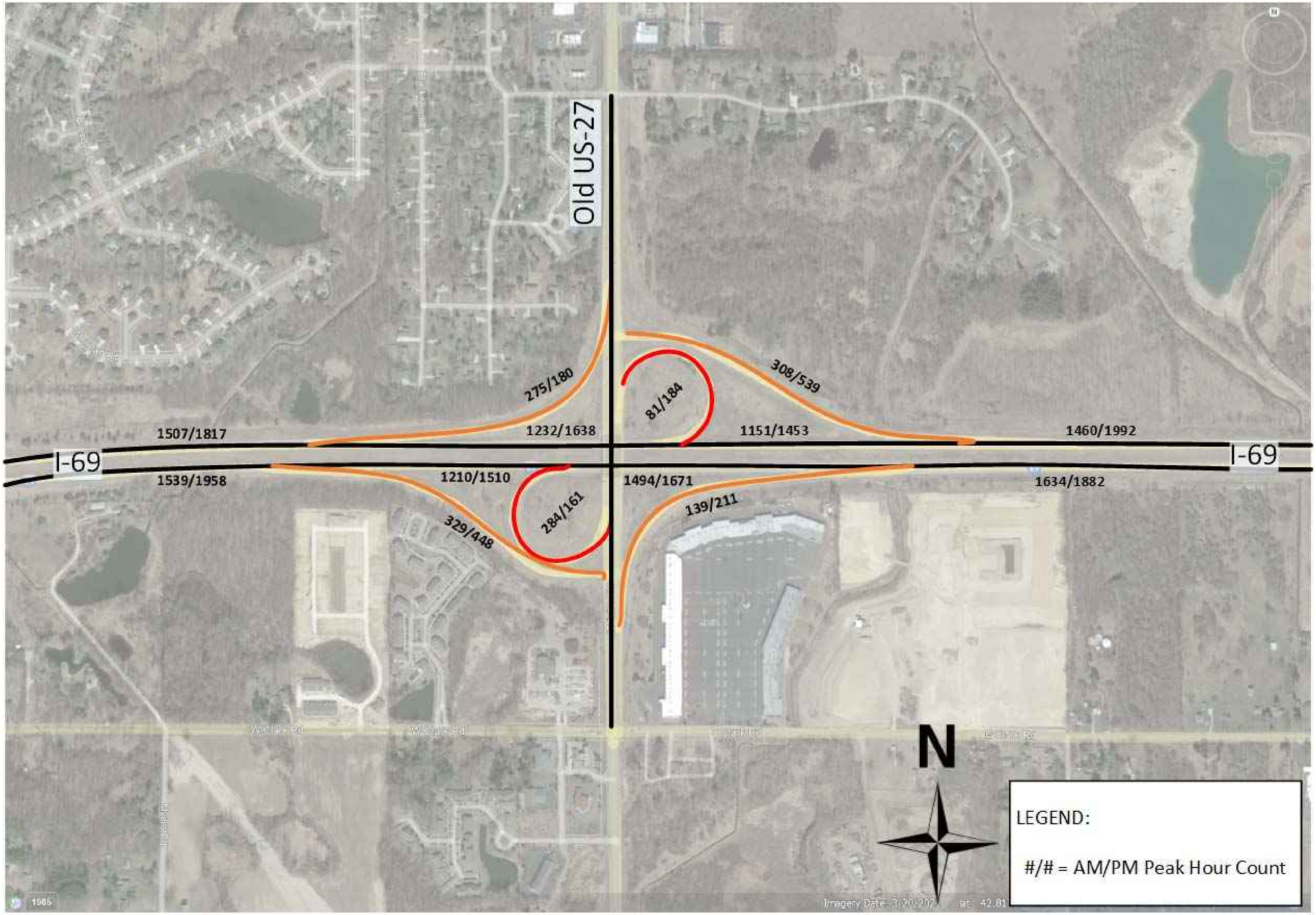
I-96 and Okemos Rd Volume Exhibit



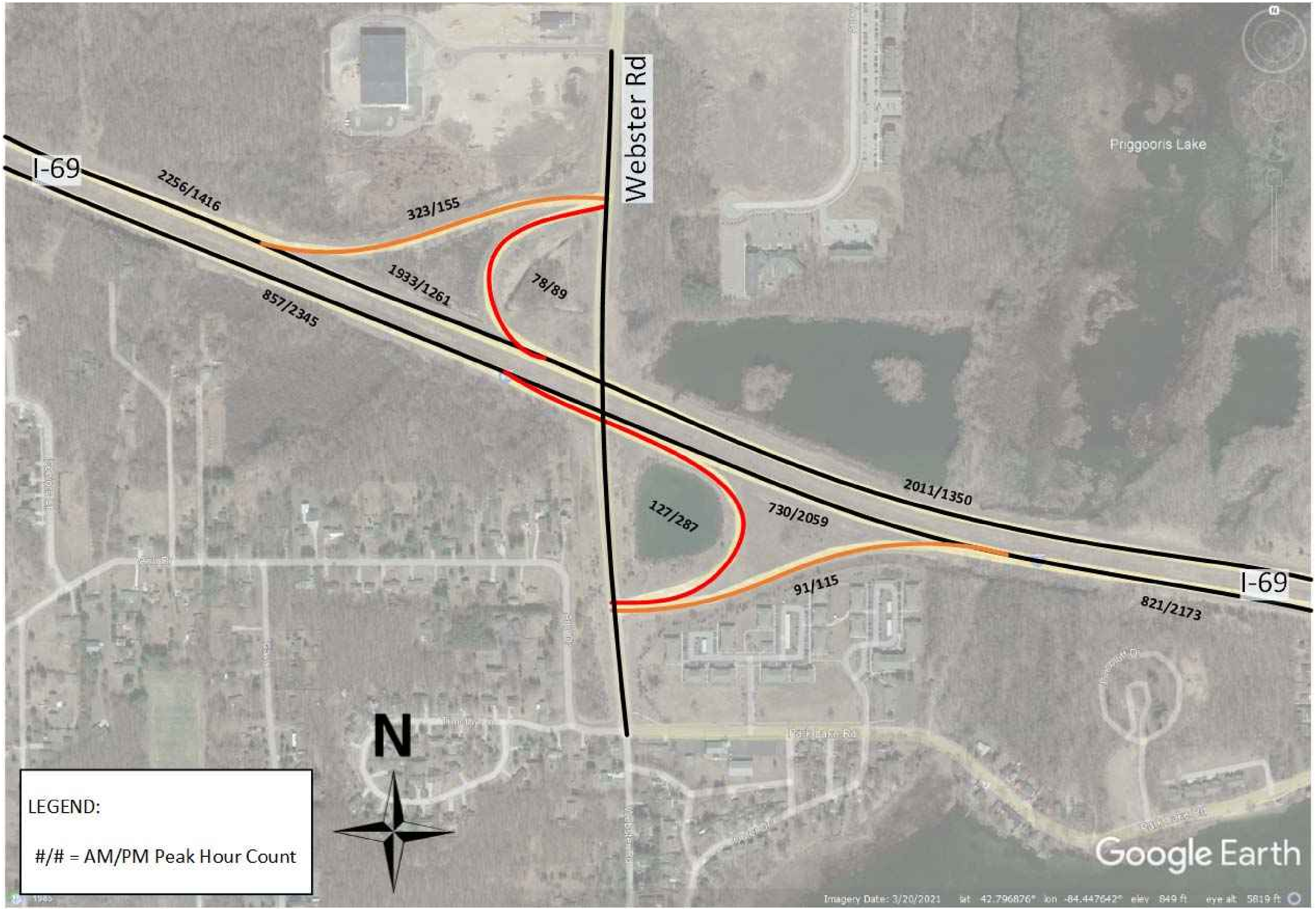
I-496 and Pennsylvania Ave Volume Exhibit



I-69 and Old US-27 Volume Exhibit

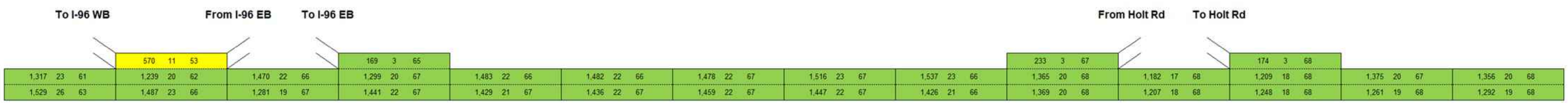


I-69 and Webster Rd Volume Exhibit

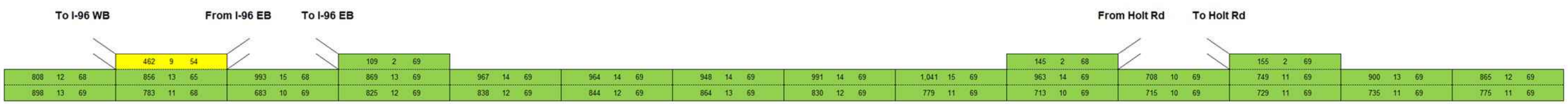


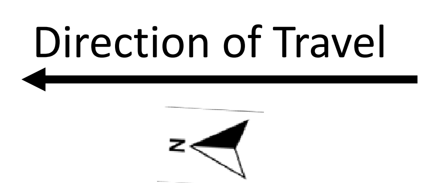
US-127 NB (S of I-96) Lane Schematics

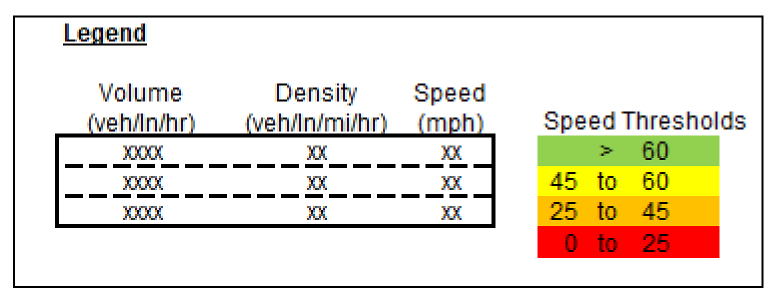
AM Peak



PM Peak

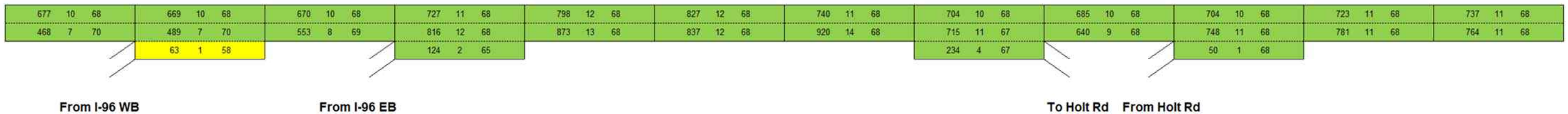




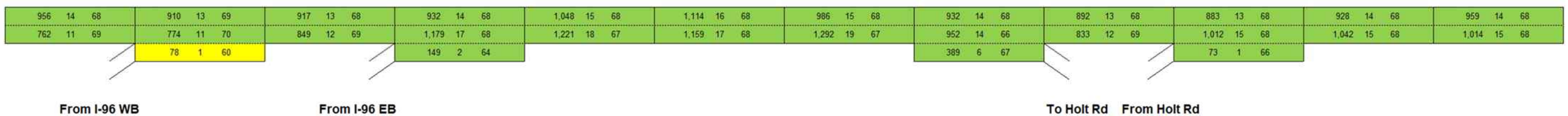


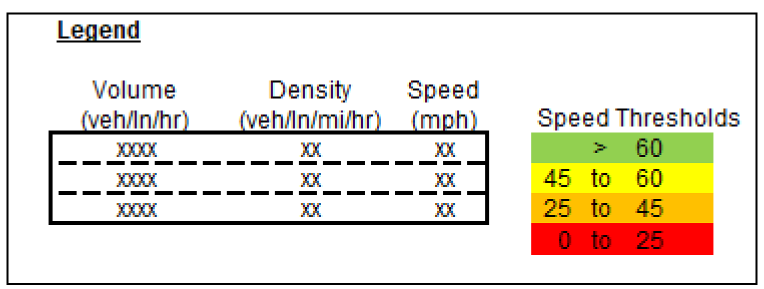
US-127 SB (S of I-96) Lane Schematics

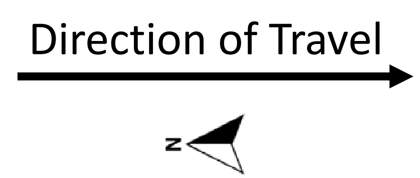
AM Peak



PM Peak

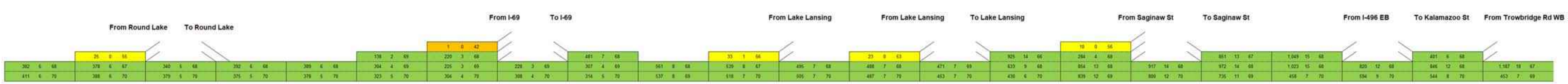




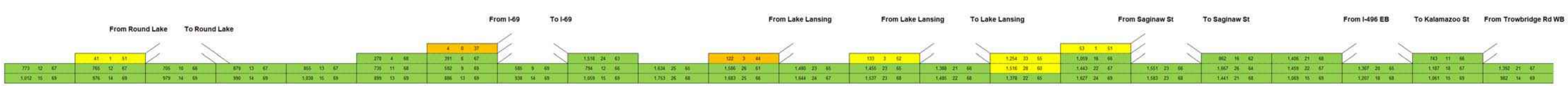


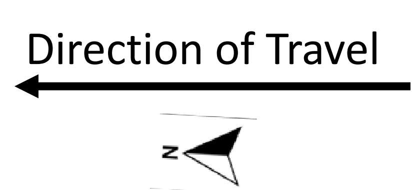
US-127 NB (N of I-496) Lane Schematics

AM Peak



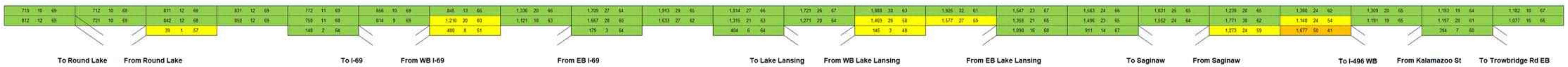
PM Peak



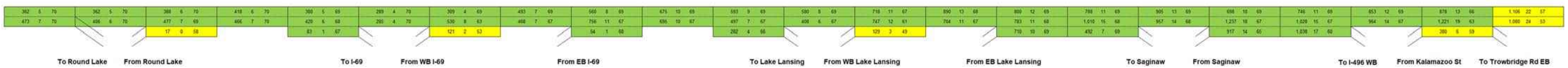


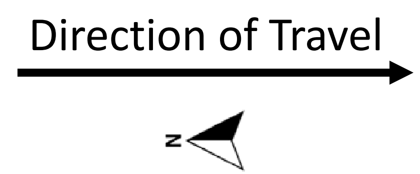
US-127 SB (N of I-496) Lane Schematics

AM Peak



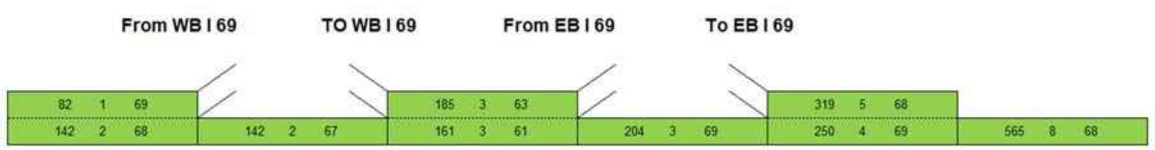
PM Peak



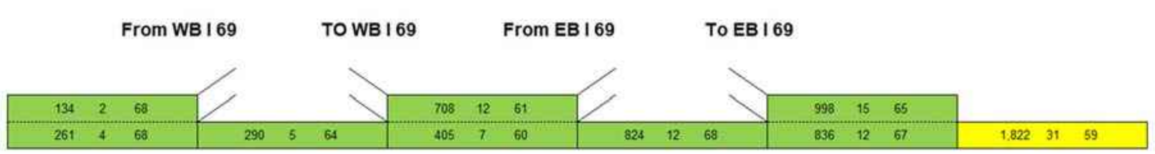


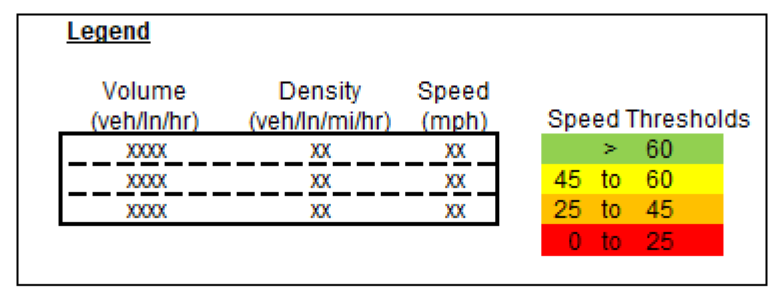
US-127 NB Collector/Distributor Lane Schematics

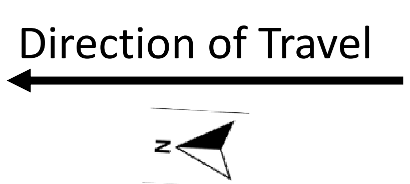
AM Peak



PM Peak

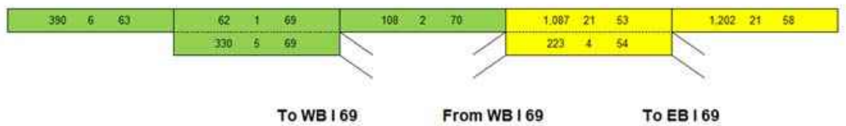




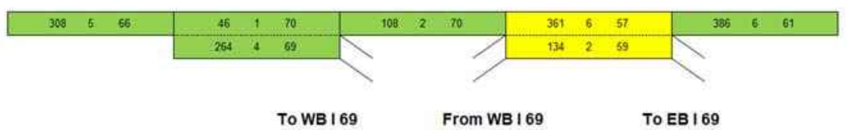


US-127 SB Collector/Distributor Lane Schematics

AM Peak



PM Peak



Direction of Travel

N

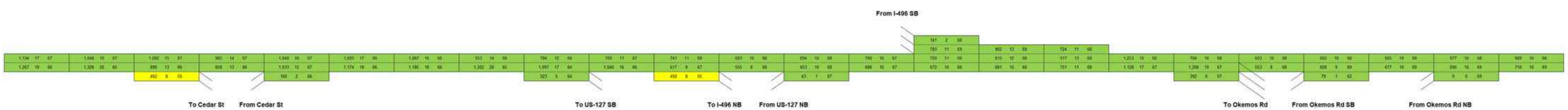
Legend

Volume (veh/ln/hr)	Density (veh/ln/mi/hr)	Speed (mph)
XXXX	XX	XX
XXXX	XX	XX
XXXX	XX	XX

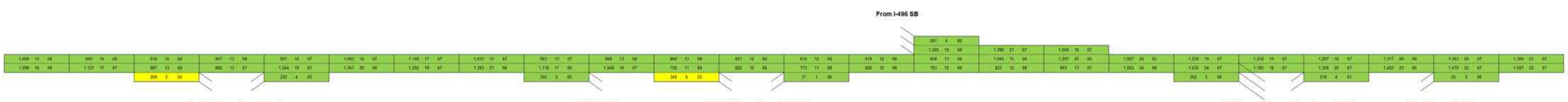
Speed Thresholds		
	>	60
45	to	60
25	to	45
0	to	25

I-96 EB Lane Schematics

AM Peak



PM Peak



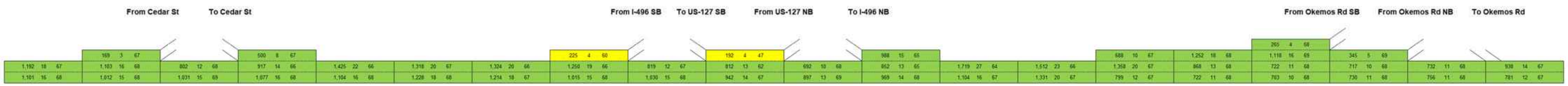
Direction of Travel

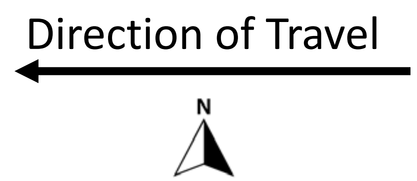
N

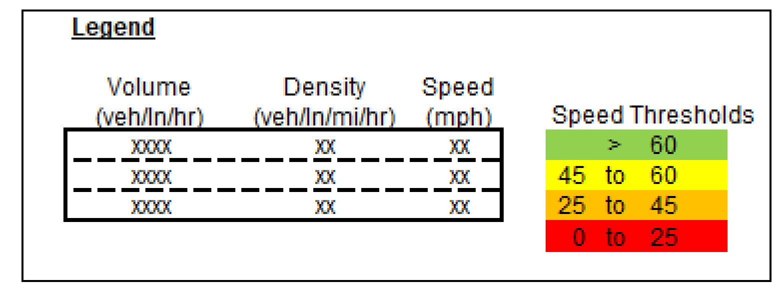
I-96 WB Lane Schematics

AM Peak

PM Peak



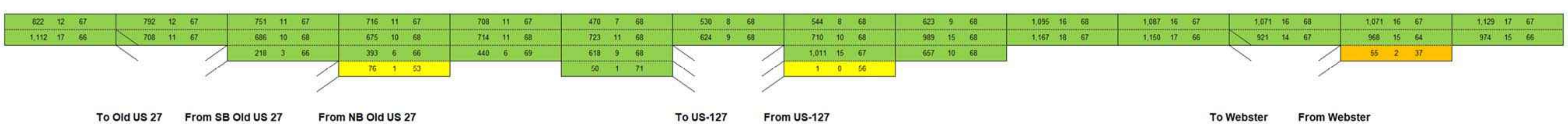


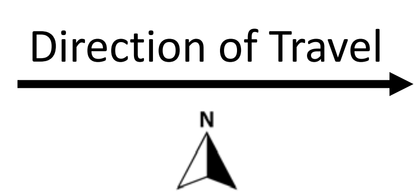


I-69 EB Lane Schematics

AM Peak

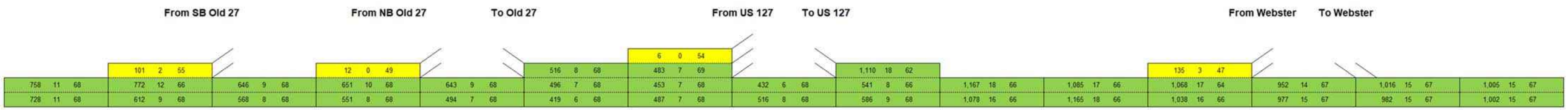
PM Peak



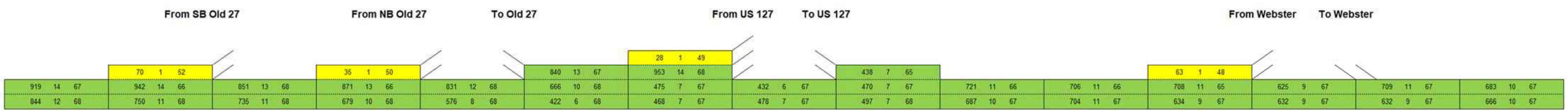


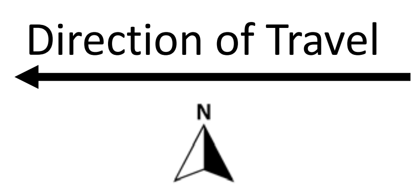
I-69 WB Lane Schematics

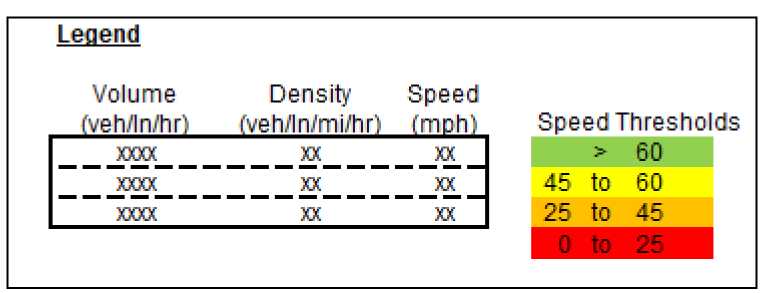
AM Peak



PM Peak

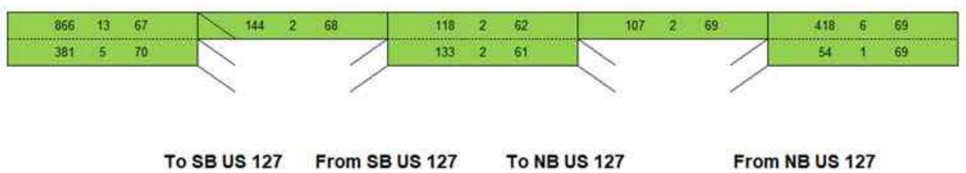




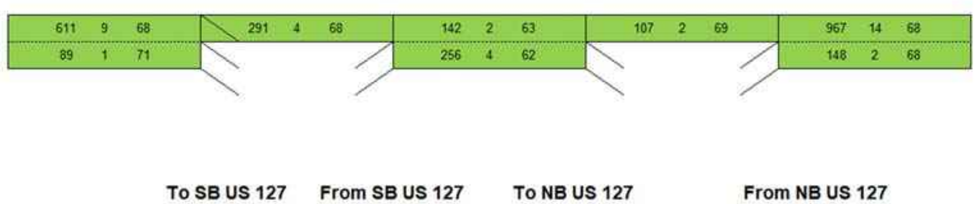


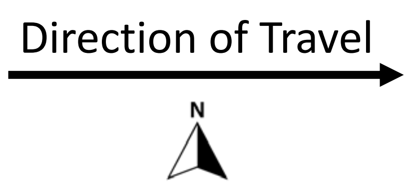
I-69 EB Collector/Distributor Lane Schematics

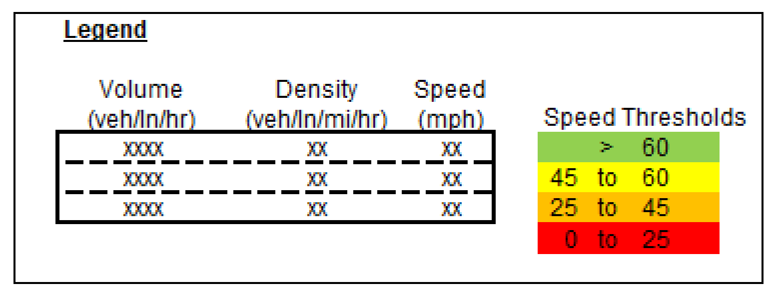
AM Peak



PM Peak

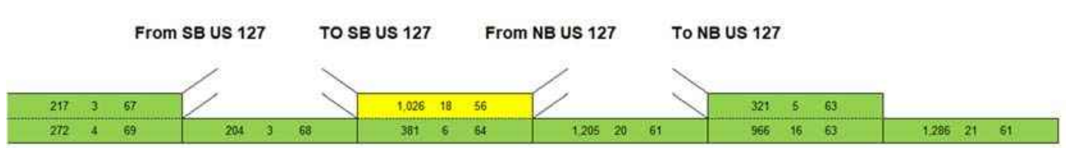






I-69 WB Collector/Distributor Lane Schematics

AM Peak



PM Peak