Appendix F. Air Quality Reports

I-39/90/94 Corridor Study

Technical Memorandum

Mobile Source Air Toxics Analysis

June 2024

Wisconsin Department of Transportation

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1. Introduction

The Wisconsin Department of Transportation (WisDOT) and the Federal Highway Administration (FHWA) are preparing an EIS to evaluate potential improvements to provide reliable and safe travel on I 39/90/94 between United States Highway (US) 12/18 in Madison and US 12/Wisconsin State Highway (WIS) 16 in Wisconsin Dells. The study also evaluates I-39 from its split with I-90/94 (the I-39 I-90/94 Split) to Levee Road near Portage. The study corridor is 67 miles long and travels through Dane, Columbia, Sauk, and Juneau counties. This memorandum presents a mobile source air toxics (MSAT) analysis for the study corridor.

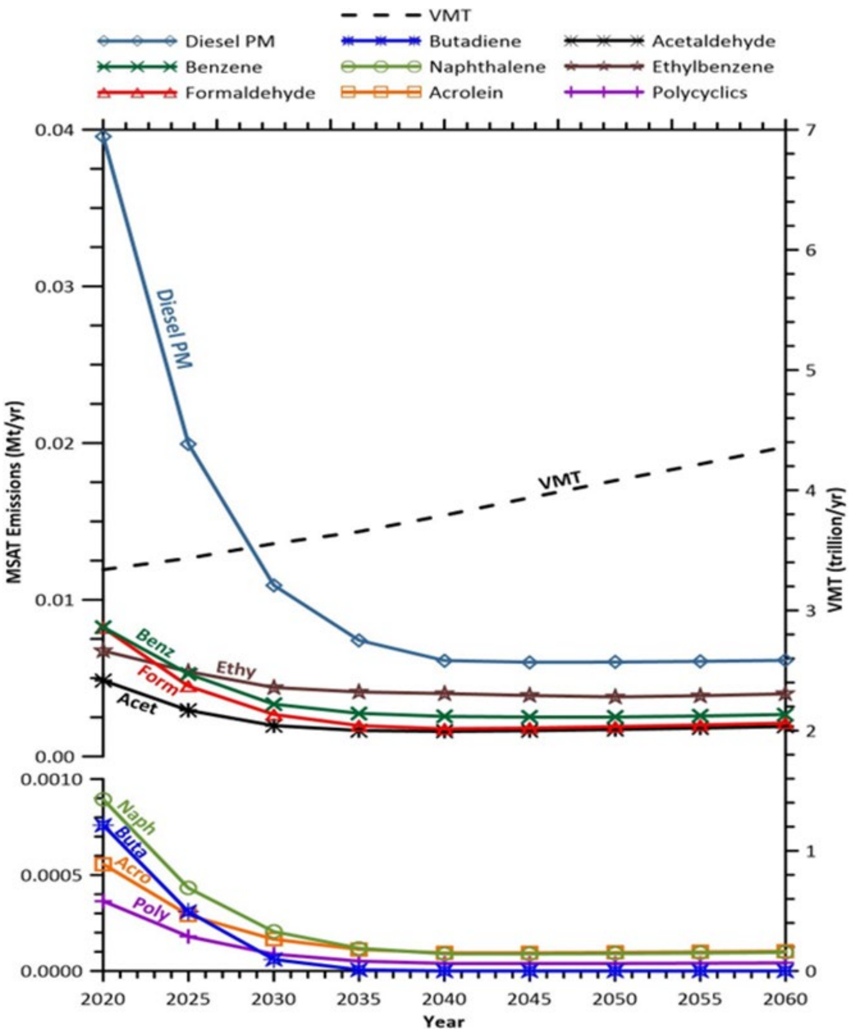
The analysis quantified MSAT emissions from existing conditions and in future years for the build alternatives and No-Build Alternative. The analysis concluded that MSAT emissions would be lower in future years than existing conditions MSAT emissions regardless of which alternative is selected. FHWA and WisDOT acknowledge that there may be increased exposure to MSAT emissions under the build alternatives in certain locations, although the concentrations and durations of exposure are uncertain; because of this uncertainty, the health effects from these emissions cannot be reliably estimated.

1.1. Background

Controlling air toxic emissions became a national priority with the Clean Air Act (CAA) Amendments of 1990. Congress mandated that the United States Environmental Protection Agency (EPA) regulate 188 air toxics, also known as hazardous air pollutants. EPA has assessed this expansive list in its rule on the Control of Hazardous Air Pollutants from Mobile Sources (*Federal Register*, Vol. 72, No. 37, page 8430, February 26, 2007) and identified a group of 93 compounds emitted from mobile sources that are listed in EPA's Integrated Risk Information System (IRIS) (EPA 2018). In addition, EPA identified nine compounds with significant contributions from mobile sources that are among the national and regional-scale cancer risk drivers from EPA's National Air Toxics Assessment (EPA 2014). These are 1,3-butadiene, acetaldehyde, acrolein, benzene, diesel particulate matter (diesel PM), ethylbenzene, formaldehyde, naphthalene and polycyclic organic matter (POM). While FHWA considers these nine compounds the priority MSATs, the list is subject to change and may be adjusted in future EPA rules. Unlike the criteria pollutants, MSATs do not have ambient air quality standards.

Using EPA's Motor Vehicle Emission Simulator (MOVES3) model, as shown on Figure 1-1, FHWA estimates that even if vehicle miles traveled (VMT) increases by 31% from 2020 to 2060 as forecasted, a combined reduction of 76% in the total annual emissions for the priority MSATs is projected for the same time period. Diesel PM is the dominant component of MSAT emissions, making up 36% to 56% of all priority MSAT pollutants by mass, depending on calendar year (FHWA 2023a).

Figure 1-1: FHWA Projected National MSAT Emission Trends 2020-2060 for Vehicles Operating on Roadways



Note: Trends for specific locations may be different depending on locally derived information representing vehicle miles traveled, vehicle speeds, vehicle mix, fuels, emission control programs, meteorology, and other factors.

Source: EPA MOVES3 model runs conducted by FHWA, March 2021

1.2. MSAT Research

Air toxics analysis is a continuing area of research. While much work has been done to assess the overall health risk of air toxics, many questions remain unanswered. In particular, the tools and techniques for assessing project-specific health outcomes caused by lifetime MSAT exposure remain limited. These limitations make it difficult to evaluate how the potential health risks posed by MSAT exposure should be factored into project-level decision-making within the context of the National Environmental Policy Act (NEPA).

Nevertheless, air toxics concerns continue to be raised on highway projects during the NEPA process. Even as the science emerges, decision makers are expected by the public and other agencies to address MSAT impacts in environmental documents. FHWA, EPA, the Health Effects Institute (HEI) and others have funded and conducted research studies to try to define potential risks more clearly from MSAT emissions associated with highway projects. FHWA will continue to monitor the developing research in this field.

1.3. Consideration of MSATs in NEPA Documents

Transportation projects may affect the regional or local air toxic concentrations because of MSAT emissions from vehicles. Potential MSAT effects from the study corridor operation were evaluated following the FHWA memorandum titled *Updated Interim Guidance on Air Toxic Analysis in NEPA Documents* (FHWA 2023). In the guidance, FHWA developed a tiered approach, with three categories for analyzing MSAT impacts depending on specific project circumstances:

- No analysis for projects with no potential for meaningful MSAT effects

  The types of projects included in this category are projects qualifying as a categorical exclusion under 23 Code of Federal Regulations (CFR) 771.117, projects exempt under the Clean Air Act conformity rule under 40 CFR 93.126 and other projects with no meaningful impacts on traffic volumes or vehicle mix.
- Qualitative analysis for projects with low potential MSAT effects

  The types of projects included in this category are those that serve to improve operations of highway, transit, or freight without adding substantial new capacity or without creating a facility that is likely to meaningfully increase MSAT emissions. Examples of these types of projects are minor widening projects, new interchanges, replacing a signalized intersection on a surface street and projects where design year traffic is projected to be less than 140,000 to 150,000 annual average daily traffic (AADT).
- Quantitative analysis to differentiate alternatives for projects with higher potential MSAT effects

  This category includes projects that have the potential for meaningful differences in MSAT emissions among project alternatives; projects that would create new capacity or add significant capacity to urban highways such as interstates, urban arterials or urban collector-distributor routes with traffic volumes where the AADT is projected to be in the range of 140,000 to 150,000 or greater by the design year; and projects that are proposed to be located in proximity to populated areas.

To determine the required level of MSAT analysis, future year AADT was estimated for the study corridor (Appendix A). The AADT on one segment of the study corridor in Dane County would be greater than 150,000 vehicles under the build condition, and some of the study corridor would be located close to populated areas. According to FHWA's updated interim guidance, the study corridor is considered to have high potential for MSAT effects. Therefore, a quantitative MSAT analysis was performed.

2. Quantitative MSAT Analysis

The quantitative MSAT analysis was conducted for the study area to provide a basis for identifying and comparing the potential differences among MSAT emissions from the build and no build alternatives. The analysis evaluated emissions for the following priority MSATs:

- 1,3-Butadiene
- Acetaldehyde
- Acrolein
- Benzene
- Diesel PM
- Ethylbenzene
- Formaldehyde
- Naphthalene
- POM

2.1. Analysis Years and Study Area

Construction of the study corridor would start in 2030 and finish in 2040. Construction will be carried out in phases with completed segments open to traffic starting in 2030. The analysis years of the MSAT effects include the existing condition year 2023, the opening year 2030 and the design year 2060, which is 20 years after the completion of construction of the entire study corridor.

MSAT emissions were evaluated for the existing condition, the No-Build Alternative and the build alternatives. Chapter 2 Project Description describes the two build alternatives evaluated within the EIS. The Modernization Hybrid alternative (Hybrid Alternative) includes active traffic management of the managed lane, thereby providing the same number of travel lanes during congested periods of the day as the Modernization Plus Added General Purpose Lane (GP Lane Alternative).

Traffic data would be the same in counties outside of Dane County for the GP Lane and Hybrid alternatives. In Dane County, the Dane County travel demand model (DCTDM) was used to estimate differences in traffic volumes and speeds between the two build alternatives by lowering the number of lanes in the managed lane area during the midday and night periods.

The DCTDM models four discrete time periods for both a base year 2016 and horizon year 2050 including AM period of 6-9 AM, midday period of 9 AM to 3 PM, PM period of 3-6 PM and night period of 6 PM to 6 AM. This architecture allows for modeling of a managed lane being open in one or more time periods and closed in others. This architecture also requires the managed lane to be modeled as either open or closed for the duration of each respective time period. However, the Hybrid alternative incorporates a dynamic managed lane which could be opened at any time of day based on observed traffic conditions. The draft concept of operations developed for the Hybrid alternative uses hourly projected traffic demands for year 2050 to determine the likely hours of operation of the managed lane including 2 PM to 6 PM for select sections of the system. The 2 PM to 3 PM portion of that managed lane operation is not able to be captured with the DCTDM's midday analysis period, resulting in small differences in traffic assignments from the DCTDM during that midday time period. Build traffic forecasts were developed using the GP Lane alternative's DCTDM outputs with the understanding that the managed lane would be available at times of the day when traffic congestion warranted the need.

Traffic operations and safety modeling was conducted using the traffic forecasts developed with the GP Lane alternatives DCTDM outputs.

For purposes of documenting the potential differences in GHG analysis outputs, both the GP Lane and Hybrid alternatives' DCTDM outputs were evaluated with the understanding that the Hybrid alternative's DCTDM outputs were not fully capturing the midday traffic demands. This approach provides the envelope within which to compare the GP Lane and Hybrid alternatives relative difference in impacts to GHG.

The Hybrid Alternative results in a net decrease in VMT within the affected roadway links of 4,832 vehicle miles traveled, or 0.116 percent of VMT for the 2050 build condition, compared to the GP Lane Alternative. This is compared to the GP Lane Alternative's increase in VMT over the No Build of 3.43 percent for that same area.

Maximum directional volume difference under the Hybrid Alternative is a reduction of 565 vehicles per day on the segment between WIS 30/I-94 and US 12/18, compared to the GP Lane Alternative. That equates to the Hybrid alternative having a reduction of VMT within the Dane County study limits of just under one percent compared to the GP Lane alternative's Dane County study area VMT. Of the 565 vehicles per day, 561 occur in the mid-day time period.

The affected roadways evaluated in the MSAT analysis were selected according to FHWA guideline as specified in the *Frequently Asked Questions (FAQs): FHWA Recommendations for Conducting Quantitative Mobile Source Air Toxics (MSAT) Analysis for FHWA NEPA Documents* (FHWA 2023b). The southern portion of the study corridor goes through the highly urbanized Madison metropolitan area in Dane County. The rest of the corridor goes through areas that are mostly rural in Columbia, Juneau, and Sauk counties. To capture the different traffic and vehicle characteristics in these areas, the affected roadways were selected and evaluated based on two areas: the "Dane County" area which covers affected roadways within the Dane County limits, and the "Other Counties" area which covers the affected roadways outside of Dane County. Details of the selection of the affected roadways in each of the two analysis areas are discussed in the technical memorandum *I-39/90/94 Study – MSAT Analysis Impacted Links Methodology and VMT/VHT Results* in Appendix B.

As such, MSAT analysis included the following twelve scenarios:

- Affected Roadways in Dane County, 2023, Existing Condition
- Affected Roadways in Dane County, 2030, No-Build Alternative
- Affected Roadways in Dane County, 2030, Build Alternative – GP Lane
- Affected Roadways in Dane County, 2030, Build Alternative – Hybrid
- Affected Roadways in Dane County, 2060, No-Build Alternative
- Affected Roadways in Dane County, 2060, Build Alternative – GP Lane
- Affected Roadways in Dane County, 2060, Build Alternative - Hybrid
- Affected Roadways in Other Counties, 2023, Existing Condition
- Affected Roadways in Other Counties, 2030, No-Build Alternative
- Affected Roadways in Other Counties, 2030, Build Alternative (applies to both GP Lane and Hybrid alternatives)
- Affected Roadways in Other Counties, 2060, No-Build Alternative
- Affected Roadways in Other Counties, 2060, Build Alternative (applies to both GP Lane and Hybrid alternatives)

2.2. Model Selection and Methodology

MSAT emissions for each of the analysis scenarios were estimated using EPA's MOVES4 model, the latest official version of MOVES at the time of this study. Table 2-1 through Table 2-3 describe the input data used for the MSAT analysis. Study corridor-specific information, including VMT and vehicle speeds, was used in MOVES4 and is in Appendix C. MOVES4 default inputs were used when study corridor-specific information was not available. MOVES4 defaults were obtained using the following approach:

- Affected Roadways in Dane County: Defaults were obtained using geographic bounds of Dane County.
- Affected Roadways in Other Counties: Outside of Dane County, the study corridor is mostly in Columbia County and Sauk County, and a small segment is in Juneau County. Some of the affected roadways are also in Rock, Jefferson, Iowa, and Dodge counties, and beyond. Through coordination with FHWA, it was agreed that majority of the affected roadways outside of Dane County in the study area would have similar characteristics such vehicle population distribution, vehicle age distribution, vehicle fuel types, and meteorological conditions. Therefore, affected roadways in these counties could be reasonably represented in MOVES as one single area using representative data inputs. Because a large portion of the study corridor outside of Dane County is in Columbia County, the MOVES default inputs of vehicle population distribution, vehicle age distribution, vehicle fuel types, and meteorological data of Columbia County was used in the MOVES modeling for affected roadways in the counties outside of Dane County.

Table 2-1: MOVES RunSpec Options

MOVES Tab	Model Selections
Scale	County scale; Inventory mode
Time Span	Hourly time aggregation, including weekdays and weekends, all 24 hours for all 12 calendar months
Geographic Bounds	Dane County, Wisconsin (for affected roadways in Dane County) Columbia County, Wisconsin (for affected roadways in other counties)
Vehicles/Equipment	All MOVES4 vehicle and fuel type combinations
Road Type	Urban restricted access Urban unrestricted access Rural restricted access Rule unrestricted access Excludes off-network
Output	Output included speciation of emissions by fuel type to differentiate diesel PM from other fuel type PM
Time Aggregation	Year (Annual)

Table 2-2: MOVES RunSpec Emission Processes

Process ID	Process Description
1	Running Exhaust
15	Crankcase Running Exhaust
11	Evaporative Permeation
13	Evaporative Fuel Leaks

Table 2-3: MOVES County Data Manager Inputs

County Data Manager Tab	Data Source
Source Type Population	WisDOT DMV and MOVES4 Defaults[a]
Age Distribution	MOVES4 Defaults
Fuel	MOVES4 Defaults
Meteorology Data	Wisconsin Department of Natural Resources
Vehicle Type VMT and Time Distributions	Study corridor-specific Data and MOVES4 Defaults[b]
Average Speed Distribution	Study corridor -specific Data
Road Type Distribution	Study corridor-specific Data

Notes:

[a] MOVES4 defaults were used to project the DMV data to future years and classify the DMV data into MOVES4 source types.

[b] MOVES4 defaults were used to split vehicle categories into MOVES4 source types.

DMV = Department of Motor Vehicles

The quantitative MSAT analysis estimated the annual emissions of the priority MSATs for each of the scenarios. The daily VMT of each modeled scenario as well as the total VMT (inclusive of both the Affected Roadways in Dane County and Affected Roadways in Other Counties) is summarized in Table 2-4. Approximately 59% and 61% of the VMT in the study areas are in Dane County in 2030 and 2060, respectively. In general, VMT of the No-Build Alternative and build alternatives for analysis years 2030 and 2060 is higher than that of the Existing Condition in 2023 based on regional growth. The build alternatives would have higher VMT compared to the No-Build Alternative on affected roadways in Dane County (by 1.7% in 2030 and 3.9% to 4.1% in 2060) and in the other counties (by 0.3% in 2030 and 3.8% in 2060).

Table 2-4: Affected Roadways Daily VMT Information (miles/day)

Scenarios	Dane County	Other Counties	Total
2023	3,038,897	2,155,341	5,194,238
2030 No-Build	3,273,163	2,308,057	5,581,220
2030 Build - GP Lane	3,329,251	2,315,426	5,644,677
2030 Build - Hybrid	3,328,045	2,315,426	5,643,471
2060 No-Build	4,274,487	2,689,339	6,963,826
2060 Build - GP Lane	4,451,123	2,792,385	7,243,508
2060 Build - Hybrid	4,440,927	2,792,385	7,233,312
2030 % Increase Build - GP Lane vs No Build	1.7%	0.3%	1.1%
2030 % Increase Build - Hybrid vs No Build	1.7%	0.3%	1.1%
2060 % Increase Build - GP Lane vs No Build	4.1%	3.8%	4.0%
2060 % Increase Build - Hybrid vs No Build	3.9%	3.8%	3.9%

2.3. MSAT Analysis Results

In general, analysis results show that MSAT emissions are the highest in 2023 (Existing Condition) and lowest for the 2060 analysis year. This contrasts with the trend of VMT, where VMT is the highest in 2060 and lowest in 2023.

MSAT emissions of the two build alternatives are the same due to the minimal differences of the VMT between these two alternatives. When compared with existing conditions, the total MSAT emissions of the No-Build Alternative and build alternatives in 2030 are approximately 61% to 63% lower than the emissions in 2023, respectively. Total MSAT emissions of the No Build Alternative and build alternatives in 2060 are approximately 82% to 89% lower than the emissions in 2023, respectively. This trend is consistent with the FHWA finding that annual MSAT emissions are projected to decrease by 76% (Figure 1-1) between 2020 and 2060, even with VMT increases (FHWA 2023a).

While the build alternatives would have slightly higher MSAT emissions than the No-Build Alternative in future years, the emissions are not substantially different. In 2030, total MSAT emissions from the build alternatives are similar to the No-Build Alternative (0.8% difference) when most of the study corridor construction has not been completed and only limited segments are improved. In the 2060 design year, total MSAT emissions from the build alternatives in the study areas would be 4.4% higher than the No-Build Alternative, consistent with the trend of higher VMT under the build alternatives. Diesel PM emissions would have higher increases than other MSATs because diesel PM emissions tend to be higher at higher speeds such as 60 to 70 mph. As the improvements increase the vehicle speeds after the buildout, the diesel PM emissions increase more than other MSATs because more vehicles are traveling at higher speeds.

In summary, the localized level of MSAT emissions for the build alternatives would be higher than the No-Build Alternative in the study area. This effect could be offset by congestion relief and reductions in traffic delays (which are associated with less MSAT emissions). MSAT emissions may be higher at some locations based on roadway expansion, but they would be lower in other locations when traffic shifts away from them. On a regional basis, EPA's vehicle and fuel regulations, coupled with fleet turnover, is expected to cause substantial reductions over time that, in almost all cases, will cause region-wide and corresponding localized MSAT levels to be significantly lower than today.

Figure 2-1 to Figure 2-3 and Table 2-5 to Table 2-7 present MSAT emissions for the twelve scenarios analyzed.

Figure 2-1: Annual MSAT Emissions – Affected Roadways in Dane County

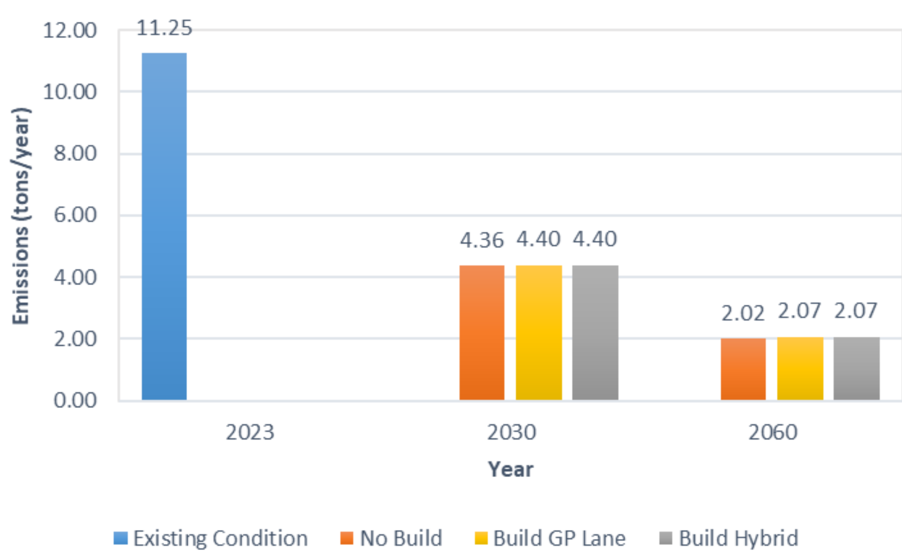


Figure 2-2: Annual MSAT Emissions – Affected Roadways in Other Counties

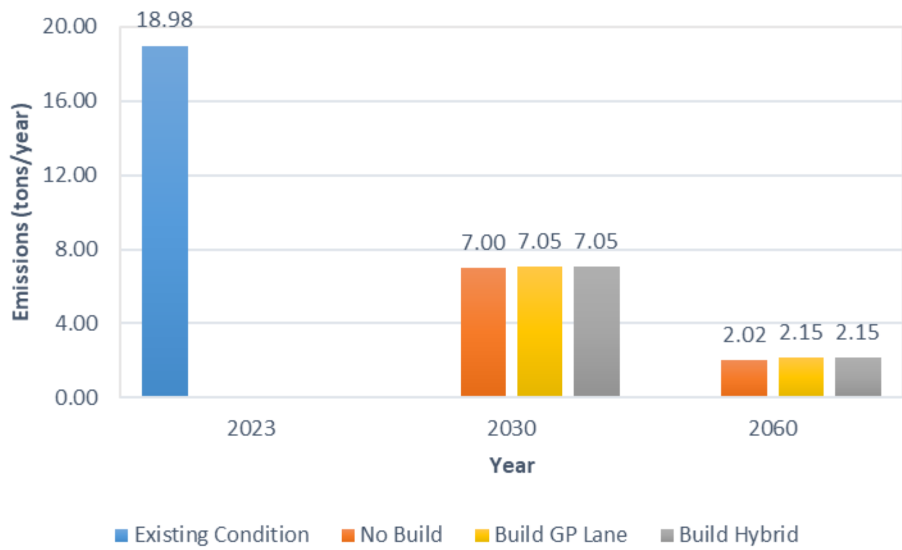


Figure 2-3: Total Annual MSAT Emissions – Entire Study Area

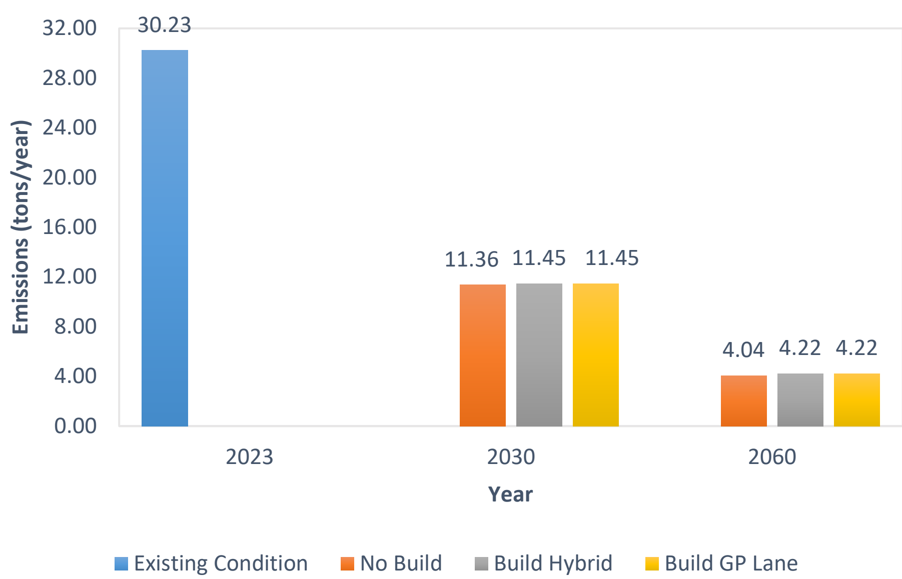


Table 2-5: Comparisons of MSAT Emissions

	Emissions (tons/year)																				
	Affected Roadways in Dane County							Affected Roadways in Other Counties							Total						
	2023	2030			2060			2023	2030			2060			2023	2030			2060		
Pollutant	**EC**	**NB**	**B GP Lane**	**B Hybrid**	**NB**	**B GP Lane**	**B Hybrid**	**EC**	**NB**	**B GP Lane**	**B Hybrid**	**NB**	**B GP Lane**	**B Hybrid**	**EC**	**NB**	**B GP Lane**	**B Hybrid**	**NB**	**B GP Lane**	**B Hybrid**
1,3-Butadiene	0.15	0.02	0.02	0.02	0.00	0.00	0.00	0.11	0.02	0.02	0.02	0.00	0.00	0.00	0.26	0.04	0.04	0.04	0.00	0.00	0.00
Acetaldehyde	0.89	0.35	0.36	0.36	0.23	0.23	0.23	1.19	0.55	0.56	0.56	0.31	0.32	0.32	2.08	0.91	0.91	0.91	0.54	0.55	0.55
Acrolein	0.09	0.04	0.04	0.04	0.01	0.01	0.01	0.14	0.06	0.06	0.06	0.01	0.01	0.01	0.23	0.09	0.09	0.09	0.03	0.03	0.03
Benzene	1.85	0.82	0.83	0.83	0.63	0.65	0.65	1.12	0.50	0.50	0.50	0.30	0.31	0.31	2.97	1.32	1.33	1.33	0.93	0.95	0.95
Diesel PM	5.45	1.85	1.87	1.87	0.33	0.34	0.34	13.44	4.59	4.63	4.63	0.78	0.88	0.88	18.89	6.45	6.50	6.50	1.11	1.22	1.22
Ethylbenzene	1.14	0.59	0.59	0.59	0.44	0.45	0.45	0.71	0.37	0.37	0.37	0.23	0.24	0.24	1.85	0.95	0.96	0.96	0.68	0.69	0.69
Formaldehyde	1.45	0.60	0.61	0.61	0.34	0.35	0.35	1.98	0.82	0.82	0.82	0.36	0.37	0.37	3.42	1.42	1.43	1.43	0.71	0.72	0.72
Naphthalene	0.17	0.06	0.06	0.06	0.03	0.03	0.03	0.19	0.07	0.07	0.07	0.01	0.01	0.01	0.36	0.12	0.13	0.13	0.04	0.04	0.04
POM	0.07	0.03	0.03	0.03	0.01	0.01	0.01	0.09	0.03	0.03	0.03	0.01	0.01	0.01	0.16	0.05	0.06	0.06	0.02	0.02	0.02
Total	11.25	4.36	4.40	4.40	2.02	2.07	2.07	18.98	7.00	7.05	7.05	2.02	2.15	2.15	30.23	11.36	11.45	11.45	4.04	4.22	4.22

Notes:

B GP Lane = Build Modernization Plus Added General Purpose Lane alternative

B Hybrid = Build Modernization Hybrid alternative

EC = Existing Condition

NB = No-Build

Table 2-6: Comparisons of MSAT Emissions Changes to Existing Condition (Percent Difference)

	Affected Roadways in Dane County						Affected Roadways in Other Counties						Total					
	2030			2060			2030			2060			2030			2060		
Pollutant	**NB**	**B GP Lane**	**B Hybrid**	**NB**	**B GP Lane**	**B Hybrid**	**NB**	**B GP Lane**	**B Hybrid**	**NB**	**B GP Lane**	**B Hybrid**	**NB**	**B GP Lane**	**B Hybrid**	**NB**	**B GP Lane**	**B Hybrid**
1,3-Butadiene	-87%	-87%	-87%	-100%	-100%	-100%	-83%	-83%	-83%	-100%	-100%	-100%	-85%	-85%	-85%	-100%	-100%	-100%
Acetaldehyde	-60%	-60%	-60%	-75%	-74%	-74%	-53%	-53%	-53%	-74%	-73%	-73%	-56%	-56%	-56%	-74%	-73%	-73%
Acrolein	-61%	-61%	-61%	-85%	-85%	-85%	-61%	-61%	-61%	-91%	-90%	-90%	-61%	-61%	-61%	-89%	-88%	-88%
Benzene	-55%	-55%	-55%	-66%	-65%	-65%	-56%	-56%	-56%	-73%	-73%	-73%	-55%	-55%	-55%	-69%	-68%	-68%
Diesel PM	-66%	-66%	-66%	-94%	-94%	-94%	-66%	-66%	-66%	-94%	-93%	-93%	-66%	-66%	-66%	-94%	-94%	-94%
Ethylbenzene	-49%	-48%	-48%	-61%	-60%	-60%	-48%	-48%	-48%	-67%	-66%	-66%	-49%	-48%	-48%	-64%	-63%	-63%
Formaldehyde	-58%	-58%	-58%	-76%	-76%	-76%	-59%	-58%	-58%	-82%	-81%	-81%	-58%	-58%	-58%	-79%	-79%	-79%
Naphthalene	-64%	-64%	-64%	-84%	-84%	-84%	-66%	-66%	-66%	-93%	-93%	-93%	-65%	-65%	-65%	-89%	-89%	-89%
POM	-63%	-63%	-63%	-85%	-84%	-84%	-67%	-67%	-67%	-93%	-93%	-93%	-65%	-65%	-65%	-90%	-89%	-89%
Total	-61%	-61%	-61%	-82%	-82%	-82%	-63%	-63%	-63%	-89%	-89%	-89%	-62%	-62%	-62%	-87%	-86%	-86%

Notes:

B GP Lane = Build Modernization Plus Added General Purpose Lane alternative

B Hybrid = Build Modernization Hybrid alternative

NB = No-Build

Table 2-7: Comparison of MSAT Emissions Changes to No-Build Alternative (Percent Difference)

	Affected Roadways in Dane County				Affected Roadways in Other Counties				Total			
	2030	2030	2060	2060	2030	2030	2060	2060	2030	2030	2060	2060
	B GP Lane	B Hybrid	B GP Lane	B Hybrid	B GP Lane	B Hybrid	B GP Lane	B Hybrid	B GP Lane	B Hybrid	B GP Lane	B Hybrid
Pollutant	**Increase %**	**Increase %**	**Increase %**	**Increase %**	**Increase %**	**Increase %**	**Increase %**	**Increase %**	**Increase %**	**Increase %**	**Increase %**	**Increase %**
1,3-Butadiene	1.0%	1.0%	0.0%	0.0%	0.1%	0.1%	0.0%	0.0%	0.6%	0.6%	0.0%	0.0%
Acetaldehyde	0.8%	0.8%	1.5%	1.4%	0.7%	0.7%	4.0%	4.0%	0.7%	0.7%	3.0%	2.9%
Acrolein	0.9%	0.9%	2.2%	2.0%	0.6%	0.6%	12.5%	12.5%	0.8%	0.7%	7.2%	7.1%
Benzene	1.1%	1.0%	3.0%	2.8%	-0.1%	-0.1%	2.3%	2.3%	0.6%	0.6%	2.8%	2.6%
Diesel PM	0.9%	0.9%	2.4%	2.2%	0.9%	0.9%	12.5%	12.5%	0.9%	0.9%	9.5%	9.4%
Ethyl Benzene	0.9%	0.8%	2.3%	2.1%	-0.2%	-0.2%	1.8%	1.8%	0.5%	0.4%	2.1%	2.0%
Formaldehyde	1.0%	0.9%	2.1%	1.9%	0.5%	0.5%	1.8%	1.8%	0.7%	0.7%	2.0%	1.9%
Naphthalene	1.1%	1.0%	3.0%	2.8%	0.3%	0.3%	4.3%	4.3%	0.7%	0.7%	3.4%	3.3%
POM	1.1%	1.1%	3.2%	3.0%	0.4%	0.4%	5.1%	5.1%	0.7%	0.7%	3.9%	3.7%
Total	0.9%	0.9%	2.4%	2.2%	0.7%	0.7%	6.5%	6.5%	0.8%	0.8%	4.4%	4.3%

Notes:

B GP Lane = Build Modernization Plus Added General Purpose Lane alternative

B Hybrid = Build Modernization Hybrid alternative

3. Incomplete or Unavailable Information for Project-Specific MSAT Health Impacts Analysis

This MSAT analysis is a basic analysis of the likely MSAT impacts of the study corridor. Because of the limitations of information and methodology of the analysis, the following discussion is included in accordance with Council on Environmental Quality regulations regarding incomplete or unavailable information (40 CFR 1502.22[b]). The discussion regarding the limitations of the MSAT analysis is taken from Appendix C of the *Updated Interim Guidance on Mobile Source Air Toxic Analysis in NEPA Documents* (FHWA 2023a).

In FHWA's view, information is incomplete or unavailable to credibly predict the project-specific health impacts due to changes in MSAT emissions associated with a proposed set of highway alternatives. The outcome of such an assessment, adverse or not, would be influenced more by the uncertainty introduced into the process through assumption and speculation rather than any genuine insight into the actual health impacts directly attributable to MSAT exposure associated with a proposed action.

EPA is responsible for protecting public health and welfare from any known or anticipated effects of an air pollutant. EPA is the lead authority for administering the CAA and its amendments and has specific statutory obligations with respect to hazardous air pollutants and MSATs. EPA is continually assessing human health effects, exposures and risks posed by air pollutants. It maintains IRIS, which is "a compilation of electronic reports on specific substances found in the environment and their potential to cause human health effects." (EPA 2024) Each report provides assessments of noncancerous and cancerous effects for individual compounds and quantitative estimates of risk levels from lifetime oral and inhalation exposures with uncertainty spanning perhaps an order of magnitude.

Other organizations are also active in the research and analyses of the human health effects of MSATs, including HEI. Numerous HEI studies are summarized in Appendix D of FHWA's *Updated Interim Guidance on Mobile Source Air Toxic Analysis in NEPA Documents* (FHWA 2023a). Among the adverse health effects linked to MSAT compounds at high exposures are cancer in humans in occupational settings, cancer in animals and irritation to the respiratory tract, including the exacerbation of asthma. Less obvious is the adverse human health effects of MSAT compounds at current environmental concentrations (HEI 2007) or in the future as vehicle emissions substantially decrease.

The methodologies for forecasting the impacts include emissions modeling, dispersion modeling, exposure modeling and then the final determination of health impacts, with each step in the process building on the model predictions obtained in the previous step. All are encumbered by technical shortcomings or uncertain science that prevents a more complete differentiation of the MSAT health impacts among a set of project alternatives. These difficulties are magnified for lifetime (i.e., 70-year) assessments, particularly because unsupportable assumptions would have to be made regarding changes in travel patterns and vehicle technology (which affect emissions rates) over that time frame, because such information is unavailable.

It is particularly difficult to forecast 70-year lifetime MSAT concentrations and exposure near roadways reliably, to determine the portion of time that people are actually exposed at a specific location, and to establish the extent of exposure attributable to a specific proposed action, especially given that some of the information needed is unavailable.

There are considerable uncertainties associated with the existing estimates of toxicity of the various MSATs because of factors such as low-dose extrapolation and translation of occupational exposure data to the general population, a concern expressed by HEI (HEI 2007). As a result, there is no national consensus on air dose-response values assumed to protect the public health and welfare for MSAT compounds, and in particular for diesel PM. EPA states that with respect to diesel engine exhaust, "[t]he absence of adequate data to develop a sufficiently confident dose-response relationship from the epidemiologic studies has prevented the estimation of inhalation carcinogenic risk." (EPA 2003)

There is also a lack of national consensus on an acceptable level of risk. The current context is the process used by EPA as provided by the CAA to determine whether more stringent controls are required to provide an ample margin of safety to protect public health or to prevent an adverse environmental effect for industrial sources subject to the maximum achievable control technology standards, such as benzene emissions from refineries. The decision framework is a two-step process. The first step requires EPA to determine an "acceptable" level of risk due to emissions from a source, which is generally no greater than approximately 100 in a million. Additional factors are considered in the second step, the goal of which is to maximize the number of people with risks less than one in a million due to emissions from a source. The results of this statutory two-step process do not guarantee that cancer risks from exposure to air toxics are less than one in a million; in some cases, the residual risk determination could result in maximum individual cancer risks that are as high as approximately 100 in a million. In a June 2008 decision, the U.S. Court of Appeals for the District of Columbia Circuit upheld EPA's approach to addressing risk in its two-step decision framework. Information is incomplete or unavailable to establish that even the largest highway projects would result in levels of risk greater than deemed acceptable.

Because of the limitations in the methodologies for forecasting health impacts described, any predicted difference in health impacts between alternatives is likely to be much smaller than the uncertainties associated with predicting the impacts. Consequently, the results of such assessments would not be useful to decision makers, who would need to weigh this information against project benefits such as reducing traffic delays and improving travel times, crash rates and fatalities plus improved access for emergency response, which are better suited for quantitative analysis.

4. References

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Appendix A

Study Corridor AADT Data

Projected AADT - Project South Segments

	2050 No Build	2050 Build Alternative(s)
I-39/90/94		
North of CTH V	67,800	71,500
Between CTH V & WIS 19	75,300	78,400
Between WIS 19 & US 51	89,100	96,400
Between US 51 & Hoepker	93,900	108,400
Between Hoepker & US151	93,900	110,500
Between High Crossing & Badger (includes C-D roads in Build)	141,700	162,300
Between Badger & BIC	126,700	134,700
South of BIC	62,800	64,800
US151		
Between Spring Dr & 399094	59,900	49,300
Between 399094 & American Pkwy (includes C-D roads in Build)	102,900	112,600
WIS30		
Between 399094 & Thompson	49,700	59,200
Between Thompson & US 51	65,200	73,000
I94		
Between 3990 & Milwaukee	70,300	84,400
Between Milwaukee & CTH N	70,300	68,900
East of CTH N	56,200	56,400

Projected AADT - Project North Segments

Segment	2050 No Build	2050 Build Alternative(s)
I-39/90/94		
WIS 60 to CTH CS	63,400	68,310
CTH CS to I-39	64,370	69,100
I-39 to WIS 33	43,830	48,300
WIS 33 to US 12	46,450	51,200
US 12 to WIS 23	49,100	54,850
WIS 23 to WIS 13	50,260	52,470
WIS 13 to US 12	44,780	46,310
I-39		
North of CTH U	24,150	24,780
CTY U to I-39/90/94	23,440	23,950

Appendix B

Technical Memorandum: I-39/90/94 Study – MSAT Analysis Impacted Links Methodology and VMT/VHT Results

I-39/90/94 Study – MSAT Analysis Impacted Links Methodology and VMT/VHT Results

Date:	June 3, 2024
Topic:	Methodology to Select Impacted Links for Inclusion in MSAT Quantitative Analysis with VMT/VHT Results
From:	CDMCT

Introduction

This technical memorandum presents the methodology for selecting roadway segments for inclusion in Mobile Source Air Toxics (MSAT) analysis as part of the environmental documentation of the Interstate 39/90/94 Corridor Study. The MSAT analysis will be quantitative in nature using the Motor Vehicle Emissions Simulator (MOVES) model.

The Interstate 39/90/94 Corridor consists of 67 miles of Instate facility in Columbia, Dane, Juneau and Sauk counties in south-central Wisconsin. The project includes the Interstate facility from north of the US 12 (Beltline) interchange in Dane County to north of the US 12/WIS 16 interchange in Juneau County, along with short segments of I-39 north of I-90/94 in Columbia County and I-94 east of I-39/90 in Dane County.

FHWA Recommendations for Determining Affected Network

The Federal Highway Administration (FHWA) provides recommendations for conducting MSAT analysis. https://www.fhwa.dot.gov/environment/air_quality/air_toxics/policy_and_guidance/msat/fhwa_nepa_msat_faq_moves3_.pdf

Question 2 in the recommendations document addresses how to define the affected environment:

> *"NEPA documentation should focus on the impacts of the proposed project on the affected environment. Traffic analysis normally performed for NEPA (purpose and need, scope, design, etc.) should be the basis of the MSAT analysis and defining the affected environment. MSAT analyses are intended to capture the anticipated changes in emissions within an affected environment, defined as the transportation network directly affected by the project. Analyzing MSATs only within a geographically-defined "study area" will not capture the emissions effects of changes in traffic on roadways outside of that area, which is particularly important where the proposed project would create an alternative route or divert traffic from one roadway class to another. At the other extreme, analyzing a metropolitan area's entire roadway network will result in emissions estimates for many roadway links not affected by the project, diluting the results of the analysis.*

The FHWA recommends analyzing all segments associated with the project, plus those segments expecting meaningful changes in emissions due to the project (e.g., ± 10 percent or more). Define the affected network based on available project-specific information in the environmental document's traffic analysis, considering changes in such metrics as:

- *± 5 percent or more in annual average daily traffic (AADT) on congested highway links of level of service (LOS) D or worse;*

- *± 10 percent or more in AADT on uncongested highway links of LOS C or better;*
- *± 10 percent or more in travel time; or*
- *± 10 percent or more in intersection delay.*

These recommendations are not a substitute for project-specific knowledge and consideration of local circumstances. For example, if traffic modeling shows that some low-volume links far removed from the project area show a meaningful change in traffic, one would have to consider whether this is a real effect, or a modeling artifact. Likewise, when analyzing a project that has no meaningful alternative routes (e.g., upgrading an isolated river crossing), it may not be necessary to evaluate traffic changes on other routes. Any such deviation from these recommendations should include documentation in the project file explaining what segments were included or excluded from the affected area and why."

Defining the Affected Environment for the I-39/90/94 Corridor Study MSAT Analysis

Traffic forecasts for the I-39/90/94 Corridor Study have been developed using the travel demand models of record for the respective geographies. The Wisconsin statewide travel demand model (STDM) is a daily travel demand model which covers the entire state of Wisconsin including the limits of the I-39/90/94 Corridor Study. As there is no metropolitan planning organization or regional planning commission model for Columbia, Juneau or Sauk counties, the STDM, which is maintained by Wisconsin Department of Transportation (WisDOT) is used as the model of record for these three counties.

The Dane County travel demand model (DCTDM) covers Dane County including a portion of the I-39/90/94 Corridor study limits. The DCTDM is maintained by the Greater Madison Metropolitan Planning Organization in conjunction with WisDOT. The DCTDM is a more robust model compared to the STDM, including four peak periods (in lieu of one 24-hour model timeframe), transit and non-motorized travel.

The EIS document discusses two build alternatives for the Dane County area between US 12/18 and WIS 19 including Modernization Plus Added General-Purpose Lane and Modernization Hybrid. The Modernization Hybrid employs a managed shoulder lane which would be opened for active traffic use when traffic demands warrant its use. The DCTDM was run with both concepts with only minor changes in daily traffic volumes and vehicle miles traveled (VMT) predicted, almost entirely in the midday period (9 AM to 3 PM). The largest volume difference on a specific roadway segment was 565 daily vehicles, with 561 in the midday period. VMT differed by 0.12% between the two modeled concepts. These modeled differences are conservative as the hybrid lane could be opened during portions of the midday to accommodate traffic demands however the DCTDM can only assume the lane is either open or closed throughout the duration of the period. Traffic forecasts have used the traffic demands from the Modernization Plus Added General-Purpose Lane.

Within both the DCTDM and STDM, the links within the immediate limits of the project (Interstate links and the interchanges) were flagged for inclusion within the MSAT analysis.

Both the DCTDM and STDM include a post-processing application that calculates a level of service (LOS) based on the assigned traffic volume and a number of roadway attributes including number of lanes, functional classification, median type and area type. The LOS should be considered a planning-level as no specific Highway Capacity Manual level of analysis was conducted for this effort. This planning-level LOS provides a consistent estimate of LOS for every roadway segment included within either of the two travel demand models.

The LOS process was conducted using 2050 traffic assignments for both the DCTDM and STDM models. 2050 is the only year that housing and employment data was projected for the STDM and is the year that both the STDM and DCTDM were executed for developing traffic forecasts for the I-39/90/94 Corridor Study. Therefore, the most accurate comparison of impacts was deemed to occur using the 2050 traffic model outputs. The No Build and Build model assignment outputs were compared based on the FHWA guidance noted above, with the planning-level LOS used along with the difference in model traffic assignments (in lieu of forecasted average annual daily traffic which would require an observed traffic count on every model link) to determine each model link's inclusion for the following two criteria:

- *± 5 percent or more in annual average daily traffic (AADT) on congested highway links of level of service (LOS) D or worse;*
- *± 10 percent or more in AADT on uncongested highway links of LOS C or better;*

Link-specific congested travel times were directly output from the STDM. Daily average congested travel times were calculated from the DCTDM by summarizing total daily vehicle hours traveled across the various model time periods and dividing by the total daily vehicle miles traveled across those same model time periods. This data was used to determine each model link's inclusion for the following criteria:

- *± 10 percent or more in travel time;*

The final criteria noted by FHWA uses intersection delay to determine inclusion into the analysis. This criteria was not accommodated as neither the STDM nor DCTDM generate intersection delays as outputs of their modeling process. Given the size of the potential affected area beyond the geographic limits of the corridor, the estimation of the data to evaluate links by this criteria is not reasonable.

Resulting Affected Links for MSAT Analysis

All roadways within the I-39/90/94 corridor study limits were flagged for inclusion. Figure 1ow shows the limits of the study in orange overlaid on the DCTDM network.

Figure 1: Dane County Travel Demand Model Network

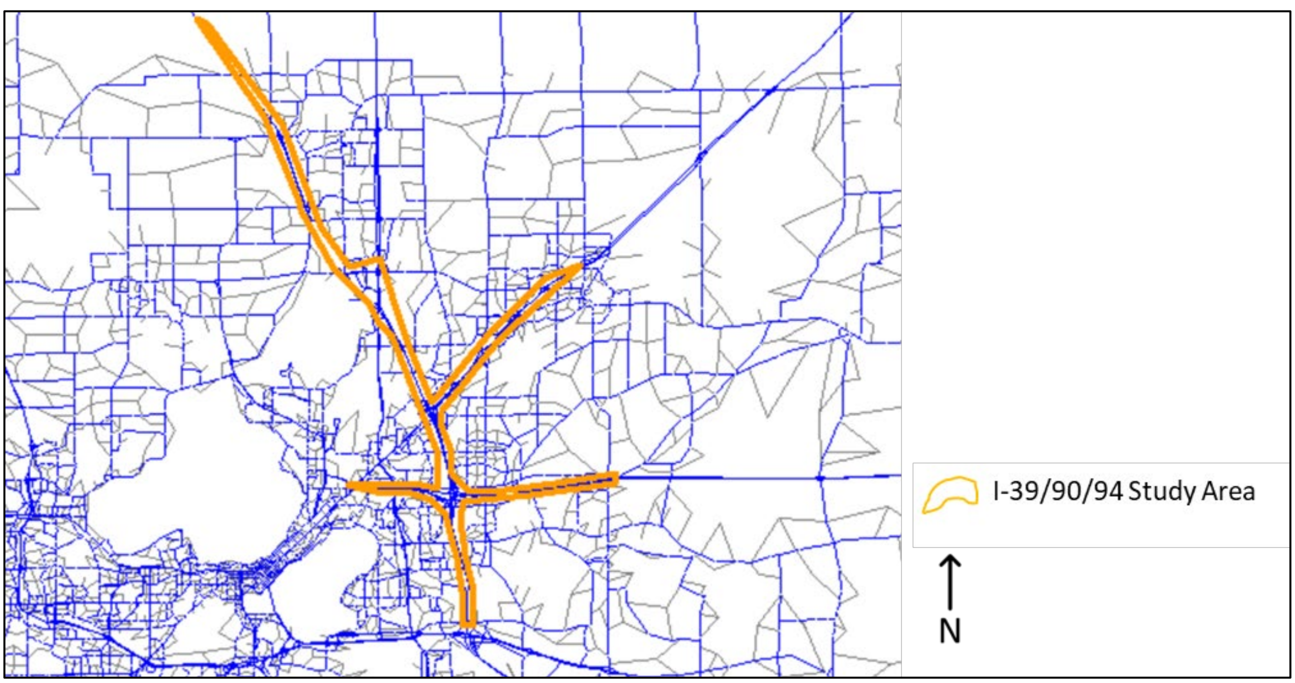
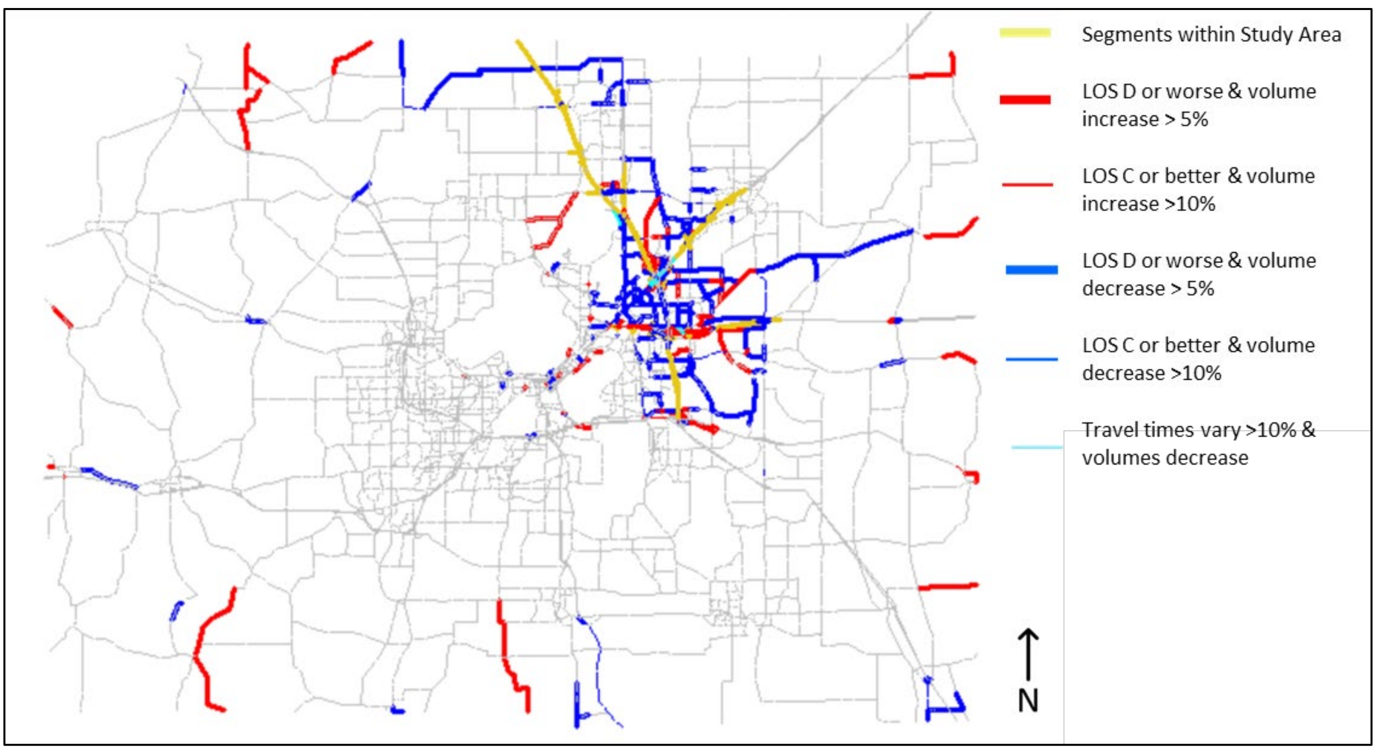


Figure 2 shows the links that met one of the criteria to be included in the MSAT analysis for Dane County.

- Yellow links are within the immediate study area.
- Thick red links have LOS D or worse in the Build model and have travel demand model estimated traffic volume assignments more than five percent higher than the No Build model.
- Thin red links have LOS C or better in the Build model and have travel demand model estimated traffic volume assignments more than ten percent higher than the No Build model.
- Thick blue links have LOS D or worse in the Build model and have travel demand model estimated traffic volume assignments more than five percent lower than the No Build model.
- Thin blue links have LOS C or better in the Build model and have travel demand model estimated traffic volume assignments more than ten percent lower than the No Build model.
- There were no instances in the DCTDM where links have model-estimated travel times that vary by more than 10 percent compared to the No Build model and Build assignments are higher than No Build assignments.
- Aqua blue links have travel demand model-estimated travel times that vary by more than 10 percent compared to the No Build model and Build assignments are lower than No Build assignments.

Figure 2: Segments that Meet Criteria for Inclusion in MSAT Analysis in Dane County



The FHWA guidance on determining affected links does allow for judgement on including links that appear to be significantly far from the study area and are flagged as an artifact of the travel demand model. Given the manageable size of the DCTDM, all flagged links within the limits of the DCTDM were determined to be included for MSAT analysis.

The determination of affected links for Columbia, Juneau and Sauk counties used the STDM. The same criteria were used for the STDM as were done for DCTDM. All links within Dane County were omitted from consideration by the STDM to avoid double-counting. Figure 4 shows Columbia, Juneau and Sauk counties limits of the I-39/90/94 Corridor Study in orange overlaid within the STDM network. Note the black links representing Dane County.

Figure 4: Statewide Travel Demand Model and Columbia, Sauk, and Juneau Counties Study Area

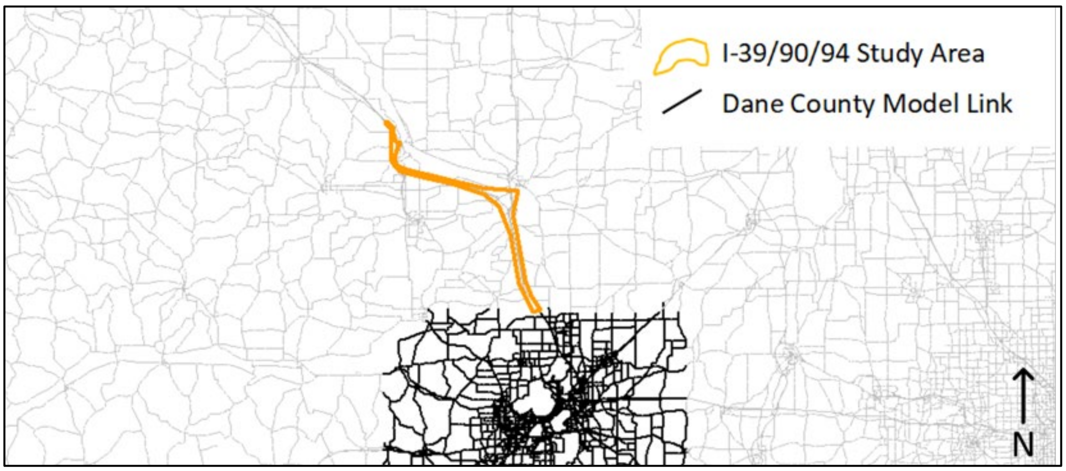


Figure 5 shows the links that met one of the criteria to be included in the MSAT analysis for Columbia, Juneau and Sauk counties or beyond.

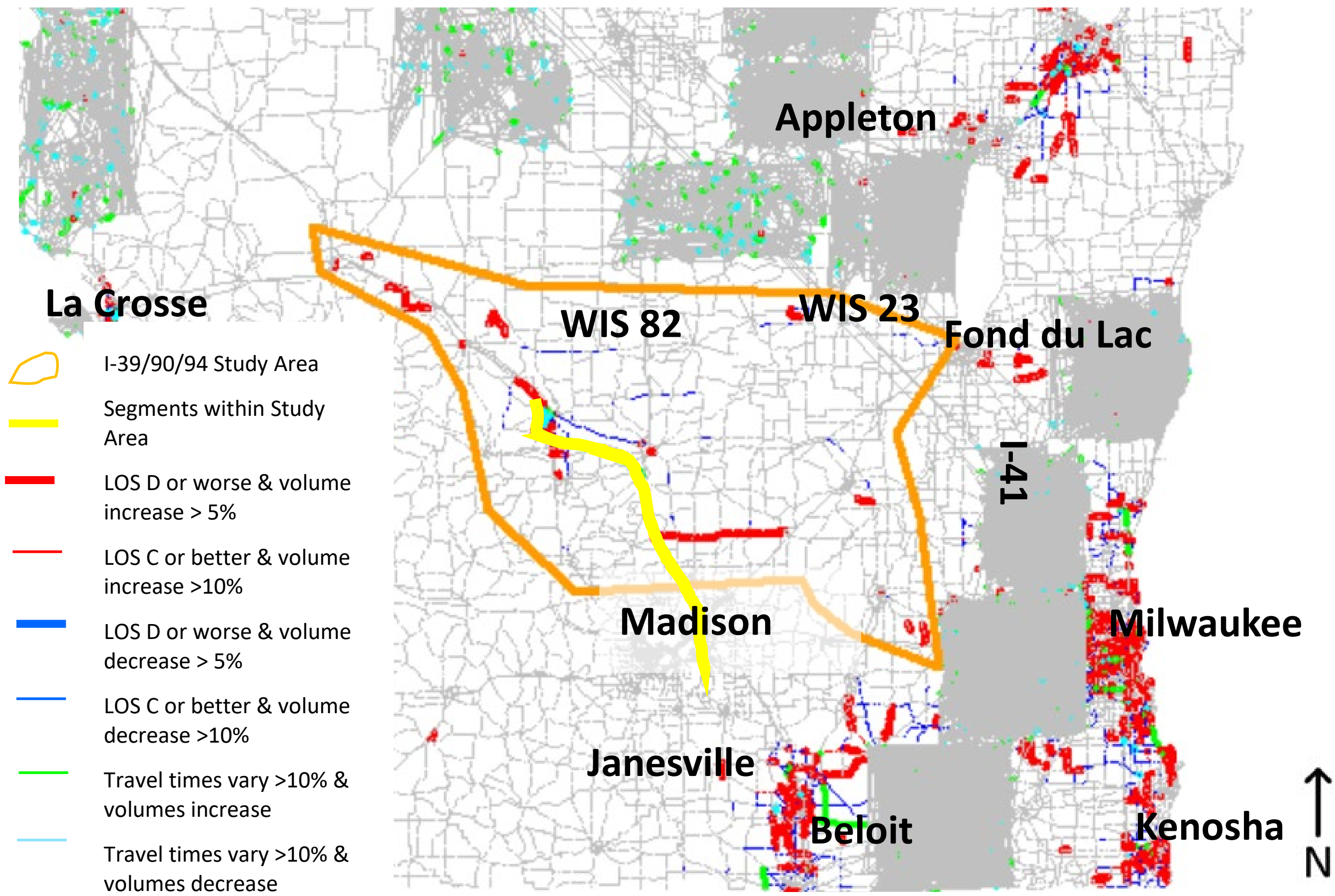
- Yellow links are within the immediate study area.
- Thick red links have LOS D or worse in the Build model and have travel demand model estimated traffic volume assignments more than five percent higher than the No Build model.
- Thin red links have LOS C or better in the Build model and have travel demand model estimated traffic volume assignments more than ten percent higher than the No Build model.
- Thick blue links have LOS D or worse in the Build model and have travel demand model estimated traffic volume assignments more than five percent lower than the No Build model.
- Thin blue links have LOS C or better in the Build model and have travel demand model estimated traffic volume assignments more than ten percent lower than the No Build model.
- Green links have travel demand model-estimated travel times that vary by more than 10 percent compared to the No Build model and Build assignments are higher than No Build assignments.
- Aqua blue links have travel demand model-estimated travel times that vary by more than 10 percent compared to the No Build model and Build assignments are lower than No Build assignments

Note the orange boundary excludes the links within Dane County but does include roadways east of Dane County.

The impacts generally extend north to WIS 82 and WIS 23 which connect Mauston and Fond du Lac. This is a logical northern boundary given Mauston's location north of the limits of the proposed expansion of I-90/94 and Fond du Lac's location along I-41.

The major metropolitan areas of Milwaukee, Appleton, La Crosse, Janesville and Beloit all show many links that meet the criteria noted above. The exact location in the area between Madison, Janesville, Beloit and Milwaukee where the impacts are truly a product of the I-39/90/94 corridor study improvements versus being an artifact of using a statewide model is not clear. FHWA's guidance notes the potential of travel demand models to produce results indicating "[when] *links far removed from the project area show a meaningful change in traffic, one would have to consider whether this is a real effect, or a modeling artifact"* It would seem illogical that roadways within distant metro areas 30 or more miles away from the project such as Janesville would be influenced by the changes within the project when the major roadways connecting these distant metro areas to the project (I-39/90 in this case) are not themselves flagged as being impacted by the project.

Figure 5: Segments that Meet Criteria for Inclusion in MSAT Analysis in Columbia, Sauk, and Juneau Counties



Travel Demand Model Outputs for MSAT Analysis using MOVES

Analysis years were established based on MSAT analysis needs. The year of the environmental document's notice of intent is commonly deemed the base year for MSAT analysis, in this case 2023. The beginning of construction is commonly analysis year and is anticipated for 2030. Due to the magnitude of the project, construction is anticipated to last for 10 years. The final analysis year is commonly 20 year after construction, in this case year 2060. These MSAT analysis years (2023, 2030 and 2060) were developed by interpolating between model base year (2016 for DCTDM and 2017 for STDM) and the 2050 horizon year trip tables. These additional MSAT analysis trip tables were then assigned to the 2050 no build and build networks. The values of traffic volume, traffic travel time and their surrogates of vehicle miles traveled (VMT) and vehicle hours traveled (VHT) are then summed for all links deemed to be included in the analysis as described previously. A link that is deemed to be included based on 2050 model results is then included in the summation of VMT and VHT for all analysis years (2023, 2030 and 2060).

Travel demand model generated VMT and VHT is first sub-aggregated based on the following criteria:

- Rural Restricted Access
- Urban Restricted Access
- Rural Unrestricted Access
- Urban Unrestricted Access

The average daily congested speed is then used to sub-divide the demand model generated VMT and VHT. The VMT and VHT is reported within 5 mile per hour bins, such as 0-5 mph, 5-10 mph and so on through 60-65 mph and 65+ mph. The data is finally sub-divided into automobile and truck values to be incorporated into the MOVES modeling for the MSAT analysis.

VMT/VHT Summary

Tables below show the total 2060 VMT for Dane and the Statewide model areas respectively. Note the total vehicles miles traveled increases from the no build to the Modernization Plus Added General-Purpose Lanes (build) condition by four percent for the Dane affected links and just over one percent for the statewide model area affected links.

Dane

2060			
TOTAL	No Build	Build (Added GP Lane)	
Speed Range			
(mph)	VMT	VMT	Delta
0-5	10	9	-1
5-10	180	172	-9
10-15	608	579	-29
15-20	2,524	2,566	42
20-25	22,943	18,591	-4,352
25-30	86,780	92,774	5,994
30-35	348,800	304,360	-44,440
35-40	550,827	537,953	-12,874
40-45	174,329	156,244	-18,085
45-50	420,115	314,813	-105,302
50-55	140,656	232,795	92,139
55-60	45,122	219,799	174,677
60-65	637,971	438,141	-199,829

65-70	1,843,622	2,132,328	288,705
	4,274,487	4,451,123	176,637

Statewide

2060			
TOTAL	No Build	Build	
Speed Range			
(mph)	VMT	VMT	Delta
0-5	0	0	0
5-10	0	0	0
10-15	0	0	0
15-20	0	0	0
20-25	202	203	1
25-30	19,651	18,126	-1,525
30-35	115,436	112,399	-3,037
35-40	80,708	89,571	8,864
40-45	230,985	222,194	-8,791
45-50	215,089	151,376	-63,713
50-55	150,741	136,164	-14,577
55-60	305,971	0	-305,971
60-65	1,201,571	0	-1,201,571
65-70	368,986	2,062,352	1,693,366
	2,689,339	2,792,385	103,045

Appendix C

VMT and Speed Bin Information of Affected Roadways

Project Specific Data Used in MOVES4 Modeling

County	Year	Scenario	Speed Range (mph)	Average Speed (mph)	Road Type	Auto Daily VMT	Truck Daily VMT
Dane	2023	EC	0-5	-	Urban Restricted	-	-
Dane	2023	EC	5-10	9.4	Urban Restricted	1	-
Dane	2023	EC	10-15	13.8	Urban Restricted	80	6
Dane	2023	EC	15-20	18.4	Urban Restricted	268	25
Dane	2023	EC	20-25	23.7	Urban Restricted	3831	623
Dane	2023	EC	25-30	29.3	Urban Restricted	35792	2798
Dane	2023	EC	30-35	33.8	Urban Restricted	2413	148
Dane	2023	EC	35-40	37.3	Urban Restricted	39307	3274
Dane	2023	EC	40-45	41.6	Urban Restricted	11470	627
Dane	2023	EC	45-50	-	Urban Restricted	-	-
Dane	2023	EC	50-55	52.3	Urban Restricted	192	25
Dane	2023	EC	55-60	-	Urban Restricted	-	-
Dane	2023	EC	60-65	65.0	Urban Restricted	321049	35469
Dane	2023	EC	65-70	69.9	Urban Restricted	1192458	142567
Dane	2023	EC	70-75	-	Urban Restricted	-	-
Dane	2023	EC	75-80	-	Urban Restricted	-	-
Dane	2023	EC	0-5	4.5	Urban Unrestricted	6	-
Dane	2023	EC	5-10	8.4	Urban Unrestricted	55	7
Dane	2023	EC	10-15	11.5	Urban Unrestricted	296	35
Dane	2023	EC	15-20	17.6	Urban Unrestricted	1123	105
Dane	2023	EC	20-25	23.3	Urban Unrestricted	4628	464
Dane	2023	EC	25-30	27.2	Urban Unrestricted	9964	1051
Dane	2023	EC	30-35	33.2	Urban Unrestricted	136674	12074
Dane	2023	EC	35-40	37.8	Urban Unrestricted	299483	23844
Dane	2023	EC	40-45	41.1	Urban Unrestricted	88339	6780
Dane	2023	EC	45-50	47.1	Urban Unrestricted	123745	13205
Dane	2023	EC	50-55	53.4	Urban Unrestricted	38939	4311
Dane	2023	EC	55-60	57.0	Urban Unrestricted	18963	2637
Dane	2023	EC	60-65	-	Urban Unrestricted	-	-
Dane	2023	EC	65-70	-	Urban Unrestricted	-	-
Dane	2023	EC	70-75	-	Urban Unrestricted	-	-
Dane	2023	EC	75-80	-	Urban Unrestricted	-	-
Dane	2023	EC	0-5	-	Rural Restricted	-	-
Dane	2023	EC	5-10	-	Rural Restricted	-	-
Dane	2023	EC	10-15	-	Rural Restricted	-	-
Dane	2023	EC	15-20	-	Rural Restricted	-	-
Dane	2023	EC	20-25	-	Rural Restricted	-	-
Dane	2023	EC	25-30	-	Rural Restricted	-	-
Dane	2023	EC	30-35	-	Rural Restricted	-	-
Dane	2023	EC	35-40	-	Rural Restricted	-	-
Dane	2023	EC	40-45	-	Rural Restricted	-	-
Dane	2023	EC	45-50	46.9	Rural Restricted	6092	959
Dane	2023	EC	50-55	53.7	Rural Restricted	70194	8529
Dane	2023	EC	55-60	-	Rural Restricted	-	-
Dane	2023	EC	60-65	-	Rural Restricted	-	-
Dane	2023	EC	65-70	70.0	Rural Restricted	175357	14672
Dane	2023	EC	70-75	-	Rural Restricted	-	-
Dane	2023	EC	75-80	-	Rural Restricted	-	-
Dane	2023	EC	0-5	-	Rural Unrestricted	-	-
Dane	2023	EC	5-10	-	Rural Unrestricted	-	-
Dane	2023	EC	10-15	-	Rural Unrestricted	-	-
Dane	2023	EC	15-20	-	Rural Unrestricted	-	-
Dane	2023	EC	20-25	20.7	Rural Unrestricted	39	2
Dane	2023	EC	25-30	-	Rural Unrestricted	-	-
Dane	2023	EC	30-35	-	Rural Unrestricted	-	-
Dane	2023	EC	35-40	39.8	Rural Unrestricted	11026	354
Dane	2023	EC	40-45	43.5	Rural Unrestricted	11477	622
Dane	2023	EC	45-50	49.0	Rural Unrestricted	94838	3547
Dane	2023	EC	50-55	52.1	Rural Unrestricted	58566	3473
Dane	2023	EC	55-60	-	Rural Unrestricted	-	-
Dane	2023	EC	60-65	-	Rural Unrestricted	-	-
Dane	2023	EC	65-70	-	Rural Unrestricted	-	-
Dane	2023	EC	70-75	-	Rural Unrestricted	-	-
Dane	2023	EC	75-80	-	Rural Unrestricted	-	-
Dane	2030	NB	0-5	-	Urban Restricted	-	-
Dane	2030	NB	5-10	9.4	Urban Restricted	1	-
Dane	2030	NB	10-15	13.8	Urban Restricted	87	7
Dane	2030	NB	15-20	17.9	Urban Restricted	298	30

County	Year	Scenario	Speed Range (mph)	Average Speed (mph)	Road Type	Auto Daily VMT	Truck Daily VMT
Dane	2030	NB	20-25	22.7	Urban Restricted	4302	705
Dane	2030	NB	25-30	29.1	Urban Restricted	38490	3193
Dane	2030	NB	30-35	33.9	Urban Restricted	4530	356
Dane	2030	NB	35-40	37.2	Urban Restricted	40638	3536
Dane	2030	NB	40-45	41.4	Urban Restricted	12354	739
Dane	2030	NB	45-50	-	Urban Restricted	-	-
Dane	2030	NB	50-55	52.3	Urban Restricted	204	27
Dane	2030	NB	55-60	-	Urban Restricted	-	-
Dane	2030	NB	60-65	64.9	Urban Restricted	342733	39110
Dane	2030	NB	65-70	69.7	Urban Restricted	1266001	155467
Dane	2030	NB	70-75	-	Urban Restricted	-	-
Dane	2030	NB	75-80	-	Urban Restricted	-	-
Dane	2030	NB	0-5	4.5	Urban Unrestricted	7	-
Dane	2030	NB	5-10	8.3	Urban Unrestricted	61	8
Dane	2030	NB	10-15	11.4	Urban Unrestricted	314	37
Dane	2030	NB	15-20	17.7	Urban Unrestricted	1441	134
Dane	2030	NB	20-25	23.4	Urban Unrestricted	5014	524
Dane	2030	NB	25-30	27.3	Urban Unrestricted	11729	1298
Dane	2030	NB	30-35	33.1	Urban Unrestricted	157826	14051
Dane	2030	NB	35-40	37.7	Urban Unrestricted	328452	27571
Dane	2030	NB	40-45	41.1	Urban Unrestricted	92281	7604
Dane	2030	NB	45-50	47.0	Urban Unrestricted	132897	14374
Dane	2030	NB	50-55	53.2	Urban Unrestricted	41108	4651
Dane	2030	NB	55-60	56.9	Urban Unrestricted	21129	3108
Dane	2030	NB	60-65	-	Urban Unrestricted	-	-
Dane	2030	NB	65-70	-	Urban Unrestricted	-	-
Dane	2030	NB	70-75	-	Urban Unrestricted	-	-
Dane	2030	NB	75-80	-	Urban Unrestricted	-	-
Dane	2030	NB	0-5	-	Rural Restricted	-	-
Dane	2030	NB	5-10	-	Rural Restricted	-	-
Dane	2030	NB	10-15	-	Rural Restricted	-	-
Dane	2030	NB	15-20	-	Rural Restricted	-	-
Dane	2030	NB	20-25	-	Rural Restricted	-	-
Dane	2030	NB	25-30	-	Rural Restricted	-	-
Dane	2030	NB	30-35	-	Rural Restricted	-	-
Dane	2030	NB	35-40	-	Rural Restricted	-	-
Dane	2030	NB	40-45	-	Rural Restricted	-	-
Dane	2030	NB	45-50	45.9	Rural Restricted	9112	1535
Dane	2030	NB	50-55	53.4	Rural Restricted	72832	9086
Dane	2030	NB	55-60	-	Rural Restricted	-	-
Dane	2030	NB	60-65	-	Rural Restricted	-	-
Dane	2030	NB	65-70	70.0	Rural Restricted	180159	15402
Dane	2030	NB	70-75	-	Rural Restricted	-	-
Dane	2030	NB	75-80	-	Rural Restricted	-	-
Dane	2030	NB	0-5	-	Rural Unrestricted	-	-
Dane	2030	NB	5-10	-	Rural Unrestricted	-	-
Dane	2030	NB	10-15	-	Rural Unrestricted	-	-
Dane	2030	NB	15-20	-	Rural Unrestricted	-	-
Dane	2030	NB	20-25	20.7	Rural Unrestricted	44	2
Dane	2030	NB	25-30	-	Rural Unrestricted	-	-
Dane	2030	NB	30-35	-	Rural Unrestricted	-	-
Dane	2030	NB	35-40	39.8	Rural Unrestricted	12300	435
Dane	2030	NB	40-45	43.3	Rural Unrestricted	13038	720
Dane	2030	NB	45-50	48.8	Rural Unrestricted	106773	4470
Dane	2030	NB	50-55	51.8	Rural Unrestricted	64659	4168
Dane	2030	NB	55-60	-	Rural Unrestricted	-	-
Dane	2030	NB	60-65	-	Rural Unrestricted	-	-
Dane	2030	NB	65-70	-	Rural Unrestricted	-	-
Dane	2030	NB	70-75	-	Rural Unrestricted	-	-
Dane	2030	NB	75-80	-	Rural Unrestricted	-	-
Dane	2030	B GP Lane	0-5	-	Urban Restricted	-	-
Dane	2030	B GP Lane	5-10	9.4	Urban Restricted	2	-
Dane	2030	B GP Lane	10-15	13.8	Urban Restricted	75	5
Dane	2030	B GP Lane	15-20	16.6	Urban Restricted	31	3
Dane	2030	B GP Lane	20-25	20.3	Urban Restricted	377	24
Dane	2030	B GP Lane	25-30	28.9	Urban Restricted	34372	2760
Dane	2030	B GP Lane	30-35	32.8	Urban Restricted	9896	905
Dane	2030	B GP Lane	35-40	37.4	Urban Restricted	49095	4091
Dane	2030	B GP Lane	40-45	41.7	Urban Restricted	13021	726
Dane	2030	B GP Lane	45-50	49.3	Urban Restricted	4894	306

County	Year	Scenario	Speed Range (mph)	Average Speed (mph)	Road Type	Auto Daily VMT	Truck Daily VMT
Dane	2030	B GP Lane	50-55	54.8	Urban Restricted	24646	2725
Dane	2030	B GP Lane	55-60	60.0	Urban Restricted	106877	15190
Dane	2030	B GP Lane	60-65	64.9	Urban Restricted	298286	34421
Dane	2030	B GP Lane	65-70	70.0	Urban Restricted	1298410	154727
Dane	2030	B GP Lane	70-75	-	Urban Restricted	-	-
Dane	2030	B GP Lane	75-80	-	Urban Restricted	-	-
Dane	2030	B GP Lane	0-5	4.5	Urban Unrestricted	7	-
Dane	2030	B GP Lane	5-10	8.4	Urban Unrestricted	55	7
Dane	2030	B GP Lane	10-15	11.7	Urban Unrestricted	308	36
Dane	2030	B GP Lane	15-20	17.6	Urban Unrestricted	994	88
Dane	2030	B GP Lane	20-25	23.6	Urban Unrestricted	5984	744
Dane	2030	B GP Lane	25-30	27.7	Urban Unrestricted	14341	1581
Dane	2030	B GP Lane	30-35	33.3	Urban Unrestricted	143025	13061
Dane	2030	B GP Lane	35-40	37.9	Urban Unrestricted	322237	27521
Dane	2030	B GP Lane	40-45	41.2	Urban Unrestricted	73511	5742
Dane	2030	B GP Lane	45-50	47.1	Urban Unrestricted	97636	10570
Dane	2030	B GP Lane	50-55	53.3	Urban Unrestricted	40759	4550
Dane	2030	B GP Lane	55-60	56.9	Urban Unrestricted	20599	2857
Dane	2030	B GP Lane	60-65	-	Urban Unrestricted	-	-
Dane	2030	B GP Lane	65-70	55.1	Urban Unrestricted	113	7
Dane	2030	B GP Lane	70-75	-	Urban Unrestricted	-	-
Dane	2030	B GP Lane	75-80	-	Urban Unrestricted	-	-
Dane	2030	B GP Lane	0-5	-	Rural Restricted	-	-
Dane	2030	B GP Lane	5-10	-	Rural Restricted	-	-
Dane	2030	B GP Lane	10-15	-	Rural Restricted	-	-
Dane	2030	B GP Lane	15-20	-	Rural Restricted	-	-
Dane	2030	B GP Lane	20-25	-	Rural Restricted	-	-
Dane	2030	B GP Lane	25-30	-	Rural Restricted	-	-
Dane	2030	B GP Lane	30-35	-	Rural Restricted	-	-
Dane	2030	B GP Lane	35-40	-	Rural Restricted	-	-
Dane	2030	B GP Lane	40-45	-	Rural Restricted	-	-
Dane	2030	B GP Lane	45-50	-	Rural Restricted	-	-
Dane	2030	B GP Lane	50-55	52.8	Rural Restricted	66913	8011
Dane	2030	B GP Lane	55-60	60.0	Rural Restricted	10788	789
Dane	2030	B GP Lane	60-65	65.0	Rural Restricted	6779	522
Dane	2030	B GP Lane	65-70	70.0	Rural Restricted	185085	15830
Dane	2030	B GP Lane	70-75	-	Rural Restricted	-	-
Dane	2030	B GP Lane	75-80	-	Rural Restricted	-	-
Dane	2030	B GP Lane	0-5	-	Rural Unrestricted	-	-
Dane	2030	B GP Lane	5-10	-	Rural Unrestricted	-	-
Dane	2030	B GP Lane	10-15	-	Rural Unrestricted	-	-
Dane	2030	B GP Lane	15-20	-	Rural Unrestricted	-	-
Dane	2030	B GP Lane	20-25	20.7	Rural Unrestricted	43	2
Dane	2030	B GP Lane	25-30	-	Rural Unrestricted	-	-
Dane	2030	B GP Lane	30-35	-	Rural Unrestricted	-	-
Dane	2030	B GP Lane	35-40	39.9	Rural Unrestricted	10009	338
Dane	2030	B GP Lane	40-45	43.5	Rural Unrestricted	11083	573
Dane	2030	B GP Lane	45-50	48.9	Rural Unrestricted	104365	4375
Dane	2030	B GP Lane	50-55	52.4	Rural Unrestricted	57812	3737
Dane	2030	B GP Lane	55-60	-	Rural Unrestricted	-	-
Dane	2030	B GP Lane	60-65	-	Rural Unrestricted	-	-
Dane	2030	B GP Lane	65-70	-	Rural Unrestricted	-	-
Dane	2030	B GP Lane	70-75	-	Rural Unrestricted	-	-
Dane	2030	B GP Lane	75-80	-	Rural Unrestricted	-	-
Dane	2030	B Hybrid	0-5	-	Urban Restricted	-	-
Dane	2030	B Hybrid	5-10	9.4	Urban Restricted	2	-
Dane	2030	B Hybrid	10-15	13.8	Urban Restricted	75	5
Dane	2030	B Hybrid	15-20	16.6	Urban Restricted	31	3
Dane	2030	B Hybrid	20-25	20.3	Urban Restricted	377	24
Dane	2030	B Hybrid	25-30	28.9	Urban Restricted	34368	2758
Dane	2030	B Hybrid	30-35	32.8	Urban Restricted	9890	905
Dane	2030	B Hybrid	35-40	37.4	Urban Restricted	49085	4087
Dane	2030	B Hybrid	40-45	41.7	Urban Restricted	13025	726
Dane	2030	B Hybrid	45-50	49.3	Urban Restricted	4891	305
Dane	2030	B Hybrid	50-55	54.8	Urban Restricted	24659	2727
Dane	2030	B Hybrid	55-60	60.0	Urban Restricted	106771	15175
Dane	2030	B Hybrid	60-65	64.9	Urban Restricted	298048	34376
Dane	2030	B Hybrid	65-70	69.9	Urban Restricted	1297039	154514
Dane	2030	B Hybrid	70-75	-	Urban Restricted	-	-
Dane	2030	B Hybrid	75-80	-	Urban Restricted	-	-

County	Year	Scenario	Speed Range (mph)	Average Speed (mph)	Road Type	Auto Daily VMT	Truck Daily VMT
Dane	2030	B Hybrid	0-5	4.5	Urban Unrestricted	7	-
Dane	2030	B Hybrid	5-10	8.3	Urban Unrestricted	56	7
Dane	2030	B Hybrid	10-15	11.8	Urban Unrestricted	334	40
Dane	2030	B Hybrid	15-20	17.7	Urban Unrestricted	973	84
Dane	2030	B Hybrid	20-25	23.6	Urban Unrestricted	6048	753
Dane	2030	B Hybrid	25-30	27.7	Urban Unrestricted	14347	1583
Dane	2030	B Hybrid	30-35	33.2	Urban Unrestricted	143304	13118
Dane	2030	B Hybrid	35-40	37.9	Urban Unrestricted	322149	27521
Dane	2030	B Hybrid	40-45	41.2	Urban Unrestricted	73559	5746
Dane	2030	B Hybrid	45-50	47.1	Urban Unrestricted	97899	10604
Dane	2030	B Hybrid	50-55	53.3	Urban Unrestricted	40830	4562
Dane	2030	B Hybrid	55-60	56.9	Urban Unrestricted	20739	2866
Dane	2030	B Hybrid	60-65	-	Urban Unrestricted	-	-
Dane	2030	B Hybrid	65-70	55.0	Urban Unrestricted	112	7
Dane	2030	B Hybrid	70-75	-	Urban Unrestricted	-	-
Dane	2030	B Hybrid	75-80	-	Urban Unrestricted	-	-
Dane	2030	B Hybrid	0-5	-	Rural Restricted	-	-
Dane	2030	B Hybrid	5-10	-	Rural Restricted	-	-
Dane	2030	B Hybrid	10-15	-	Rural Restricted	-	-
Dane	2030	B Hybrid	15-20	-	Rural Restricted	-	-
Dane	2030	B Hybrid	20-25	-	Rural Restricted	-	-
Dane	2030	B Hybrid	25-30	-	Rural Restricted	-	-
Dane	2030	B Hybrid	30-35	-	Rural Restricted	-	-
Dane	2030	B Hybrid	35-40	-	Rural Restricted	-	-
Dane	2030	B Hybrid	40-45	-	Rural Restricted	-	-
Dane	2030	B Hybrid	45-50	-	Rural Restricted	-	-
Dane	2030	B Hybrid	50-55	52.8	Rural Restricted	66769	7990
Dane	2030	B Hybrid	55-60	60.0	Rural Restricted	10790	790
Dane	2030	B Hybrid	60-65	65.0	Rural Restricted	6776	523
Dane	2030	B Hybrid	65-70	70.0	Rural Restricted	185085	15830
Dane	2030	B Hybrid	70-75	-	Rural Restricted	-	-
Dane	2030	B Hybrid	75-80	-	Rural Restricted	-	-
Dane	2030	B Hybrid	0-5	-	Rural Unrestricted	-	-
Dane	2030	B Hybrid	5-10	-	Rural Unrestricted	-	-
Dane	2030	B Hybrid	10-15	-	Rural Unrestricted	-	-
Dane	2030	B Hybrid	15-20	-	Rural Unrestricted	-	-
Dane	2030	B Hybrid	20-25	20.7	Rural Unrestricted	43	2
Dane	2030	B Hybrid	25-30	-	Rural Unrestricted	-	-
Dane	2030	B Hybrid	30-35	-	Rural Unrestricted	-	-
Dane	2030	B Hybrid	35-40	39.9	Rural Unrestricted	10008	338
Dane	2030	B Hybrid	40-45	43.5	Rural Unrestricted	11100	574
Dane	2030	B Hybrid	45-50	48.9	Rural Unrestricted	104369	4377
Dane	2030	B Hybrid	50-55	52.4	Rural Unrestricted	57827	3739
Dane	2030	B Hybrid	55-60	-	Rural Unrestricted	-	-
Dane	2030	B Hybrid	60-65	-	Rural Unrestricted	-	-
Dane	2030	B Hybrid	65-70	-	Rural Unrestricted	-	-
Dane	2030	B Hybrid	70-75	-	Rural Unrestricted	-	-
Dane	2030	B Hybrid	75-80	-	Rural Unrestricted	-	-
Dane	2060	NB	0-5	-	Urban Restricted	-	-
Dane	2060	NB	5-10	9.4	Urban Restricted	5	-
Dane	2060	NB	10-15	13.8	Urban Restricted	114	10
Dane	2060	NB	15-20	15.5	Urban Restricted	426	49
Dane	2060	NB	20-25	21.2	Urban Restricted	8458	1315
Dane	2060	NB	25-30	28.8	Urban Restricted	47066	4463
Dane	2060	NB	30-35	32.2	Urban Restricted	18057	1967
Dane	2060	NB	35-40	36.8	Urban Restricted	45958	4430
Dane	2060	NB	40-45	41.6	Urban Restricted	11296	713
Dane	2060	NB	45-50	-	Urban Restricted	-	-
Dane	2060	NB	50-55	52.2	Urban Restricted	257	37
Dane	2060	NB	55-60	56.9	Urban Restricted	8150	1419
Dane	2060	NB	60-65	64.1	Urban Restricted	562690	75281
Dane	2060	NB	65-70	68.9	Urban Restricted	1435724	188442
Dane	2060	NB	70-75	-	Urban Restricted	-	-
Dane	2060	NB	75-80	-	Urban Restricted	-	-
Dane	2060	NB	0-5	4.5	Urban Unrestricted	9	1
Dane	2060	NB	5-10	8.1	Urban Unrestricted	158	18
Dane	2060	NB	10-15	12.1	Urban Unrestricted	430	54
Dane	2060	NB	15-20	16.7	Urban Unrestricted	1859	191
Dane	2060	NB	20-25	23.1	Urban Unrestricted	11658	1436
Dane	2060	NB	25-30	27.6	Urban Unrestricted	31959	3293

County	Year	Scenario	Speed Range (mph)	Average Speed (mph)	Road Type	Auto Daily VMT	Truck Daily VMT
Dane	2060	NB	30-35	32.8	Urban Unrestricted	298171	30606
Dane	2060	NB	35-40	37.4	Urban Unrestricted	431809	39603
Dane	2060	NB	40-45	42.3	Urban Unrestricted	125010	13580
Dane	2060	NB	45-50	47.2	Urban Unrestricted	133320	15034
Dane	2060	NB	50-55	52.6	Urban Unrestricted	37634	4735
Dane	2060	NB	55-60	56.7	Urban Unrestricted	30484	5069
Dane	2060	NB	60-65	-	Urban Unrestricted	-	-
Dane	2060	NB	65-70	-	Urban Unrestricted	-	-
Dane	2060	NB	70-75	-	Urban Unrestricted	-	-
Dane	2060	NB	75-80	-	Urban Unrestricted	-	-
Dane	2060	NB	0-5	-	Rural Restricted	-	-
Dane	2060	NB	5-10	-	Rural Restricted	-	-
Dane	2060	NB	10-15	-	Rural Restricted	-	-
Dane	2060	NB	15-20	-	Rural Restricted	-	-
Dane	2060	NB	20-25	-	Rural Restricted	-	-
Dane	2060	NB	25-30	-	Rural Restricted	-	-
Dane	2060	NB	30-35	-	Rural Restricted	-	-
Dane	2060	NB	35-40	38.2	Rural Restricted	7147	1299
Dane	2060	NB	40-45	40.5	Rural Restricted	881	146
Dane	2060	NB	45-50	47.9	Rural Restricted	40809	7486
Dane	2060	NB	50-55	53.8	Rural Restricted	54602	5962
Dane	2060	NB	55-60	-	Rural Restricted	-	-
Dane	2060	NB	60-65	-	Rural Restricted	-	-
Dane	2060	NB	65-70	70.0	Rural Restricted	200907	18549
Dane	2060	NB	70-75	-	Rural Restricted	-	-
Dane	2060	NB	75-80	-	Rural Restricted	-	-
Dane	2060	NB	0-5	-	Rural Unrestricted	-	-
Dane	2060	NB	5-10	-	Rural Unrestricted	-	-
Dane	2060	NB	10-15	-	Rural Unrestricted	-	-
Dane	2060	NB	15-20	-	Rural Unrestricted	-	-
Dane	2060	NB	20-25	20.3	Rural Unrestricted	73	3
Dane	2060	NB	25-30	-	Rural Unrestricted	-	-
Dane	2060	NB	30-35	-	Rural Unrestricted	-	-
Dane	2060	NB	35-40	39.7	Rural Unrestricted	19655	925
Dane	2060	NB	40-45	42.2	Rural Unrestricted	21471	1232
Dane	2060	NB	45-50	48.4	Rural Unrestricted	210066	13399
Dane	2060	NB	50-55	51.2	Rural Unrestricted	35294	2135
Dane	2060	NB	55-60	-	Rural Unrestricted	-	-
Dane	2060	NB	60-65	-	Rural Unrestricted	-	-
Dane	2060	NB	65-70	-	Rural Unrestricted	-	-
Dane	2060	NB	70-75	-	Rural Unrestricted	-	-
Dane	2060	NB	75-80	-	Rural Unrestricted	-	-
Dane	2060	B GP Lane	0-5	-	Urban Restricted	-	-
Dane	2060	B GP Lane	5-10	9.6	Urban Restricted	8	1
Dane	2060	B GP Lane	10-15	13.9	Urban Restricted	103	8
Dane	2060	B GP Lane	15-20	14.9	Urban Restricted	369	30
Dane	2060	B GP Lane	20-25	21.2	Urban Restricted	4769	567
Dane	2060	B GP Lane	25-30	28.4	Urban Restricted	53134	4877
Dane	2060	B GP Lane	30-35	33.5	Urban Restricted	15026	1551
Dane	2060	B GP Lane	35-40	37.1	Urban Restricted	53327	5053
Dane	2060	B GP Lane	40-45	41.3	Urban Restricted	17007	1151
Dane	2060	B GP Lane	45-50	49.7	Urban Restricted	7167	576
Dane	2060	B GP Lane	50-55	53.7	Urban Restricted	38281	4903
Dane	2060	B GP Lane	55-60	59.8	Urban Restricted	147664	22759
Dane	2060	B GP Lane	60-65	64.2	Urban Restricted	379860	48555
Dane	2060	B GP Lane	65-70	69.7	Urban Restricted	1678718	217191
Dane	2060	B GP Lane	70-75	-	Urban Restricted	-	-
Dane	2060	B GP Lane	75-80	-	Urban Restricted	-	-
Dane	2060	B GP Lane	0-5	4.5	Urban Unrestricted	8	1
Dane	2060	B GP Lane	5-10	8.3	Urban Unrestricted	147	16
Dane	2060	B GP Lane	10-15	12.2	Urban Unrestricted	415	53
Dane	2060	B GP Lane	15-20	17.8	Urban Unrestricted	1952	215
Dane	2060	B GP Lane	20-25	23.5	Urban Unrestricted	11621	1570
Dane	2060	B GP Lane	25-30	27.5	Urban Unrestricted	31565	3199
Dane	2060	B GP Lane	30-35	32.9	Urban Unrestricted	262330	25453
Dane	2060	B GP Lane	35-40	37.7	Urban Unrestricted	422565	39125
Dane	2060	B GP Lane	40-45	41.8	Urban Unrestricted	79766	8107
Dane	2060	B GP Lane	45-50	46.8	Urban Unrestricted	113619	12526
Dane	2060	B GP Lane	50-55	52.3	Urban Unrestricted	47775	5491
Dane	2060	B GP Lane	55-60	56.8	Urban Unrestricted	28739	4435

County	Year	Scenario	Speed Range (mph)	Average Speed (mph)	Road Type	Auto Daily VMT	Truck Daily VMT
Dane	2060	B GP Lane	60-65	-	Urban Unrestricted	-	-
Dane	2060	B GP Lane	65-70	53.8	Urban Unrestricted	146	11
Dane	2060	B GP Lane	70-75	-	Urban Unrestricted	-	-
Dane	2060	B GP Lane	75-80	-	Urban Unrestricted	-	-
Dane	2060	B GP Lane	0-5	-	Rural Restricted	-	-
Dane	2060	B GP Lane	5-10	-	Rural Restricted	-	-
Dane	2060	B GP Lane	10-15	-	Rural Restricted	-	-
Dane	2060	B GP Lane	15-20	-	Rural Restricted	-	-
Dane	2060	B GP Lane	20-25	-	Rural Restricted	-	-
Dane	2060	B GP Lane	25-30	-	Rural Restricted	-	-
Dane	2060	B GP Lane	30-35	-	Rural Restricted	-	-
Dane	2060	B GP Lane	35-40	-	Rural Restricted	-	-
Dane	2060	B GP Lane	40-45	42.4	Rural Restricted	24068	4569
Dane	2060	B GP Lane	45-50	48.0	Rural Restricted	19034	3237
Dane	2060	B GP Lane	50-55	54.1	Rural Restricted	45980	4288
Dane	2060	B GP Lane	55-60	60.0	Rural Restricted	14927	1275
Dane	2060	B GP Lane	60-65	65.0	Rural Restricted	8949	777
Dane	2060	B GP Lane	65-70	70.0	Rural Restricted	216371	19891
Dane	2060	B GP Lane	70-75	-	Rural Restricted	-	-
Dane	2060	B GP Lane	75-80	-	Rural Restricted	-	-
Dane	2060	B GP Lane	0-5	-	Rural Unrestricted	-	-
Dane	2060	B GP Lane	5-10	-	Rural Unrestricted	-	-
Dane	2060	B GP Lane	10-15	-	Rural Unrestricted	-	-
Dane	2060	B GP Lane	15-20	-	Rural Unrestricted	-	-
Dane	2060	B GP Lane	20-25	20.5	Rural Unrestricted	63	3
Dane	2060	B GP Lane	25-30	-	Rural Unrestricted	-	-
Dane	2060	B GP Lane	30-35	-	Rural Unrestricted	-	-
Dane	2060	B GP Lane	35-40	39.7	Rural Unrestricted	17117	766
Dane	2060	B GP Lane	40-45	42.9	Rural Unrestricted	20394	1182
Dane	2060	B GP Lane	45-50	48.4	Rural Unrestricted	150788	7866
Dane	2060	B GP Lane	50-55	51.2	Rural Unrestricted	79783	6295
Dane	2060	B GP Lane	55-60	-	Rural Unrestricted	-	-
Dane	2060	B GP Lane	60-65	-	Rural Unrestricted	-	-
Dane	2060	B GP Lane	65-70	-	Rural Unrestricted	-	-
Dane	2060	B GP Lane	70-75	-	Rural Unrestricted	-	-
Dane	2060	B GP Lane	75-80	-	Rural Unrestricted	-	-
Dane	2060	B Hybrid	0-5	-	Urban Restricted	-	-
Dane	2060	B Hybrid	5-10	9.7	Urban Restricted	8	1
Dane	2060	B Hybrid	10-15	13.8	Urban Restricted	102	8
Dane	2060	B Hybrid	15-20	15.1	Urban Restricted	365	30
Dane	2060	B Hybrid	20-25	21.3	Urban Restricted	4758	565
Dane	2060	B Hybrid	25-30	28.4	Urban Restricted	52964	4844
Dane	2060	B Hybrid	30-35	33.6	Urban Restricted	14941	1533
Dane	2060	B Hybrid	35-40	37.2	Urban Restricted	53210	5031
Dane	2060	B Hybrid	40-45	41.3	Urban Restricted	17025	1155
Dane	2060	B Hybrid	45-50	49.7	Urban Restricted	7124	569
Dane	2060	B Hybrid	50-55	54.0	Urban Restricted	37969	4865
Dane	2060	B Hybrid	55-60	59.8	Urban Restricted	147626	22679
Dane	2060	B Hybrid	60-65	64.3	Urban Restricted	376704	47938
Dane	2060	B Hybrid	65-70	69.0	Urban Restricted	1671803	216004
Dane	2060	B Hybrid	70-75	-	Urban Restricted	-	-
Dane	2060	B Hybrid	75-80	-	Urban Restricted	-	-
Dane	2060	B Hybrid	0-5	4.5	Urban Unrestricted	8	1
Dane	2060	B Hybrid	5-10	8.3	Urban Unrestricted	146	16
Dane	2060	B Hybrid	10-15	12.2	Urban Unrestricted	409	51
Dane	2060	B Hybrid	15-20	17.6	Urban Unrestricted	1643	162
Dane	2060	B Hybrid	20-25	23.3	Urban Unrestricted	10091	1431
Dane	2060	B Hybrid	25-30	27.4	Urban Unrestricted	33128	3348
Dane	2060	B Hybrid	30-35	33.0	Urban Unrestricted	265456	26057
Dane	2060	B Hybrid	35-40	37.8	Urban Unrestricted	421860	38966
Dane	2060	B Hybrid	40-45	41.8	Urban Unrestricted	77992	7954
Dane	2060	B Hybrid	45-50	46.8	Urban Unrestricted	114760	12667
Dane	2060	B Hybrid	50-55	52.2	Urban Unrestricted	48250	5573
Dane	2060	B Hybrid	55-60	56.7	Urban Unrestricted	29304	4479
Dane	2060	B Hybrid	60-65	-	Urban Unrestricted	-	-
Dane	2060	B Hybrid	65-70	53.7	Urban Unrestricted	145	11
Dane	2060	B Hybrid	70-75	-	Urban Unrestricted	-	-
Dane	2060	B Hybrid	75-80	-	Urban Unrestricted	-	-
Dane	2060	B Hybrid	0-5	-	Rural Restricted	-	-
Dane	2060	B Hybrid	5-10	-	Rural Restricted	-	-

County	Year	Scenario	Speed Range (mph)	Average Speed (mph)	Road Type	Auto Daily VMT	Truck Daily VMT
Dane	2060	B Hybrid	10-15	-	Rural Restricted	-	-
Dane	2060	B Hybrid	15-20	-	Rural Restricted	-	-
Dane	2060	B Hybrid	20-25	-	Rural Restricted	-	-
Dane	2060	B Hybrid	25-30	-	Rural Restricted	-	-
Dane	2060	B Hybrid	30-35	-	Rural Restricted	-	-
Dane	2060	B Hybrid	35-40	-	Rural Restricted	-	-
Dane	2060	B Hybrid	40-45	43.0	Rural Restricted	23725	4492
Dane	2060	B Hybrid	45-50	48.3	Rural Restricted	18794	3187
Dane	2060	B Hybrid	50-55	54.1	Rural Restricted	45670	4255
Dane	2060	B Hybrid	55-60	60.0	Rural Restricted	14956	1274
Dane	2060	B Hybrid	60-65	65.0	Rural Restricted	8905	767
Dane	2060	B Hybrid	65-70	70.0	Rural Restricted	216371	19891
Dane	2060	B Hybrid	70-75	-	Rural Restricted	-	-
Dane	2060	B Hybrid	75-80	-	Rural Restricted	-	-
Dane	2060	B Hybrid	0-5	-	Rural Unrestricted	-	-
Dane	2060	B Hybrid	5-10	-	Rural Unrestricted	-	-
Dane	2060	B Hybrid	10-15	-	Rural Unrestricted	-	-
Dane	2060	B Hybrid	15-20	-	Rural Unrestricted	-	-
Dane	2060	B Hybrid	20-25	20.5	Rural Unrestricted	63	3
Dane	2060	B Hybrid	25-30	-	Rural Unrestricted	-	-
Dane	2060	B Hybrid	30-35	-	Rural Unrestricted	-	-
Dane	2060	B Hybrid	35-40	39.7	Rural Unrestricted	17046	762
Dane	2060	B Hybrid	40-45	42.9	Rural Unrestricted	20462	1183
Dane	2060	B Hybrid	45-50	48.4	Rural Unrestricted	151170	7908
Dane	2060	B Hybrid	50-55	51.2	Rural Unrestricted	79977	6342
Dane	2060	B Hybrid	55-60	-	Rural Unrestricted	-	-
Dane	2060	B Hybrid	60-65	-	Rural Unrestricted	-	-
Dane	2060	B Hybrid	65-70	-	Rural Unrestricted	-	-
Dane	2060	B Hybrid	70-75	-	Rural Unrestricted	-	-
Dane	2060	B Hybrid	75-80	-	Rural Unrestricted	-	-
Other Counties	2023	EC	0-5	-	Rural Unrestricted	-	-
Other Counties	2023	EC	5-10	-	Rural Unrestricted	-	-
Other Counties	2023	EC	10-15	-	Rural Unrestricted	-	-
Other Counties	2023	EC	15-20	-	Rural Unrestricted	-	-
Other Counties	2023	EC	20-25	-	Rural Unrestricted	-	-
Other Counties	2023	EC	25-30	-	Rural Unrestricted	-	-
Other Counties	2023	EC	30-35	-	Rural Unrestricted	-	-
Other Counties	2023	EC	35-40	40.0	Rural Unrestricted	16312	876
Other Counties	2023	EC	40-45	44.8	Rural Unrestricted	144157	14878
Other Counties	2023	EC	45-50	49.6	Rural Unrestricted	105761	10593
Other Counties	2023	EC	50-55	54.2	Rural Unrestricted	73160	21694
Other Counties	2023	EC	55-60	-	Rural Unrestricted	-	-
Other Counties	2023	EC	60-65	-	Rural Unrestricted	-	-
Other Counties	2023	EC	65-70	-	Rural Unrestricted	-	-
Other Counties	2023	EC	70-75	-	Rural Unrestricted	-	-
Other Counties	2023	EC	75-80	-	Rural Unrestricted	-	-
Other Counties	2023	EC	0-5	-	Urban Unrestricted	-	-
Other Counties	2023	EC	5-10	-	Urban Unrestricted	-	-
Other Counties	2023	EC	10-15	-	Urban Unrestricted	-	-
Other Counties	2023	EC	15-20	-	Urban Unrestricted	-	-
Other Counties	2023	EC	20-25	25.0	Urban Unrestricted	112	8
Other Counties	2023	EC	25-30	30.0	Urban Unrestricted	2099	121
Other Counties	2023	EC	30-35	34.1	Urban Unrestricted	47153	2305
Other Counties	2023	EC	35-40	37.6	Urban Unrestricted	33109	2668
Other Counties	2023	EC	40-45	45.0	Urban Unrestricted	446	138
Other Counties	2023	EC	45-50	-	Urban Unrestricted	-	-
Other Counties	2023	EC	50-55	-	Urban Unrestricted	-	-
Other Counties	2023	EC	55-60	-	Urban Unrestricted	-	-
Other Counties	2023	EC	60-65	-	Urban Unrestricted	-	-
Other Counties	2023	EC	65-70	-	Urban Unrestricted	-	-
Other Counties	2023	EC	70-75	-	Urban Unrestricted	-	-
Other Counties	2023	EC	75-80	-	Urban Unrestricted	-	-
Other Counties	2023	EC	0-5	-	Rural Restricted	-	-
Other Counties	2023	EC	5-10	-	Rural Restricted	-	-
Other Counties	2023	EC	10-15	-	Rural Restricted	-	-
Other Counties	2023	EC	15-20	-	Rural Restricted	-	-
Other Counties	2023	EC	20-25	-	Rural Restricted	-	-
Other Counties	2023	EC	25-30	-	Rural Restricted	-	-
Other Counties	2023	EC	30-35	34.9	Rural Restricted	14339	1888
Other Counties	2023	EC	35-40	-	Rural Restricted	-	-

County	Year	Scenario	Speed Range (mph)	Average Speed (mph)	Road Type	Auto Daily VMT	Truck Daily VMT
Other Counties	2023	EC	40-45	-	Rural Restricted	-	-
Other Counties	2023	EC	45-50	-	Rural Restricted	-	-
Other Counties	2023	EC	50-55	-	Rural Restricted	-	-
Other Counties	2023	EC	55-60	-	Rural Restricted	-	-
Other Counties	2023	EC	60-65	-	Rural Restricted	-	-
Other Counties	2023	EC	65-70	68.8	Rural Restricted	483913	334515
Other Counties	2023	EC	70-75	-	Rural Restricted	-	-
Other Counties	2023	EC	75-80	-	Rural Restricted	-	-
Other Counties	2023	EC	0-5	-	Urban Restricted	-	-
Other Counties	2023	EC	5-10	-	Urban Restricted	-	-
Other Counties	2023	EC	10-15	-	Urban Restricted	-	-
Other Counties	2023	EC	15-20	-	Urban Restricted	-	-
Other Counties	2023	EC	20-25	-	Urban Restricted	-	-
Other Counties	2023	EC	25-30	-	Urban Restricted	-	-
Other Counties	2023	EC	30-35	33.1	Urban Restricted	16047	1394
Other Counties	2023	EC	35-40	-	Urban Restricted	-	-
Other Counties	2023	EC	40-45	-	Urban Restricted	-	-
Other Counties	2023	EC	45-50	-	Urban Restricted	-	-
Other Counties	2023	EC	50-55	-	Urban Restricted	-	-
Other Counties	2023	EC	55-60	-	Urban Restricted	-	-
Other Counties	2023	EC	60-65	-	Urban Restricted	-	-
Other Counties	2023	EC	65-70	68.5	Urban Restricted	433476	394177
Other Counties	2023	EC	70-75	-	Urban Restricted	-	-
Other Counties	2023	EC	75-80	-	Urban Restricted	-	-
Other Counties	2030	NB	0-5	-	Rural Unrestricted	-	-
Other Counties	2030	NB	5-10	-	Rural Unrestricted	-	-
Other Counties	2030	NB	10-15	-	Rural Unrestricted	-	-
Other Counties	2030	NB	15-20	-	Rural Unrestricted	-	-
Other Counties	2030	NB	20-25	-	Rural Unrestricted	-	-
Other Counties	2030	NB	25-30	-	Rural Unrestricted	-	-
Other Counties	2030	NB	30-35	-	Rural Unrestricted	-	-
Other Counties	2030	NB	35-40	40.0	Rural Unrestricted	17412	963
Other Counties	2030	NB	40-45	44.7	Rural Unrestricted	157490	16912
Other Counties	2030	NB	45-50	49.5	Rural Unrestricted	116692	12571
Other Counties	2030	NB	50-55	54.0	Rural Unrestricted	75115	25039
Other Counties	2030	NB	55-60	-	Rural Unrestricted	-	-
Other Counties	2030	NB	60-65	-	Rural Unrestricted	-	-
Other Counties	2030	NB	65-70	-	Rural Unrestricted	-	-
Other Counties	2030	NB	70-75	-	Rural Unrestricted	-	-
Other Counties	2030	NB	75-80	-	Rural Unrestricted	-	-
Other Counties	2030	NB	0-5	-	Urban Unrestricted	-	-
Other Counties	2030	NB	5-10	-	Urban Unrestricted	-	-
Other Counties	2030	NB	10-15	-	Urban Unrestricted	-	-
Other Counties	2030	NB	15-20	-	Urban Unrestricted	-	-
Other Counties	2030	NB	20-25	25.0	Urban Unrestricted	119	8
Other Counties	2030	NB	25-30	30.0	Urban Unrestricted	2182	130
Other Counties	2030	NB	30-35	33.9	Urban Unrestricted	60287	3890
Other Counties	2030	NB	35-40	37.8	Urban Unrestricted	27771	1917
Other Counties	2030	NB	40-45	45.0	Urban Unrestricted	474	168
Other Counties	2030	NB	45-50	-	Urban Unrestricted	-	-
Other Counties	2030	NB	50-55	-	Urban Unrestricted	-	-
Other Counties	2030	NB	55-60	-	Urban Unrestricted	-	-
Other Counties	2030	NB	60-65	-	Urban Unrestricted	-	-
Other Counties	2030	NB	65-70	-	Urban Unrestricted	-	-
Other Counties	2030	NB	70-75	-	Urban Unrestricted	-	-
Other Counties	2030	NB	75-80	-	Urban Unrestricted	-	-
Other Counties	2030	NB	0-5	-	Rural Restricted	-	-
Other Counties	2030	NB	5-10	-	Rural Restricted	-	-
Other Counties	2030	NB	10-15	-	Rural Restricted	-	-
Other Counties	2030	NB	15-20	-	Rural Restricted	-	-
Other Counties	2030	NB	20-25	-	Rural Restricted	-	-
Other Counties	2030	NB	25-30	-	Rural Restricted	-	-
Other Counties	2030	NB	30-35	34.9	Rural Restricted	14954	2087
Other Counties	2030	NB	35-40	-	Rural Restricted	-	-
Other Counties	2030	NB	40-45	-	Rural Restricted	-	-
Other Counties	2030	NB	45-50	-	Rural Restricted	-	-
Other Counties	2030	NB	50-55	-	Rural Restricted	-	-
Other Counties	2030	NB	55-60	-	Rural Restricted	-	-
Other Counties	2030	NB	60-65	62.7	Rural Restricted	24717	30511
Other Counties	2030	NB	65-70	67.6	Rural Restricted	460384	350546

County	Year	Scenario	Speed Range (mph)	Average Speed (mph)	Road Type	Auto Daily VMT	Truck Daily VMT
Other Counties	2030	NB	70-75	-	Rural Restricted	-	-
Other Counties	2030	NB	75-80	-	Rural Restricted	-	-
Other Counties	2030	NB	0-5	-	Urban Restricted	-	-
Other Counties	2030	NB	5-10	-	Urban Restricted	-	-
Other Counties	2030	NB	10-15	-	Urban Restricted	-	-
Other Counties	2030	NB	15-20	-	Urban Restricted	-	-
Other Counties	2030	NB	20-25	-	Urban Restricted	-	-
Other Counties	2030	NB	25-30	29.7	Urban Restricted	2245	140
Other Counties	2030	NB	30-35	33.7	Urban Restricted	14297	1325
Other Counties	2030	NB	35-40	-	Urban Restricted	-	-
Other Counties	2030	NB	40-45	-	Urban Restricted	-	-
Other Counties	2030	NB	45-50	-	Urban Restricted	-	-
Other Counties	2030	NB	50-55	-	Urban Restricted	-	-
Other Counties	2030	NB	55-60	-	Urban Restricted	-	-
Other Counties	2030	NB	60-65	-	Urban Restricted	-	-
Other Counties	2030	NB	65-70	66.4	Urban Restricted	434610	453099
Other Counties	2030	NB	70-75	-	Urban Restricted	-	-
Other Counties	2030	NB	75-80	-	Urban Restricted	-	-
Other Counties	2030	B GP Lane	0-5	-	Rural Unrestricted	-	-
Other Counties	2030	B GP Lane	5-10	-	Rural Unrestricted	-	-
Other Counties	2030	B GP Lane	10-15	-	Rural Unrestricted	-	-
Other Counties	2030	B GP Lane	15-20	-	Rural Unrestricted	-	-
Other Counties	2030	B GP Lane	20-25	-	Rural Unrestricted	-	-
Other Counties	2030	B GP Lane	25-30	-	Rural Unrestricted	-	-
Other Counties	2030	B GP Lane	30-35	-	Rural Unrestricted	-	-
Other Counties	2030	B GP Lane	35-40	40.0	Rural Unrestricted	16325	900
Other Counties	2030	B GP Lane	40-45	44.8	Rural Unrestricted	150083	16845
Other Counties	2030	B GP Lane	45-50	49.6	Rural Unrestricted	105279	11103
Other Counties	2030	B GP Lane	50-55	54.0	Rural Unrestricted	74786	24868
Other Counties	2030	B GP Lane	55-60	-	Rural Unrestricted	-	-
Other Counties	2030	B GP Lane	60-65	-	Rural Unrestricted	-	-
Other Counties	2030	B GP Lane	65-70	-	Rural Unrestricted	-	-
Other Counties	2030	B GP Lane	70-75	-	Rural Unrestricted	-	-
Other Counties	2030	B GP Lane	75-80	-	Rural Unrestricted	-	-
Other Counties	2030	B GP Lane	0-5	-	Urban Unrestricted	-	-
Other Counties	2030	B GP Lane	5-10	-	Urban Unrestricted	-	-
Other Counties	2030	B GP Lane	10-15	-	Urban Unrestricted	-	-
Other Counties	2030	B GP Lane	15-20	-	Urban Unrestricted	-	-
Other Counties	2030	B GP Lane	20-25	25.0	Urban Unrestricted	119	8
Other Counties	2030	B GP Lane	25-30	29.8	Urban Unrestricted	1427	156
Other Counties	2030	B GP Lane	30-35	34.1	Urban Unrestricted	55756	3550
Other Counties	2030	B GP Lane	35-40	37.9	Urban Unrestricted	25342	1658
Other Counties	2030	B GP Lane	40-45	44.2	Urban Unrestricted	3827	422
Other Counties	2030	B GP Lane	45-50	49.4	Urban Unrestricted	6254	590
Other Counties	2030	B GP Lane	50-55	-	Urban Unrestricted	-	-
Other Counties	2030	B GP Lane	55-60	-	Urban Unrestricted	-	-
Other Counties	2030	B GP Lane	60-65	-	Urban Unrestricted	-	-
Other Counties	2030	B GP Lane	65-70	-	Urban Unrestricted	-	-
Other Counties	2030	B GP Lane	70-75	-	Urban Unrestricted	-	-
Other Counties	2030	B GP Lane	75-80	-	Urban Unrestricted	-	-
Other Counties	2030	B GP Lane	0-5	-	Rural Restricted	-	-
Other Counties	2030	B GP Lane	5-10	-	Rural Restricted	-	-
Other Counties	2030	B GP Lane	10-15	-	Rural Restricted	-	-
Other Counties	2030	B GP Lane	15-20	-	Rural Restricted	-	-
Other Counties	2030	B GP Lane	20-25	-	Rural Restricted	-	-
Other Counties	2030	B GP Lane	25-30	-	Rural Restricted	-	-
Other Counties	2030	B GP Lane	30-35	34.9	Rural Restricted	15443	2172
Other Counties	2030	B GP Lane	35-40	-	Rural Restricted	-	-
Other Counties	2030	B GP Lane	40-45	-	Rural Restricted	-	-
Other Counties	2030	B GP Lane	45-50	-	Rural Restricted	-	-
Other Counties	2030	B GP Lane	50-55	-	Rural Restricted	-	-
Other Counties	2030	B GP Lane	55-60	-	Rural Restricted	-	-
Other Counties	2030	B GP Lane	60-65	-	Rural Restricted	-	-
Other Counties	2030	B GP Lane	65-70	69.7	Rural Restricted	486839	378811
Other Counties	2030	B GP Lane	70-75	-	Rural Restricted	-	-
Other Counties	2030	B GP Lane	75-80	-	Rural Restricted	-	-
Other Counties	2030	B GP Lane	0-5	-	Urban Restricted	-	-
Other Counties	2030	B GP Lane	5-10	-	Urban Restricted	-	-
Other Counties	2030	B GP Lane	10-15	-	Urban Restricted	-	-
Other Counties	2030	B GP Lane	15-20	-	Urban Restricted	-	-

County	Year	Scenario	Speed Range (mph)	Average Speed (mph)	Road Type	Auto Daily VMT	Truck Daily VMT
Other Counties	2030	B GP Lane	20-25	-	Urban Restricted	-	-
Other Counties	2030	B GP Lane	25-30	-	Urban Restricted	-	-
Other Counties	2030	B GP Lane	30-35	33.4	Urban Restricted	19271	1796
Other Counties	2030	B GP Lane	35-40	35.0	Urban Restricted	655	59
Other Counties	2030	B GP Lane	40-45	-	Urban Restricted	-	-
Other Counties	2030	B GP Lane	45-50	-	Urban Restricted	-	-
Other Counties	2030	B GP Lane	50-55	-	Urban Restricted	-	-
Other Counties	2030	B GP Lane	55-60	-	Urban Restricted	-	-
Other Counties	2030	B GP Lane	60-65	-	Urban Restricted	-	-
Other Counties	2030	B GP Lane	65-70	69.9	Urban Restricted	446596	464487
Other Counties	2030	B GP Lane	70-75	-	Urban Restricted	-	-
Other Counties	2030	B GP Lane	75-80	-	Urban Restricted	-	-
Other Counties	2030	B Hybrid	0-5	-	Rural Unrestricted	-	-
Other Counties	2030	B Hybrid	5-10	-	Rural Unrestricted	-	-
Other Counties	2030	B Hybrid	10-15	-	Rural Unrestricted	-	-
Other Counties	2030	B Hybrid	15-20	-	Rural Unrestricted	-	-
Other Counties	2030	B Hybrid	20-25	-	Rural Unrestricted	-	-
Other Counties	2030	B Hybrid	25-30	-	Rural Unrestricted	-	-
Other Counties	2030	B Hybrid	30-35	-	Rural Unrestricted	-	-
Other Counties	2030	B Hybrid	35-40	40.0	Rural Unrestricted	16325	900
Other Counties	2030	B Hybrid	40-45	44.8	Rural Unrestricted	150083	16845
Other Counties	2030	B Hybrid	45-50	49.6	Rural Unrestricted	105279	11103
Other Counties	2030	B Hybrid	50-55	54.0	Rural Unrestricted	74786	24868
Other Counties	2030	B Hybrid	55-60	-	Rural Unrestricted	-	-
Other Counties	2030	B Hybrid	60-65	-	Rural Unrestricted	-	-
Other Counties	2030	B Hybrid	65-70	-	Rural Unrestricted	-	-
Other Counties	2030	B Hybrid	70-75	-	Rural Unrestricted	-	-
Other Counties	2030	B Hybrid	75-80	-	Rural Unrestricted	-	-
Other Counties	2030	B Hybrid	0-5	-	Urban Unrestricted	-	-
Other Counties	2030	B Hybrid	5-10	-	Urban Unrestricted	-	-
Other Counties	2030	B Hybrid	10-15	-	Urban Unrestricted	-	-
Other Counties	2030	B Hybrid	15-20	-	Urban Unrestricted	-	-
Other Counties	2030	B Hybrid	20-25	25.0	Urban Unrestricted	119	8
Other Counties	2030	B Hybrid	25-30	29.8	Urban Unrestricted	1427	156
Other Counties	2030	B Hybrid	30-35	34.1	Urban Unrestricted	55756	3550
Other Counties	2030	B Hybrid	35-40	37.9	Urban Unrestricted	25342	1658
Other Counties	2030	B Hybrid	40-45	44.2	Urban Unrestricted	3827	422
Other Counties	2030	B Hybrid	45-50	49.4	Urban Unrestricted	6254	590
Other Counties	2030	B Hybrid	50-55	-	Urban Unrestricted	-	-
Other Counties	2030	B Hybrid	55-60	-	Urban Unrestricted	-	-
Other Counties	2030	B Hybrid	60-65	-	Urban Unrestricted	-	-
Other Counties	2030	B Hybrid	65-70	-	Urban Unrestricted	-	-
Other Counties	2030	B Hybrid	70-75	-	Urban Unrestricted	-	-
Other Counties	2030	B Hybrid	75-80	-	Urban Unrestricted	-	-
Other Counties	2030	B Hybrid	0-5	-	Rural Restricted	-	-
Other Counties	2030	B Hybrid	5-10	-	Rural Restricted	-	-
Other Counties	2030	B Hybrid	10-15	-	Rural Restricted	-	-
Other Counties	2030	B Hybrid	15-20	-	Rural Restricted	-	-
Other Counties	2030	B Hybrid	20-25	-	Rural Restricted	-	-
Other Counties	2030	B Hybrid	25-30	-	Rural Restricted	-	-
Other Counties	2030	B Hybrid	30-35	34.9	Rural Restricted	15443	2172
Other Counties	2030	B Hybrid	35-40	-	Rural Restricted	-	-
Other Counties	2030	B Hybrid	40-45	-	Rural Restricted	-	-
Other Counties	2030	B Hybrid	45-50	-	Rural Restricted	-	-
Other Counties	2030	B Hybrid	50-55	-	Rural Restricted	-	-
Other Counties	2030	B Hybrid	55-60	-	Rural Restricted	-	-
Other Counties	2030	B Hybrid	60-65	-	Rural Restricted	-	-
Other Counties	2030	B Hybrid	65-70	69.7	Rural Restricted	486839	378811
Other Counties	2030	B Hybrid	70-75	-	Rural Restricted	-	-
Other Counties	2030	B Hybrid	75-80	-	Rural Restricted	-	-
Other Counties	2030	B Hybrid	0-5	-	Urban Restricted	-	-
Other Counties	2030	B Hybrid	5-10	-	Urban Restricted	-	-
Other Counties	2030	B Hybrid	10-15	-	Urban Restricted	-	-
Other Counties	2030	B Hybrid	15-20	-	Urban Restricted	-	-
Other Counties	2030	B Hybrid	20-25	-	Urban Restricted	-	-
Other Counties	2030	B Hybrid	25-30	-	Urban Restricted	-	-
Other Counties	2030	B Hybrid	30-35	33.4	Urban Restricted	19271	1796
Other Counties	2030	B Hybrid	35-40	35.0	Urban Restricted	655	59
Other Counties	2030	B Hybrid	40-45	-	Urban Restricted	-	-
Other Counties	2030	B Hybrid	45-50	-	Urban Restricted	-	-

County	Year	Scenario	Speed Range (mph)	Average Speed (mph)	Road Type	Auto Daily VMT	Truck Daily VMT
Other Counties	2030	B Hybrid	50-55	-	Urban Restricted	-	-
Other Counties	2030	B Hybrid	55-60	-	Urban Restricted	-	-
Other Counties	2030	B Hybrid	60-65	-	Urban Restricted	-	-
Other Counties	2030	B Hybrid	65-70	69.9	Urban Restricted	446596	464487
Other Counties	2030	B Hybrid	70-75	-	Urban Restricted	-	-
Other Counties	2030	B Hybrid	75-80	-	Urban Restricted	-	-
Other Counties	2060	NB	0-5	-	Rural Unrestricted	-	-
Other Counties	2060	NB	5-10	-	Rural Unrestricted	-	-
Other Counties	2060	NB	10-15	-	Rural Unrestricted	-	-
Other Counties	2060	NB	15-20	-	Rural Unrestricted	-	-
Other Counties	2060	NB	20-25	-	Rural Unrestricted	-	-
Other Counties	2060	NB	25-30	-	Rural Unrestricted	-	-
Other Counties	2060	NB	30-35	-	Rural Unrestricted	-	-
Other Counties	2060	NB	35-40	39.9	Rural Unrestricted	35787	3878
Other Counties	2060	NB	40-45	44.3	Rural Unrestricted	208091	21390
Other Counties	2060	NB	45-50	48.9	Rural Unrestricted	151571	21031
Other Counties	2060	NB	50-55	52.4	Rural Unrestricted	81063	53028
Other Counties	2060	NB	55-60	-	Rural Unrestricted	-	-
Other Counties	2060	NB	60-65	-	Rural Unrestricted	-	-
Other Counties	2060	NB	65-70	-	Rural Unrestricted	-	-
Other Counties	2060	NB	70-75	-	Rural Unrestricted	-	-
Other Counties	2060	NB	75-80	-	Rural Unrestricted	-	-
Other Counties	2060	NB	0-5	-	Urban Unrestricted	-	-
Other Counties	2060	NB	5-10	-	Urban Unrestricted	-	-
Other Counties	2060	NB	10-15	-	Urban Unrestricted	-	-
Other Counties	2060	NB	15-20	-	Urban Unrestricted	-	-
Other Counties	2060	NB	20-25	25.0	Urban Unrestricted	188	15
Other Counties	2060	NB	25-30	28.1	Urban Unrestricted	16034	791
Other Counties	2060	NB	30-35	33.7	Urban Unrestricted	71483	5962
Other Counties	2060	NB	35-40	37.4	Urban Unrestricted	38139	2904
Other Counties	2060	NB	40-45	45.0	Urban Unrestricted	637	868
Other Counties	2060	NB	45-50	-	Urban Unrestricted	-	-
Other Counties	2060	NB	50-55	-	Urban Unrestricted	-	-
Other Counties	2060	NB	55-60	-	Urban Unrestricted	-	-
Other Counties	2060	NB	60-65	-	Urban Unrestricted	-	-
Other Counties	2060	NB	65-70	-	Urban Unrestricted	-	-
Other Counties	2060	NB	70-75	-	Urban Unrestricted	-	-
Other Counties	2060	NB	75-80	-	Urban Unrestricted	-	-
Other Counties	2060	NB	0-5	-	Rural Restricted	-	-
Other Counties	2060	NB	5-10	-	Rural Restricted	-	-
Other Counties	2060	NB	10-15	-	Rural Restricted	-	-
Other Counties	2060	NB	15-20	-	Rural Restricted	-	-
Other Counties	2060	NB	20-25	-	Rural Restricted	-	-
Other Counties	2060	NB	25-30	-	Rural Restricted	-	-
Other Counties	2060	NB	30-35	34.6	Rural Restricted	17332	3081
Other Counties	2060	NB	35-40	-	Rural Restricted	-	-
Other Counties	2060	NB	40-45	-	Rural Restricted	-	-
Other Counties	2060	NB	45-50	49.1	Rural Restricted	17415	25073
Other Counties	2060	NB	50-55	51.4	Rural Restricted	7299	9351
Other Counties	2060	NB	55-60	56.9	Rural Restricted	111980	94113
Other Counties	2060	NB	60-65	-	Rural Restricted	250735	237374
Other Counties	2060	NB	65-70	-	Rural Restricted	114681	88464
Other Counties	2060	NB	70-75	-	Rural Restricted	-	-
Other Counties	2060	NB	75-80	-	Rural Restricted	-	-
Other Counties	2060	NB	0-5	-	Urban Restricted	-	-
Other Counties	2060	NB	5-10	-	Urban Restricted	-	-
Other Counties	2060	NB	10-15	-	Urban Restricted	-	-
Other Counties	2060	NB	15-20	-	Urban Restricted	-	-
Other Counties	2060	NB	20-25	-	Urban Restricted	-	-
Other Counties	2060	NB	25-30	26.3	Urban Restricted	2627	200
Other Counties	2060	NB	30-35	33.6	Urban Restricted	15915	1664
Other Counties	2060	NB	35-40	-	Urban Restricted	-	-
Other Counties	2060	NB	40-45	-	Urban Restricted	-	-
Other Counties	2060	NB	45-50	-	Urban Restricted	-	-
Other Counties	2060	NB	50-55	-	Urban Restricted	-	-
Other Counties	2060	NB	55-60	59.8	Urban Restricted	49401	50477
Other Counties	2060	NB	60-65	60.7	Urban Restricted	349077	364385
Other Counties	2060	NB	65-70	66.4	Urban Restricted	67477	98364
Other Counties	2060	NB	70-75	-	Urban Restricted	-	-
Other Counties	2060	NB	75-80	-	Urban Restricted	-	-

County	Year	Scenario	Speed Range (mph)	Average Speed (mph)	Road Type	Auto Daily VMT	Truck Daily VMT
Other Counties	2060	B GP Lane	0-5	-	Rural Unrestricted	-	-
Other Counties	2060	B GP Lane	5-10	-	Rural Unrestricted	-	-
Other Counties	2060	B GP Lane	10-15	-	Rural Unrestricted	-	-
Other Counties	2060	B GP Lane	15-20	-	Rural Unrestricted	-	-
Other Counties	2060	B GP Lane	20-25	-	Rural Unrestricted	-	-
Other Counties	2060	B GP Lane	25-30	-	Rural Unrestricted	-	-
Other Counties	2060	B GP Lane	30-35	-	Rural Unrestricted	-	-
Other Counties	2060	B GP Lane	35-40	39.9	Rural Unrestricted	49809	5545
Other Counties	2060	B GP Lane	40-45	44.6	Rural Unrestricted	189048	27460
Other Counties	2060	B GP Lane	45-50	49.3	Rural Unrestricted	125959	16936
Other Counties	2060	B GP Lane	50-55	53.1	Rural Unrestricted	82683	41101
Other Counties	2060	B GP Lane	55-60	-	Rural Unrestricted	-	-
Other Counties	2060	B GP Lane	60-65	-	Rural Unrestricted	-	-
Other Counties	2060	B GP Lane	65-70	-	Rural Unrestricted	-	-
Other Counties	2060	B GP Lane	70-75	-	Rural Unrestricted	-	-
Other Counties	2060	B GP Lane	75-80	-	Rural Unrestricted	-	-
Other Counties	2060	B GP Lane	0-5	-	Urban Unrestricted	-	-
Other Counties	2060	B GP Lane	5-10	-	Urban Unrestricted	-	-
Other Counties	2060	B GP Lane	10-15	-	Urban Unrestricted	-	-
Other Counties	2060	B GP Lane	15-20	-	Urban Unrestricted	-	-
Other Counties	2060	B GP Lane	20-25	25.0	Urban Unrestricted	188	15
Other Counties	2060	B GP Lane	25-30	28.5	Urban Unrestricted	12507	1492
Other Counties	2060	B GP Lane	30-35	33.9	Urban Unrestricted	64958	4578
Other Counties	2060	B GP Lane	35-40	37.7	Urban Unrestricted	31605	2386
Other Counties	2060	B GP Lane	40-45	43.7	Urban Unrestricted	4544	1142
Other Counties	2060	B GP Lane	45-50	48.8	Urban Unrestricted	7471	1010
Other Counties	2060	B GP Lane	50-55	-	Urban Unrestricted	-	-
Other Counties	2060	B GP Lane	55-60	-	Urban Unrestricted	-	-
Other Counties	2060	B GP Lane	60-65	-	Urban Unrestricted	-	-
Other Counties	2060	B GP Lane	65-70	-	Urban Unrestricted	-	-
Other Counties	2060	B GP Lane	70-75	-	Urban Unrestricted	-	-
Other Counties	2060	B GP Lane	75-80	-	Urban Unrestricted	-	-
Other Counties	2060	B GP Lane	0-5	-	Rural Restricted	-	-
Other Counties	2060	B GP Lane	5-10	-	Rural Restricted	-	-
Other Counties	2060	B GP Lane	10-15	-	Rural Restricted	-	-
Other Counties	2060	B GP Lane	15-20	-	Rural Restricted	-	-
Other Counties	2060	B GP Lane	20-25	-	Rural Restricted	-	-
Other Counties	2060	B GP Lane	25-30	-	Rural Restricted	-	-
Other Counties	2060	B GP Lane	30-35	34.8	Rural Restricted	18603	3157
Other Counties	2060	B GP Lane	35-40	-	Rural Restricted	-	-
Other Counties	2060	B GP Lane	40-45	-	Rural Restricted	-	-
Other Counties	2060	B GP Lane	45-50	-	Rural Restricted	-	-
Other Counties	2060	B GP Lane	50-55	53.6	Rural Restricted	4072	8308
Other Counties	2060	B GP Lane	55-60	-	Rural Restricted	-	-
Other Counties	2060	B GP Lane	60-65	-	Rural Restricted	-	-
Other Counties	2060	B GP Lane	65-70	69.5	Rural Restricted	522528	465740
Other Counties	2060	B GP Lane	70-75	-	Rural Restricted	-	-
Other Counties	2060	B GP Lane	75-80	-	Rural Restricted	-	-
Other Counties	2060	B GP Lane	0-5	-	Urban Restricted	-	-
Other Counties	2060	B GP Lane	5-10	-	Urban Restricted	-	-
Other Counties	2060	B GP Lane	10-15	-	Urban Restricted	-	-
Other Counties	2060	B GP Lane	15-20	-	Urban Restricted	-	-
Other Counties	2060	B GP Lane	20-25	-	Urban Restricted	-	-
Other Counties	2060	B GP Lane	25-30	28.6	Urban Restricted	3732	394
Other Counties	2060	B GP Lane	30-35	34.2	Urban Restricted	19051	2053
Other Counties	2060	B GP Lane	35-40	35.0	Urban Restricted	219	8
Other Counties	2060	B GP Lane	40-45	-	Urban Restricted	-	-
Other Counties	2060	B GP Lane	45-50	-	Urban Restricted	-	-
Other Counties	2060	B GP Lane	50-55	-	Urban Restricted	-	-
Other Counties	2060	B GP Lane	55-60	-	Urban Restricted	-	-
Other Counties	2060	B GP Lane	60-65	-	Urban Restricted	-	-
Other Counties	2060	B GP Lane	65-70	69.5	Urban Restricted	518734	555350
Other Counties	2060	B GP Lane	70-75	-	Urban Restricted	-	-
Other Counties	2060	B GP Lane	75-80	-	Urban Restricted	-	-
Other Counties	2060	B Hybrid	0-5	-	Rural Unrestricted	-	-
Other Counties	2060	B Hybrid	5-10	-	Rural Unrestricted	-	-
Other Counties	2060	B Hybrid	10-15	-	Rural Unrestricted	-	-
Other Counties	2060	B Hybrid	15-20	-	Rural Unrestricted	-	-
Other Counties	2060	B Hybrid	20-25	-	Rural Unrestricted	-	-
Other Counties	2060	B Hybrid	25-30	-	Rural Unrestricted	-	-

County	Year	Scenario	Speed Range (mph)	Average Speed (mph)	Road Type	Auto Daily VMT	Truck Daily VMT
Other Counties	2060	B Hybrid	30-35	-	Rural Unrestricted	-	-
Other Counties	2060	B Hybrid	35-40	39.9	Rural Unrestricted	49809	5545
Other Counties	2060	B Hybrid	40-45	44.6	Rural Unrestricted	189048	27460
Other Counties	2060	B Hybrid	45-50	49.3	Rural Unrestricted	125959	16936
Other Counties	2060	B Hybrid	50-55	53.1	Rural Unrestricted	82683	41101
Other Counties	2060	B Hybrid	55-60	-	Rural Unrestricted	-	-
Other Counties	2060	B Hybrid	60-65	-	Rural Unrestricted	-	-
Other Counties	2060	B Hybrid	65-70	-	Rural Unrestricted	-	-
Other Counties	2060	B Hybrid	70-75	-	Rural Unrestricted	-	-
Other Counties	2060	B Hybrid	75-80	-	Rural Unrestricted	-	-
Other Counties	2060	B Hybrid	0-5	-	Urban Unrestricted	-	-
Other Counties	2060	B Hybrid	5-10	-	Urban Unrestricted	-	-
Other Counties	2060	B Hybrid	10-15	-	Urban Unrestricted	-	-
Other Counties	2060	B Hybrid	15-20	-	Urban Unrestricted	-	-
Other Counties	2060	B Hybrid	20-25	25.0	Urban Unrestricted	188	15
Other Counties	2060	B Hybrid	25-30	28.5	Urban Unrestricted	12507	1492
Other Counties	2060	B Hybrid	30-35	33.9	Urban Unrestricted	64958	4578
Other Counties	2060	B Hybrid	35-40	37.7	Urban Unrestricted	31605	2386
Other Counties	2060	B Hybrid	40-45	43.7	Urban Unrestricted	4544	1142
Other Counties	2060	B Hybrid	45-50	48.8	Urban Unrestricted	7471	1010
Other Counties	2060	B Hybrid	50-55	-	Urban Unrestricted	-	-
Other Counties	2060	B Hybrid	55-60	-	Urban Unrestricted	-	-
Other Counties	2060	B Hybrid	60-65	-	Urban Unrestricted	-	-
Other Counties	2060	B Hybrid	65-70	-	Urban Unrestricted	-	-
Other Counties	2060	B Hybrid	70-75	-	Urban Unrestricted	-	-
Other Counties	2060	B Hybrid	75-80	-	Urban Unrestricted	-	-
Other Counties	2060	B Hybrid	0-5	-	Rural Restricted	-	-
Other Counties	2060	B Hybrid	5-10	-	Rural Restricted	-	-
Other Counties	2060	B Hybrid	10-15	-	Rural Restricted	-	-
Other Counties	2060	B Hybrid	15-20	-	Rural Restricted	-	-
Other Counties	2060	B Hybrid	20-25	-	Rural Restricted	-	-
Other Counties	2060	B Hybrid	25-30	-	Rural Restricted	-	-
Other Counties	2060	B Hybrid	30-35	34.8	Rural Restricted	18603	3157
Other Counties	2060	B Hybrid	35-40	-	Rural Restricted	-	-
Other Counties	2060	B Hybrid	40-45	-	Rural Restricted	-	-
Other Counties	2060	B Hybrid	45-50	-	Rural Restricted	-	-
Other Counties	2060	B Hybrid	50-55	53.6	Rural Restricted	4072	8308
Other Counties	2060	B Hybrid	55-60	-	Rural Restricted	-	-
Other Counties	2060	B Hybrid	60-65	-	Rural Restricted	-	-
Other Counties	2060	B Hybrid	65-70	69.5	Rural Restricted	522528	465740
Other Counties	2060	B Hybrid	70-75	-	Rural Restricted	-	-
Other Counties	2060	B Hybrid	75-80	-	Rural Restricted	-	-
Other Counties	2060	B Hybrid	0-5	-	Urban Restricted	-	-
Other Counties	2060	B Hybrid	5-10	-	Urban Restricted	-	-
Other Counties	2060	B Hybrid	10-15	-	Urban Restricted	-	-
Other Counties	2060	B Hybrid	15-20	-	Urban Restricted	-	-
Other Counties	2060	B Hybrid	20-25	-	Urban Restricted	-	-
Other Counties	2060	B Hybrid	25-30	28.6	Urban Restricted	3732	394
Other Counties	2060	B Hybrid	30-35	34.2	Urban Restricted	19051	2053
Other Counties	2060	B Hybrid	35-40	35.0	Urban Restricted	219	8
Other Counties	2060	B Hybrid	40-45	-	Urban Restricted	-	-
Other Counties	2060	B Hybrid	45-50	-	Urban Restricted	-	-
Other Counties	2060	B Hybrid	50-55	-	Urban Restricted	-	-
Other Counties	2060	B Hybrid	55-60	-	Urban Restricted	-	-
Other Counties	2060	B Hybrid	60-65	-	Urban Restricted	-	-
Other Counties	2060	B Hybrid	65-70	69.5	Urban Restricted	518734	555350
Other Counties	2060	B Hybrid	70-75	-	Urban Restricted	-	-
Other Counties	2060	B Hybrid	75-80	-	Urban Restricted	-	-

Notes:
B = Build
EC = Existing Condition
NB = No-Build

I-39/90/94 Corridor Study

Technical Memorandum

Greenhouse Gases and Climate Change Impacts

June 2024

Wisconsin Department of Transportation

CONTENTS

APPENDICES

TABLES

FIGURES

1. Introduction of Greenhouse Gases and Climate Change

Climate change refers to long-term changes in temperature, precipitation, wind patterns, and other elements of the Earth's climate system. Climate change in the past has generally occurred gradually over millennia, or more suddenly in response to cataclysmic natural disruptions. The Intergovernmental Panel on Climate Change (IPCC) is the international body for assessing the science related to climate change. The research of the IPCC and other scientists over recent decades, however, has attributed an accelerated rate of climatological changes over the past 150 years to greenhouse gas (GHG) emissions generated from the production and use of fossil fuels (IPCC 2014). The impacts of climate change are being observed in the form of sea level rise, drought, more intense heat, extended and severe fire seasons and historic flooding from changing storm patterns. Climate change does not affect all people equally. Some communities experience disproportionate impacts because of existing vulnerabilities, historical patterns of inequity, socioeconomic disparities and systemic environmental injustices. People who already face the greatest burdens are often the ones affected most by climate change.

Human activities generate GHGs consisting primarily of carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), tetrafluoromethane, hexafluoroethane, sulfur hexafluoride and various hydrofluorocarbons. CO_2 is the most abundant GHG; although CO_2 is a naturally occurring and necessary component of Earth's atmosphere, fossil fuel combustion is the main source of additional, human-generated CO_2 that is the main driver of climate change. In the U.S., transportation is the largest source of GHG emissions, mostly CO_2. In Wisconsin, the electricity sector is the top GHG contributor. Transportation is the second-largest source of GHG emissions in Wisconsin.

The Council on Environmental Quality (CEQ) published interim guidance on January 9, 2023, regarding how to evaluate GHG emissions and climate change under the National Environmental Policy Act (NEPA). According to the interim guidance, when conducting climate change analyses in NEPA reviews, agencies should consider the potential effects of a proposed action on climate change, including by assessing both GHG emissions and reductions from the proposed action, as well as the effects of climate change on a proposed action and its environmental impacts. The CEQ interim guidance does not establish any particular quantity of GHG emissions as "significantly" affecting the quality of the human environment (CEQ 2023).

The interim guidance also provides considerations to document how GHG emissions impact environmental justice populations. The guidance notes: "Numerous studies have found that environmental hazards (including those driven by climate change) are more prevalent in and pose particular risks to areas where people of color and low-income populations represent a higher fraction of the population compared with the general population." The guidance also notes: "Agencies should be aware of the ongoing efforts to address the effects of climate change on human health and vulnerable communities. Certain groups, including children, the elderly, communities with environmental justice concerns, which often include communities of color, low-income communities, Tribal Nations, Indigenous communities and underserved communities are more vulnerable to climate-related health effects and may face barriers to engaging on issues that disproportionately affect them" (CEQ 2023).

This technical memorandum summarizes the GHG and climate change impact analysis of the Interstate 39 (I-39)/90/94 Corridor Study (the study) following the CEQ (2023) interim guidance. Because there are environmental justice populations present in the I-39/90/94 Corridor, and the interim guidance notes that environmental justice populations are generally at increased risk for climate change-related harms, this technical memorandum also documents the impacts of GHG emissions on environmental justice populations. Environmental justice populations, including minority and low-income populations, are located in the Madison metropolitan area and near the Wisconsin Dells as well as in Juneau County, the city of Portage, and the town of Fairfield. Detailed information on project engagement with environmental justice communities and impacts can be found in Section 3.9 of the study's Environmental Impact Statement (EIS).

2. Project Description

The Wisconsin Department of Transportation (WisDOT) and the Federal Highway Administration (FHWA) are preparing an EIS to evaluate potential improvements to provide reliable and safe travel on I-39/90/94 between United States Highway (US) 12/18 in Madison and US 12/Wisconsin State Highway (WIS) 16 in Wisconsin Dells. The study also evaluates I-39 from its split with I-90/94 (the I-39 I-90/94 Split) to Levee Road near Portage. The study corridor is 67 miles long and travels through Dane, Columbia, Sauk and Juneau counties. The Wisconsin River bridges project, the WIS 60 Interchange reconstruction, and the County V Interchange reconstruction are not part of the study corridor and were not analyzed in this memo. The study corridor location is shown in Figure 2-1.

I-39/90/94 in the study corridor is a multi-lane interstate with 15 interchanges and over 100 bridges. Two build alternatives are being evaluated in the EIS, as summarized below. Details of the alternatives are in the WisDOT Technical Memorandum: Alternatives Screening Analysis (WisDOT 2023a):

- Modernization Plus Added General-Purpose Lane

  The Modernization Plus Added General-Purpose Lane Alternative would reconstruct the Interstate with 12-foot shoulders and would provide an additional general-purpose lane in each direction along the present freeway alignment throughout a majority of the corridor. I-39 from the I-39 I-90/94 Split to Levee Road would maintain the same number of lanes as the existing condition. Where operationally prudent, the alternatives include collector-distributor (C-D) and auxiliary lanes.

- Modernization Hybrid

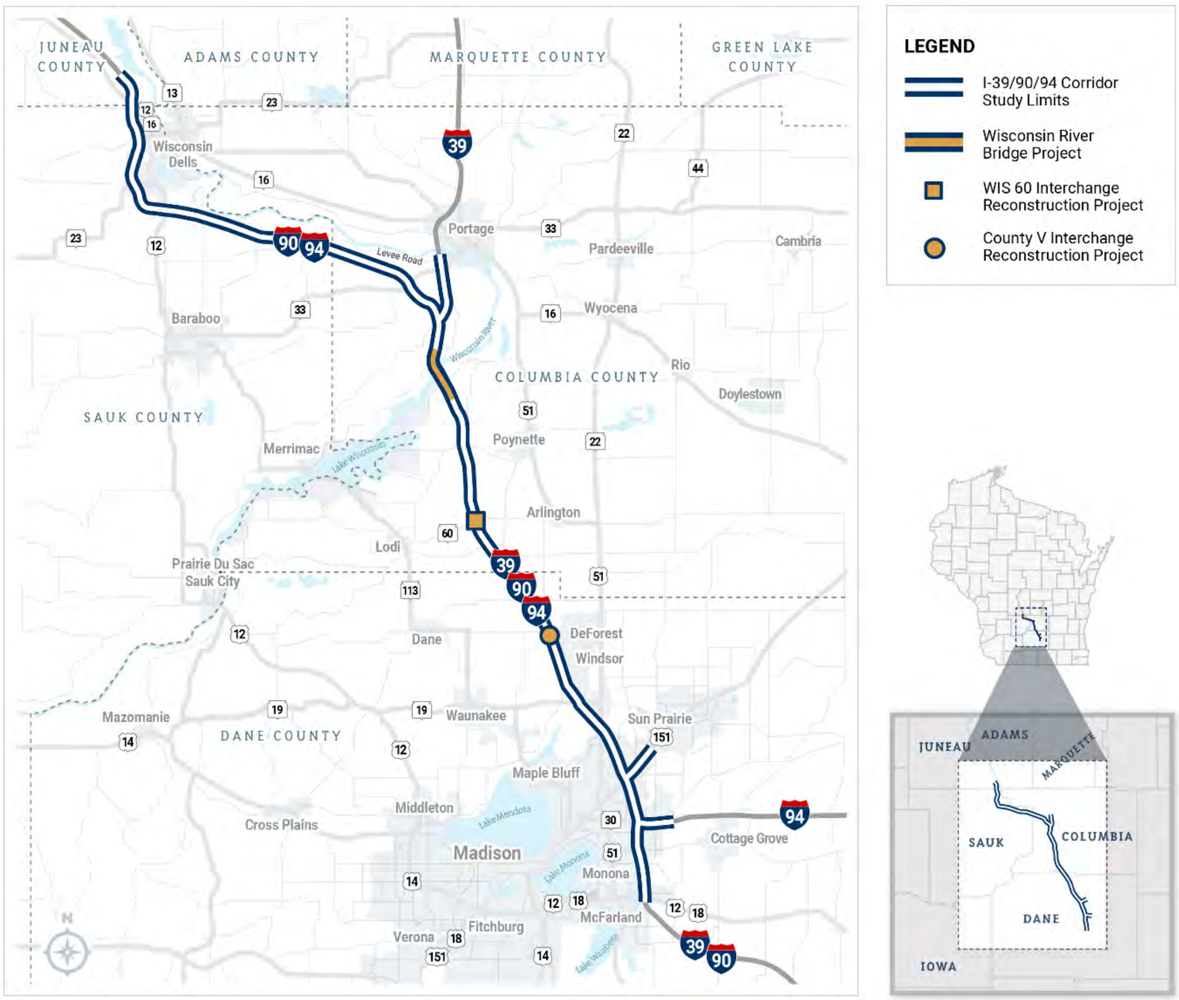
  The Modernization Hybrid Alternative would reconstruct the Interstate with a combination of adding a general-purpose lane or adding a managed lane; this alternative also uses C-D lanes and auxiliary lanes to further manage traffic. Managed lanes could be used in a variety of situations including part-time hard shoulder running, high-occupancy vehicle lanes, transit-only lanes or Connected and Automated Vehicles.

  From US 12/18 to WIS 19, the Interstate would feature the same number of general-purpose lanes as are currently present and include an 18-foot inside shoulder that would be used as a managed lane. C-D lanes are proposed between the I-94/WIS 30 and US 151 interchanges. Auxiliary lanes are proposed between the US 12/18 and I-94/WIS 30 interchanges and between the US 151 and WIS 19 interchanges.

  A general-purpose lane would be added to the Interstate from WIS 19 to the I-39 I-90/94 Split and to I-90/94 from the I-39 I-90/94 Split to the US 12/WIS 16 interchange. I-39 from the I-39 I-90/94 Split to Levee Road would maintain the same number of lanes as the existing condition.

Transportation Demand Management (TDM) strategies reduce personal vehicular travel or shift such travel to alternative times and routes, allowing for more efficient use of the existing transportation system's capacity. Transportation System Management and Operations (TSMO) strategies maximize existing transportation facilities' capacity and travel efficiency through freeway traffic management, street and highway traffic management, and other measures to help alleviate congestion. WisDOT's long-range transportation plan, Connect 2050[1], supports TDM and TSMO measures, as applicable to the Interstate system. While the TDM/TSMO measures do not meet the study purpose and need as a standalone alternative for the study, WisDOT may include TDM/TSMO measures in the build alternatives.

Figure 2-1: Study Corridor Location



[1] Connect 2050 with appendices.pdf - Google Drive

3. Regulatory Background

3.1. Federal

3.1.1. Regulations

The federal government has taken steps to improve fuel economy and energy efficiency to address climate change and its associated effects. The most important of these were the Energy Policy and Conservation Act of 1975 (42 United States Code Section 6201), as amended by the Energy Independence and Security Act of 2007, and Corporate Average Fuel Economy (CAFE) standards. The National Highway Traffic Safety Administration (NHTSA) of the United States Department of Transportation (USDOT) sets and enforces the CAFE standards based on each manufacturer's average fuel economy for the portion of its vehicles produced for sale in the United States. The United States Environmental Protection Agency (EPA) calculates average fuel economy levels for manufacturers, and also sets related GHG emissions standards under the Clean Air Act. Raising CAFE standards leads automakers to create a more fuel-efficient fleet, which improves our nation's energy security, saves consumers money at the pump and reduces GHG emissions (USDOT 2014).

NHTSA and EPA have issued a series of regulations to set fuel efficiency and GHG emission standards for vehicles since 2012. In December 2021, EPA published a final rulemaking that raised federal GHG emissions standards for passenger cars and light trucks for model years 2023 through 2026, increasing in stringency each year. The updated GHG emissions standards are anticipated to eliminate more than 3 billion tons of GHG emissions nation-wide through 2050. In May 2022, NHTSA published corresponding new fuel economy standards for model years 2024 through 2026 light-duty and medium-duty vehicles, which are anticipated to reduce fuel use by more than 200 billion gallons through 2050 compared with the old standards published in 2021 and reduce fuel costs for drivers (EPA 2022; NHTSA 2022).

On March 29, 2024, EPA issued a final rule "Greenhouse Gas Emissions Standards for Heavy-Duty Vehicles – Phase 3" to revise existing standards to reduce greenhouse gas emissions from heavy-duty vehicles in model year 2027 and set new, more stringent standards for model years 2028 through 2032. The final standards for heavy-duty vehicles will avoid approximately 1 billion metric tons of GHG emissions from 2027 through 2055, making an important contribution to efforts to limit climate change and its impacts such as heat waves, drought, sea level rise, extreme climate and weather events, coastal flooding, and wildfires (EPA 2024a).

3.1.2. National Environmental Policy Act Context

NEPA (42 United States Code Part 4332) requires federal agencies to assess the environmental effects of their proposed actions prior to deciding on the action or project. To date, no nationwide mobile-source GHG reduction targets have been established, nor have any regulations or legislation been enacted specifically to address climate change and GHG emissions reduction at the project level.

In January 2021, President Biden issued the "Executive Order on Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis" (Executive Order [EO] 13990). EO 13990 calls for all federal agencies to review climate-related regulations and actions taken between 2017 and 2021 and tasks CEQ with updating its "Final Guidance for Federal Departments and Agencies on Consideration of Greenhouse Gas Emissions and the Effects of Climate Change in National Environmental Policy Act Reviews" (81 FR 51866). On January 9, 2023, CEQ issued interim "National Environmental Policy Act Guidance on Consideration of Greenhouse Gas Emissions and Climate Change" with immediate effect, and the public comment period ended on April 10, 2023 (88 FR 10097). This GHG and climate change analysis for the I-39/90/94 Corridor Study followed the CEQ recommendations in this interim guidance.

3.2. State

Wisconsin has been active in addressing GHG emissions and climate change. EO 38 was signed on August 16, 2019, and established the Office of Sustainability and Clean Energy. The Office of Sustainability and Clean Energy is charged with promoting the development and use of clean and renewable energy across the state, advancing innovative sustainability solutions that improve the state's economy and environment, and diversifying the resources used to meet the state's energy needs. The goal is to ensure that all electricity consumed within the State of Wisconsin is 100 percent carbon-free by 2050. As directed by EO 38, Wisconsin's first Clean Energy Plan was released in 2022 (Wisconsin Office of Sustainability and Clean Energy 2022).

On October 17, 2019, Governor Tony Evers, along with Lieutenant Governor Mandela Barnes, signed EO 52, establishing the Governor's Task Force on Climate Change (Task Force). The Task Force advises and assists the governor in developing a strategy to mitigate and adapt to the effects of climate change for the benefit of all Wisconsin communities. The Task Force published the Governor's Task Force on Climate Change Report (State of Wisconsin 2020). Several policy recommendations in the report are relevant to the transportation sector. The strategy includes recommending WisDOT to perform climate and environmental justice impact analyses as transportation-related projects are considered and developed. Climate and environmental justice impact analyses are part of the I-39/90/94 Corridor study.

Following this strategy, WisDOT transportation planning and development staff analyzed the carbon emissions and environmental justice impacts associated with the study corridor. The carbon and climate impact analysis included an evaluation of the study's potential impacts on vehicle miles traveled (VMT), transportation-related carbon emissions and an assessment of climate resilience.

EO 52 also directed the Wisconsin Initiative on Climate Change Impacts (WICCI) to collect and update scientific data on the rate of climate change in Wisconsin and its impact on Wisconsin's natural environment. Following the requirements in EO 52, WICCI released the Wisconsin's Changing Climate: Impacts and Solutions for a Warmer Climate – 2021 Assessment Report (WICCI 2021) to share information that could foster solutions to climate change in Wisconsin.

4. Environmental Setting

GHGs are trace gases that trap heat in the Earth's atmosphere. Some GHGs such as CO_2 occur naturally and are emitted to the atmosphere through natural processes and human activities. Others (e.g., fluorinated gases) are created and emitted solely through human activities. The principal GHGs that enter the atmosphere because of human activities are CO_2, CH_4, N_2O and fluorinated gases. This section discusses the study corridor setting, national and state GHG inventory and application of regional plans and policies.

4.1. Study Corridor Setting

The proposed study corridor travels through the largely urban/suburban Madison metropolitan area in Dane County on the south end of the corridor, while the northern portion of the corridor in Columbia, Sauk and Juneau counties are mostly rural, with agricultural, low-density residential, and open space (land that is not intensively developed for residential, commercial, industrial, or institutional use). Details of the land use characteristics are in Section 3.1 of the EIS.

In Dane County, much of the I-39/90/94 corridor is near the city of Madison and other municipalities. Land use along the I-39/90/94 corridor and at the interchanges is primarily commercial and industrial with some park, open space, and environmental corridor lands. Land use along US 51, US 151 and WIS 30/I-94, and at County V and WIS 19 interchanges is primarily commercial and industrial.

In Columbia County, the land adjacent to I-39/90/94 is largely agricultural, low-density residential and open space. There is a large undeveloped, low-lying area between I-90/94 and the Wisconsin River. Development in rural Columbia County is focused around the five interchanges with I-39/90/94. All the interchanges have commercial and residential land use adjacent to them. Industrial land is only found at the I-39 I-90/94 Split interchange.

The Wisconsin Dells is in the northern part of the I-39/90/94 study corridor, in Sauk County. Wisconsin Dells land use is residential and commercial. South of Wisconsin Dells, land use along the corridor is similar to Columbia County – agricultural, low-density residential and open space. A small part of Juneau County is in the study area and includes the US 12/WIS 16 interchange. Land use in this portion of Juneau County is low-density commercial, agricultural and open space.

4.2. GHG Emissions Inventory

A GHG emissions inventory estimates the amount of GHGs discharged into the atmosphere by specific sources over a period of time. Tracking annual GHG emissions allows countries, states, and smaller jurisdictions to understand how emissions are changing and what actions may be needed to attain emission-reduction goals. The IPCC developed the global warming potential (GWP) concept to compare the ability of a GHG to trap heat in the atmosphere relative to another gas. CO_2 is the primary GHG emitted through human activities. In 2022, CO_2 accounted for 79.7 percent of all U.S. GHG emissions from human activities (EPA 2024b). Amounts of other gases are expressed relative to CO_2, using a metric called "carbon dioxide equivalent" (CO_2e). The GWP of CO_2 is assigned a value of 1, and the warming potentials of other gases are assessed as multiples of CO_2. For example, the Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2022 (EPA 2024b) used the GWP values from the IPCC (2014) *Fifth Assessment Report*, with the GWP of CH_4 as 28 (1 metric ton of CH_4 is equivalent to the warming effects of 28 metric tons of CO_2) and the GWP of N_2O as 265 (1 metric ton of N_2O is equivalent to the warming effects of 265 metric tons of CO_2), over a 100-year time horizon (IPCC 2014).

4.2.1. National Greenhouse Gas Inventory

According to the most recent GHG inventory, in 2022, total U.S GHG emissions are 6,343.2 million metric tons of CO_2e (MMT CO_2e). Net U.S. GHG emissions were 5,489 MMT CO_2e. Net GHG emissions increased by 1.5 percent from 2021 to 2022. The 2022 GHG emissions were 16.7 percent below 2005 levels. Between 2021 and 2022, the increase in total GHG emissions was driven largely by an increase in CO_2 emissions from fossil fuel combustion across most end-use sectors due in part to increased energy use from the continued rebound of economic activity after the height of the COVID-19 pandemic (EPA 2024b).

Figure 4-1 presents the GHG emissions trends by sector from 1990 to 2022 in the U.S. Overall, from 1990 to 2022, total emissions of CO_2 decreased by 1.5 percent, total emissions of CH_4 decreased by 19.4 percent and total emissions of N_2O decreased by 4.5 percent. U.S. GHG emissions were partly offset by carbon sequestration in managed forests, trees in urban areas, agricultural soils, landfilled yard trimmings and coastal wetlands. These were estimated to offset 14.5 percent of total gross emissions in 2022.

The five major fuel-consuming economic sectors are transportation, electric power, industrial, residential, and commercial. As shown in Figure 4-2, transportation activities accounted for the largest portion (28 percent) of total U.S. GHG emissions in 2022. Emissions from electric power accounted for the second largest portion (25 percent), while emissions from industry accounted for the third-largest portion (23 percent) of total U.S. GHG emissions in 2022. Of the total U.S. GHG emissions, 79.7 percent were CO_2. The largest source of CO_2 and of overall GHG emissions is fossil fuel combustion, primarily from transportation and power generation. The primary driver of transportation-related GHG emissions was CO_2 from fossil fuel combustion, which increased by 19.4 percent from 1990 to 2022. This rise in CO_2 emissions, combined with an increase in hydroflorocarbons (HFCs) from close to zero emissions in 1990 to 29.6 MMT CO_2e in 2022, led to an increase in overall GHG emissions from transportation activities of 18.6 percent (EPA 2024b).

Figure 4-1: U.S. GHG Emissions 1990 to 2022 by Sector (EPA 2024b)

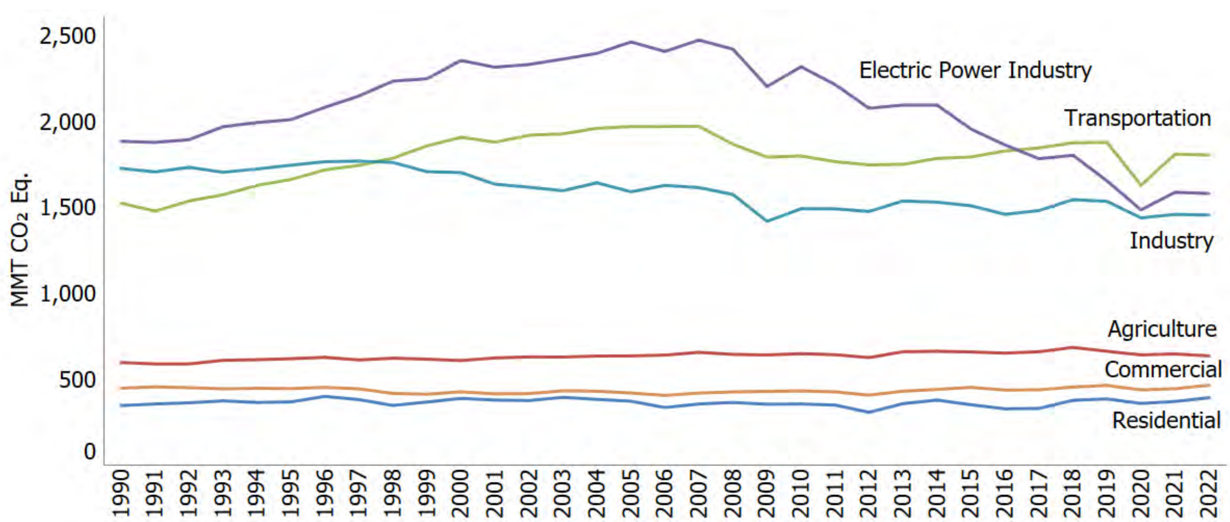
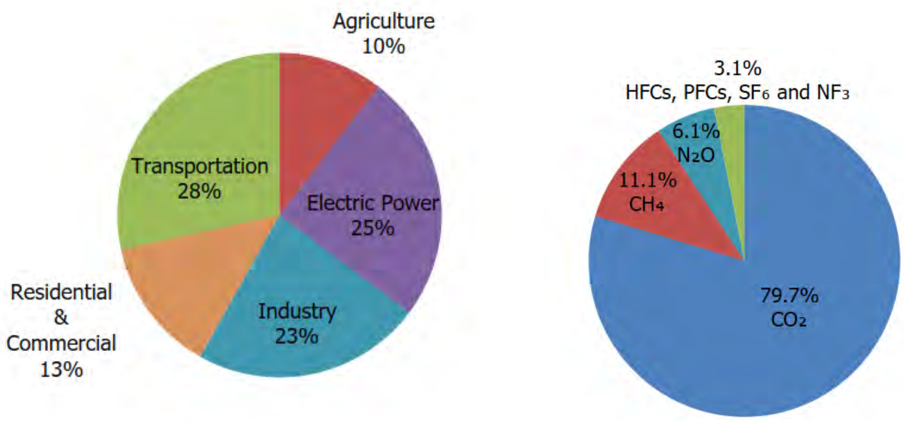


Figure 4-2: U.S. GHG Emissions in 2022 (EPA 2024b)

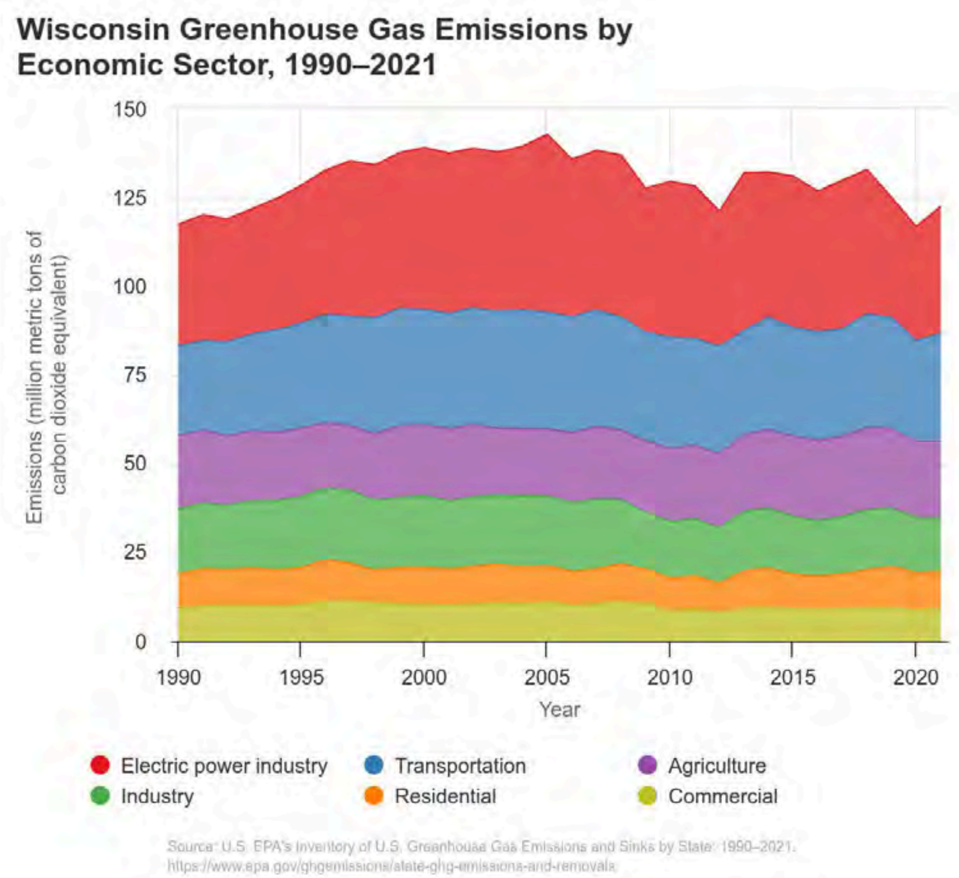


4.2.2. State Greenhouse Gas Inventory

Wisconsin's gross GHG emissions[2] were 122.5 MMT CO_2e in 2021 (EPA 2024c). Electricity generation is the top contributor to the GHG emissions in Wisconsin (29.1 percent), followed by transportation (24.9 percent). Figure 4-3 shows Wisconsin's GHG emissions by sector during 1990 to 2021. The state's gross GHG emissions decreased by 4.3 percent between 1990 and 2021. The electricity emissions as a share of total emissions peaked in 2005, representing 38 percent of total emissions in 2005 and decreased to 29.1 percent of total emissions in 2021. Emissions from the transportation sector increased the most since 1990, representing 21.4 percent of total emissions in 1990 and 24.9 percent of total emissions by 2021.

[2] *Emissions are reported as both 'net' and 'gross' in the GHG inventory. Gross emissions include emissions from nine economic sectors: electricity, residential, commercial, industrial, transportation, industrial process, natural gas and oil, waste and agriculture. Net emissions are calculated by subtracting the annual carbon storage from the land-use, land-use-change and forestry sector from the total gross emissions.*

Figure 4-3: Year by Year Change of Wisconsin GHG Emissions by Sector (1990-2021)



4.3. Regional Plans

4.3.1. State and Regional

The Capital Area Regional Planning Commission (CARPC) is one of nine commissions in Wisconsin established to coordinate planning and development among area municipalities. CARPC develops and promotes regional plans, provides objective information, and supports local planning efforts. CARPC's planning region includes Dane County and the cities, towns, and villages with incorporated areas in Dane County. In 2022, the CARPC adopted the 2050 Regional Development Framework (CARPC 2022) as the region's advisory land use guide that established goals, objectives, and strategies for accommodating future growth in the Dane County region. The strategies outlined in the Framework promotes growth that reduces greenhouse gas emissions and fosters community resilience to climate change.

The Greater Madison Metropolitan Planning Organization is the federally designated Metropolitan Planning Organization (MPO) for the Madison area. The Greater Madison MPO and the CARPC collaborated on the Connect Greater Madison Regional Transportation Plan for 2050 (The Greater Madison MPO 2022) that guides future transportation policy and investments for the region.
The Connect Greater Madison 2050 Regional Transportation Plan includes strategies to take action on critical issues, including equity and climate change. The plan established an environmental sustainability goal to minimize transportation-related greenhouse gas emissions that contribute to global climate change and design and maintain a transportation system that is resilient in the face of climate change.

The portions of the study corridor outside of Dane County are not within Greater Madison MPO area. Columbia and Sauk Counties are not served by a regional planning commission while Juneau County is part of the North Central Wisconsin Regional Planning Commission (NCWRPC). NCWRPC is in the process of updating its Regional Comprehensive Plan.

WisDOT has adopted *Connect 2050* as Wisconsin's roadmap for transportation policy making (WisDOT 2022). The goal in *Connect 2050* is to maximize transportation system resiliency and reliability through (1) developing physical and operational systems that are adept at preventing, preparing for, and coordinating responses to any incident, whether natural or the result of human activity, (2) emphasizing system resiliency to reduce repair costs and improve safety and security, and (3) identifying and assessing risk-based solutions for system vulnerabilities.

4.3.2. Local

In 2020, Dane County published the 2020 Dane County Climate Action Plan: Today's Opportunity for a Better Tomorrow (CAP, Dane County 2020). The CAP sets forth an ambitious set of climate goals for Dane County and lays out programs, policies, and projects that will enable the County to meet those goals. The goal established in the CAP is to reduce GHG emissions 50% county-wide by 2030 and put the county on a path to be carbon-neutral by 2050. Columbia, Sauk, and Juneau Counties do not have climate action plans.

5. GHG Emissions and Effects

Transportation projects may contribute to climate change due to the GHG emissions from construction and operation of the transportation systems. The primary GHGs produced by the transportation sector are CO_2, CH_4, and N_2O. CO_2 emissions are a product of gasoline or diesel fuel combustion in internal combustion engines, along with relatively small amounts of CH_4 and N_2O. Vehicles with internal combustion engines are a significant source of GHG emissions of the transportation section and contribute to global climate change, as discussed in Section 4.1.

5.1. GHG Emissions

Lifecycle GHG emissions associated with the study corridor construction and operation were quantified as a proxy to evaluate the GHG impacts to the environment, as discussed in the following subsections. This section provides a summary of the GHG emission analysis approach and the results.

5.1.1. Analysis Years and Study Area

It is anticipated that construction of the study corridor would start in 2030 and finish in around 2040. Construction will be carried out in phases with completed segments open to traffic starting in 2030. The analysis years of the GHG effects include the opening year 2030 and the design year 2060, which is 20 years after the completion of construction of the entire study corridor. The analysis evaluated the annualized and cumulative emissions of construction and operation between 2030 and 2060.

Chapter 2 Project Description describes the two build alternatives evaluated within the EIS. The Modernization Hybrid alternative (Hybrid Alternative) includes active traffic management of the managed lane, thereby providing the same number of travel lanes during congested periods of the day as the Modernization Plus Added General Purpose Lane (GP Lane Alternative).

Traffic data would be the same in counties outside of Dane County for the GP Lane and Hybrid alternatives. In Dane County, the Dane County travel demand model (DCTDM) was used to estimate differences in traffic volumes and speeds between the two build alternatives by lowering the number of lanes in the managed lane area during the midday and night periods.

The DCTDM models four discrete time periods for both a base year 2016 and horizon year 2050 including AM period of 6-9 AM, midday period of 9 AM to 3 PM, PM period of 3-6 PM and night period of 6 PM to 6 AM. This architecture allows for modeling of a managed lane being open in one or more time periods and closed in others. This architecture also requires the managed lane to be modeled as either open or closed for the duration of each respective time period. However, the Hybrid alternative incorporates a dynamic managed lane which could be opened at any time of day based on observed traffic conditions. The draft concept of operations developed for the Hybrid alternative uses hourly projected traffic demands for year 2050 to determine the likely hours of operation of the managed lane including 2 PM to 6 PM for select sections of the system. The 2 PM to 3 PM portion of that managed lane operation is not able to be captured with the DCTDM's midday analysis period, resulting in small differences in traffic assignments from the DCTDM during that midday time period. Build traffic forecasts were developed using the GP Lane alternative's DCTDM outputs with the understanding that the managed lane would be available at times of the day when traffic congestion warranted the need. Traffic operations and safety modeling was conducted using the traffic forecasts developed with the GP Lane alternatives DCTDM outputs. For purposes of documenting the potential differences in GHG analysis outputs, both the GP Lane and Hybrid alternatives' DCTDM outputs were evaluated with the understanding that the Hybrid alternative's DCTDM outputs were not fully capturing the midday traffic demands. This approach provides the envelope within which to compare the GP Lane and Hybrid alternatives relative difference in impacts to GHG.

The Hybrid Alternative results in a net decrease in VMT within the affected roadway links of 4,832 vehicle miles traveled, or 0.116 percent of VMT for the 2050 build condition, compared to the GP Lane Alternative. This is compared to the GP Lane Alternative's increase in VMT over the No Build of 3.43 percent for that same area.

Maximum directional volume difference under the Hybrid Alternative is a reduction of 565 vehicles per day on the segment between WIS 30/I-94 and US 12/18, compared to the GP Lane Alternative. That equates to the Hybrid alternative having a reduction of VMT within the Dane County study limits of just under one percent compared to the GP Lane alternative's Dane County study area VMT. Of the 565 vehicles per day, 561 occur in the mid-day time period.

Construction activities and the traffic patterns/vehicle volumes during construction and operation of the build alternatives would be similar. WisDOT typically constructs major roadways in a manner that maintains the majority of traffic within the construction zone. Both build alternatives would experience similar intensity of construction activity needs and traffic volumes/patterns of vehicles on the roadways in the study area. Therefore, GHG construction emissions of the two build alternatives were quantified using the same set of representative construction data.

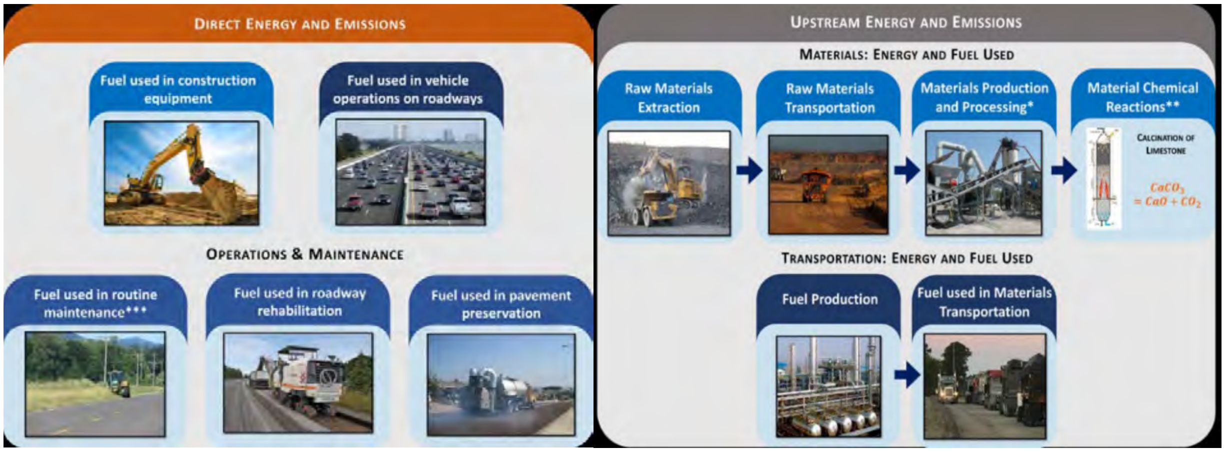
The affected roadways included in the GHG analysis are consistent with the study's mobile source air toxic analysis, described in the I-39/90/94 Study – MSAT Analysis Impacted Links Methodology and VMT/VHT Results, in Appendix A. The southern portion of the study corridor goes through the highly urbanized Madison metropolitan area in Dane County. The rest of the corridor goes through areas that are mostly rural in Columbia, Juneau, and Sauk counties. To capture the different traffic and vehicle characteristics in these areas, the affected roadways were selected and evaluated based on two analysis areas —the Dane County area covers affected roadways within the Dane County limit, and the "Other Counties" area covers the affected roadways outside of Dane County. Details of the GHG emission calculations, assumptions and results are in Appendix B.

5.1.2. Emissions from Construction and Roadway Operation and Maintenance

GHG emissions from the study corridor construction and operations and maintenance (O&M) were estimated using FHWA's Infrastructure Carbon Estimator (ICE), Version 2.2.8 (FHWA 2023). The ICE 2.2.8 was developed by FHWA to estimate the lifecycle energy and GHG emission from transportation infrastructure construction, maintenance, and operation. Lifecycle GHG accounting evaluates and reports the GHG emissions associated with the raw materials extraction, manufacturing or processing, transportation, use and end-of-life management of a good or service.

The ICE 2.2.8 considers the following direct and indirect (upstream) emissions to estimate construction-, operation- and maintenance-related emissions.

Figure 5-1: GHG Emissions Sources Evaluated in ICE 2.2.8



Source: ICE Version 2.2.8 (FHWA 2022).

Notes:
** For example, crushing of aggregate, asphalt batch plants*
*** For example, CO_2 emitted from calcination of limestone*
**** Activities include sweeping, striping, bridge deck repair, litter pickup and maintenance of appurtenances*

GHG emissions from the study area were modeled using ICE 2.2.8 and broken into five categories:

- Material: Includes the upstream emissions associated with construction materials extraction, production, chemical reaction and raw material transportation.
- Transportation: Includes upstream emissions associated with fuel used in transportation of materials to the site.
- Construction: Includes the emissions from energy and fuel used in construction equipment.
- O&M: Includes the emissions from routine maintenance of the infrastructure, such as snow removal and vegetation management, roadway repair and rehabilitation and other routine maintenance.
- Usage: Includes emissions from vehicle travel on roadways.

Construction and Maintenance Emissions

Study corridor construction is anticipated to start in 2030 and to last approximately 10 years. Segments on the study corridor will open as construction is completed. Therefore, some of the segments may start operation as early as 2030. GHG construction and maintenance emissions from the build alternatives were modeled using ICE 2.2.8 based on the construction information of each alternative and design options, and including the emissions from the following infrastructure and activities:

- Bridges and overpasses
- Lighting
- Roadways
- Signage

For the No-Build Alternative, only the emissions from roadway and lighting O&M were estimated using the ICE 2.2.8. There would be no construction activities under the No-Build Alternative.

Direct tailpipe GHG emissions during the construction phase due to vehicle traffic delay were modeled using EPA's MOVES4 model, the latest official version of MOVES at the time of this study. GHG emissions were modeled based on the impacted VMT and speed information in Dane County and the other counties. GHG emissions from these two areas were summed together and entered into the ICE 2.2.8 to obtain the lifecycle emissions. ICE 2.2.8 calculation sheets and the emission summary are in Appendix B. MOVES4 modeling methodologies are the same as described in Section 5.1.2, except the analysis years are 2030 and 2040 for the construction.

Long-term Vehicle Operation Emissions

Vehicle operation emissions were estimated for a 30-year period from 2030 to 2060. Tailpipe emissions from the vehicles in 2030 and 2060 were modeled using MOVES4 based on the anticipated VMT and speed information in Dane County and other counties. The resulting tailpipe emissions from the two areas were summed up and entered into the ICE 2.2.8 to obtain the lifecycle GHG emissions from the vehicle operation.

The input data used for the GHG analysis are described in Table 5-1 through Table 5-3. Study corridor-specific information, including VMT and vehicle speeds, were used in MOVES4 (shown in Appendix C). MOVES default inputs were used when study corridor-specific information was not available. MOVES defaults were obtained using the following approach:

- Defaults for affected roadways in Dane County: Defaults were obtained using the geographic bounds of Dane County
- Defaults for affected roadways in other counties: For the affected roadways outside of Dane County, the study corridor is mostly in Columbia County and Sauk County, and a small segment in Juneau County. Some of the affected roadways are also in Rock, Jefferson, Iowa, and Dodge counties, and beyond. Through coordination with WisDOT and FHWA, it was agreed that majority of the affected roadways outside of Dane County in the study area would have similar characteristics such vehicle population distribution, vehicle age distribution, vehicle fuel types, and meteorological conditions. Therefore, affected roadways in these counties could be reasonably represented in MOVES as one single area using representative data inputs. Because a large portion of the study corridor outside of Dane County is in Columbia County, the MOVES default inputs of vehicle population distribution, vehicle age distribution, vehicle fuel types, and meteorological data of Columbia County was used in the MOVES modeling for affected roadways in the counties outside of Dane County.

Table 5-1: MOVES RunSpec Options

MOVES Tab	Model Selections
Scale	County scale; Inventory mode
Time Span	Hourly time aggregation including weekdays and weekends, all 24 hours for all 12 calendar months
Geographic Bounds	Dane County, Wisconsin (for affected roadways in Dane County) Columbia County, Wisconsin (for affected roadways in other counties)
Vehicles/Equipment	All MOVES4 vehicle and fuel-type combinations

MOVES Tab	Model Selections
Road Type	Urban restricted access Urban unrestricted access Rural restricted access Rule unrestricted access Excluding off-network
Output	Output included speciation of emissions by fuel type
Time Aggregation	Year (Annual)

Table 5-2: MOVES RunSpec Emission Processes

Process ID	Process Description
1	Running Exhaust
15	Crankcase Running Exhaust
11	Evaporative Permeation
13	Evaporative Fuel Leaks

Table 5-3: MOVES County Data Manager Inputs

County Data Manager Tab	Data Source
Source Type Population	WisDOT Department of Motor Vehicles and MOVES4 Defaults1
Age Distribution	MOVES4 Defaults
Fuel	MOVES4 Defaults
Meteorology Data	Wisconsin Department of Natural Resources
Vehicle Type VMT and Time Distributions	Study corridor-specific data and MOVES4 Defaults2
Average Speed Distribution	Study corridor-specific Data
Road Type Distribution	Study corridor-specific Data

Notes:
1. MOVES4 Defaults were used to project the DMV data to future years and classify the DMV data into MOVES4 source types.
2. MOVES4 Defaults were used to split vehicle categories into MOVES4 source types.

Emissions Summary

ICE 2.2.8 annualizes the total construction and operation emissions over a project's lifetime. The time frame of the GHG emission analysis was based on a 30-year lifetime to be conservative, although the typical lifetime of a transportation project is anticipated to be 50 to 75 years. The lifecycle GHG emissions are presented in the unit of metric tons of carbon dioxide equivalent (MT CO_2e), which are calculated as the product of the mass of a given GHG and its specific GWP. Annualized lifecycle GHG emissions from the study corridor's construction, O&M and vehicle operation are summarized in Table 5-4.

Table 5-4: Annualized Lifecycle GHG Emissions from Construction, O&M, and Vehicle Operation ($MT\ CO_2e$/year)

Activities	No-Build	Build – GP Lane	Build - Hybrid
Bridges_Overpasses	0	2,330	2,330
Lighting (Construction and O&M)	41	96	96
Roadways (Construction and O&M)	4,154	17,316	17,316
Signage	0	210	210
Vehicle_Ops_ConstructionDelay	0	405	405
Vehicle_Ops_VMT Operations	1,062,622	1,096,127	1,095,422
Total Construction, O&M, and Vehicle Operation	1,066,817	1,116,484	1,115,779
Difference Build vs No-Build	NA	49,667	48,962
Difference Build vs No-Build %	NA	4.7%	4.6%

Data source: FHWA ICE tool, Version 2.2.8

As shown in Table 5-4, the greatest GHG emissions would be from vehicle operation (vehicle travel) on the study corridor. However, there would be no substantial differences (4.6 to 4.7 percent) between the annualized GHG emissions from the build and no-build alternatives. The annualized GHG emissions of the build alternatives would be 4.6 to 4.7 percent higher than the No-Build Alternative due to the additional lanes to be constructed.

There would be no construction emissions from the No-Build Alternative. O&M emissions from the No-Build Alternative were estimated using ICE 2.2.8 and includes the emissions from O&M of the roadways and lighting. Due to the age of the existing roadway, the deteriorated roadway conditions and the associated higher maintenance needs under the No-Build Alternative would likely require more O&M activities and result in higher GHG emissions than the newly constructed roadways of the build alternatives . Because the ICE tool does not consider the age of the roadways when estimating the O&M emissions, O&M emissions from the No-Build Alternative would likely be higher than what is presented in Table 5-1.

5.1.3. Cumulative GHG Emissions

Cumulative GHG emissions are the total emission from the study corridor construction and operation over the 30-year analysis period in the study area. Cumulative GHG emissions from the No-Build and Build alternatives were modeled by ICE 2.2.8 and summarized in Table 5-5. Emission trends between the No-Build and build alternatives are consistent with the trends of the annualized emissions that the cumulative GHG emissions from the build alternatives would be 4.7 percent higher than the No-Build Alternative.

Table 5-5: Cumulative GHG Emissions (Construction and Operation in 2030-2060), MT CO_2e

Activities	No-Build	Build – GP Lane	Build - Hybrid
Bridges_Overpasses	0	69,897	69,897
Lighting (Construction and O&M)	1,238	2,889	2,889
Roadways (Construction and O&M)	124,616	519,491	519,491
Signage	0	6,297	6,297
Vehicle_Ops_ConstructionDelay	0	12,144	12,144
Vehicle_Ops_VMT Operations	31,878,667	32,883,810	32,862,652
Total Construction and Operation	32,004,522	33,494,527	33,473,369
Difference Build vs No-Build	NA	1,490,005	1,468,847
Difference Build vs No-Build %	NA	4.7%	4.6%

Data source: FHWA ICE tool, Version 2.2.8

5.1.4. GHG Equivalency

CEQ interim guidance indicates that agencies may provide accessible comparisons or equivalents for the public and decision makers to understand GHG emissions in more familiar terms, such as placing GHG emissions as household emissions per year, average emissions from a certain number of cars on road, or amount of fuel burned. Based on the GHG emission results, GHG equivalency values were derived using EPA's Greenhouse Gas Equivalencies Calculator (EPA 2023a) and are summarized in Table 5-6.

Table 5-6: Annualized GHG Emissions Equivalency for the Emissions Increases from Build Alternatives (Compared to No-Build Alternative)

	GHG Equivalency (Emission Increase of GP Lane Alternative)	GHG Equivalency (Emission Increase of Hybrid Alternative)
Barrels of crude oil consumed per year	114,879	113,346
Gasoline-powered passenger vehicles driven for one year	11,076	11,653
Tanker truck's worth of gasoline per year	656	646
Natural-gas-fired power plant in one year	0.15	0.15

5.2. Social Cost of GHG Emissions

Following the CEQ interim guidance, to provide additional context for GHG emissions, social costs of GHG (SC-GHG) due to GHG emissions from the study alternatives were estimated to translate climate impacts into the more accessible metric of dollars, to allow decision makers and the public to make comparisons, help evaluate the significance of an action's climate change effects and better understand the tradeoffs associated with an action and its alternatives.

The SC-GHG is a measure, in dollars, of the long-term damage done by a ton of GHG emissions in a given year. This dollar figure also represents the value of damages avoided for a small emission reduction (i.e., the benefit of a GHG reduction). The SC-GHG is a comprehensive metric that includes the value of all future climate change impacts (both negative and positive), and includes changes in net agricultural productivity, human health effects, property damages from increased flood risk, and changes in the frequency and severity of natural disasters, disruption of energy systems, risk of conflict, environmental migration, and the value of ecosystem services. The SC-GHG also reflects the societal net benefit of reducing emissions of the GHG by a metric ton. In practice, data and modeling limitations restrain the ability of SC-GHG estimates to include all physical, ecological, and economic impacts of climate change, implicitly assigning a value of zero to the omitted climate damages. The estimates are, therefore, a partial accounting of climate change impacts and likely underestimate the marginal benefits of abatement (EPA 2023).

EO 13990 re-established the Interagency Working Group (IWG) on the Social Cost of Greenhouse Gases and directed it to ensure that SC-GHG estimates used by the U.S. government reflect the best available science and the recommendations of the National Academies and work toward approaches that take account of climate risk, environmental justice and intergenerational equity (IWG 2021). EPA is a member of the IWG and is participating in the IWG's work under E.O. 13990. The SC-GHG values used in this analysis are from EPA's *Supplementary Material for the Regulatory Impact Analysis for the Final Rulemaking, "Standards of Performance for New, Reconstructed, and Modified Sources and Emissions Guidelines for Existing Sources: Oil and Natural Gas Sector Climate Review" EPA Report on the Social Cost of Greenhouse Gases: Estimates Incorporating Recent Scientific Advances* (EPA 2023b).

5.2.1. Social Cost Estimate Methodology

GHG emissions from the study corridor construction and operation were estimated using the FHWA's ICE tool, and the output results are presented as CO_2e. Unit SC-GHG cost factors vary for each type of the GHG; however, emissions of different types of GHG of CO_2, CH_4 and N_2O are not provided in the ICE tool outputs. Because a majority of the GHG emissions from the construction and operation would be CO_2 from fuel combustion, it was assumed that the CO_2e emissions are 100% CO_2 in the SC-GHG calculations. SC-GHG for emissions from the opening year in 2030 and design year 2060 were calculated to provide information of the SC-GHG on an annual basis. Cumulative SC-GHG associated with the GHG emissions in the 30-year analysis period from 2030 to 2060 were calculated for the No-Build and build alternatives.

The SC-GHG discount rates are important factors influencing SC-CO_2 estimates. A large portion of climate change damages are expected to occur many decades into the future, and the present value of those damages (the value at present of damages that occur in the future) is highly dependent on the discount rate. Future costs and benefits are considered less than present costs and benefits, and the discount rate reflects this level of relative significance. A high discount rate means that future effects are considered much less significant than present effects, whereas a low discount rate means that they are closer to equally significant. The SC-GHG analysis evaluated all four discount rates in EPA's report (2.5 percent, 2.0 percent, and 1.5 percent), to present the potential ranges of the SC-GHG of the alternatives.

Because the unit SC-GHG cost factors vary by the year the emissions would occur, SC-GHG from the build and no build alternatives were calculated on a year-by-year basis. Year-by-year GHG emissions between 2030 and 2060 were estimated by interpolating the emissions for 2030 and 2060 that were obtained from the ICE 2.2.8 outputs. Annual SC-GHG between 2030 to 2060 was calculated by multiplying the unit SC-CO_2 cost factors (in 2020 dollars per MT of each respective GHG) by the corresponding GHG emissions for each year. The cumulative SC-GHG were calculated by summing the annual SC-GHG during 2030 to 2060.

5.2.2. Annual Social Cost of GHG Emissions

Annual SC-GHG were calculated for the years 2030 and 2060. The annual emissions used in the SC-GHG calculation included the vehicle operation emissions based on the operational VMT in the study area in 2030 and 2060, and the annualized construction emissions. Because unit SC-GHG cost factors are dependent on the year that the emissions would occur, the 30-year annualized emissions from the ICE 2.2.8 output, as presented in Table 5-4, were not used in the annual SC-GHG calculation. SC-GHG values resulting from the No-Build and the build alternatives in 2030 and 2060 are summarized in Table 5-7.

For the same emission year and discount rate, the SC-GHG of the build alternatives are similar. SC-GHG for the build alternatives would be 2.5 percent higher than the No-Build Alternative for the 2030 emission year, and 6.9 to 7.0 percent higher than the No-Build Alternative for the 2060 emission year. SC-GHG would be higher in 2060 than in 2030, which is consistent with the trend of the higher GHG emissions and the higher unit SC-GHG cost factors in 2060.

Table 5-7: Social Cost of Greenhouse Gases for Emissions in 2030 and 2060 (in 2020 dollars) and Comparisons to No-Build Alternative

	2030						
Discount Rate	**No-Build**	**Build – GP Lane**	**Change (GP Lane vs No Build)**	**% Change (GP Lane vs No-Build)**	**Build - Hybrid**	**Change (Hybrid vs No Build)**	**% Change (Hybrid vs No-Build)**
2.5%	$152,917,250	$156,704,898	$3,787,648	2.5%	$156,679,624	$3,762,375	2.5%
2.0%	$251,221,196	$257,443,761	$6,222,565	2.5%	$257,402,240	$6,181,044	2.5%
1.5%	$415,061,106	$425,341,866	$10,280,760	2.5%	$425,273,266	$10,212,160	2.5%
	2060						
Discount Rate	**No-Build**	**Build – GP Lane**	**Change (GP Lane vs No Build)**	**% Change (GP Lane vs No-Build)**	**Build - Hybrid**	**Change (Hybrid vs No Build)**	**% Change (Hybrid vs No-Build)**
2.5%	$231,439,342	$247,571,035	$16,131,693	7.0%	$247,293,455	$15,854,112	6.9%
2.0%	$352,190,304	$376,738,532	$24,548,228	7.0%	$376,316,127	$24,125,823	6.9%
1.5%	$533,316,745	$570,489,776	$37,173,031	7.0%	$569,850,135	$36,533,389	6.9%

5.2.3. Cumulative Social Cost

Cumulative SC-GHGs during the 30-year analysis period were estimated for the No-Build and build alternatives as described in Section 5.2.1. The cumulative SC-GHGs of the study corridor are summarized in Table 5-8. The cumulative SC-GHG of the build alternatives would be approximately 5% higher than the cumulative SC-GHG of the No-Build Alternative.

Table 5-8: Cumulative Social Cost in 2030 to 2060 (in 2020 dollars) and Comparisons to No-*Build* Alternative

	SC-GHG ($) 2030-2060						
Discount Rate	**No-Build**	**Build - GP Lane**	**Changes (GP Lane vs No Build)**	**Percent Changes (GP Lane vs No Build)**	**Build Hybrid**	**Changes (Hybrid vs No Build)**	**Percent Changes (Hybrid vs No Build)**
2.5%	$5,892,190,180	$6,178,295,014	$286,104,834	4.9%	$6,178,341,546	$6,178,295,014	4.9%
2.0%	$9,243,116,199	$9,689,156,188	$446,039,989	4.8%	$9,689,218,230	$9,689,156,188	4.8%
1.5%	$14,514,313,546	$15,209,688,982	$695,375,436	4.8%	$15,209,766,534	$15,209,688,981	4.8%

5.3. Mitigation for Greenhouse Gas Emissions

Reducing GHG emissions is a key strategy to address climate change impacts. GHG emissions would be produced at different levels throughout the study corridor's construction phase. At a project level, although GHG mitigation measures are not specifically required under NEPA or other state and federal regulations, WisDOT will follow its Standard Specifications that exist to address pollution reduction/containment measures for the contractor, and also implement the following mitigation measures to help reduce GHG emissions, as appropriate to the size and scale of each construction project:

- Implement detours and strategic construction timing where feasible to reduce construction delays, including vehicle idling from backups.
- Set up active construction zones, staging areas and material transfer sites in a way that reduces standing wait times for equipment. Reducing idling times reduces GHG emissions from passenger cars and construction vehicles.
- Work with contractors and subcontractors to reduce idling times. An example would be for contractors and subcontractors to complete and submit idling logs of construction vehicles/equipment every 6 months and monitor by comparing a baseline log at inception of the project.
- Communicate with local municipalities and neighborhood groups, including groups focused on serving environmental justice populations, as to the location of staging areas and material transfer sites. Work with the same municipalities and groups to minimize the impacts of staging areas and material transfer sites.
- Encourage construction contractors to use ridesharing and other commute trip reduction efforts to reduce GHG emissions from commute vehicles of employees working on the project.
    - WisDOT will evaluate areas in proximity to the jobsite where construction staff and equipment parking could occur, and that results in distribution of GHG emissions.
    - WisDOT will post signs to encourage construction staff to use public transport or rideshare.
- Some anticipated TDM/ TSMO measures to be included are freeway monitoring and advisory information, crash investigation sites and law enforcement pads, traffic detectors and enhanced mile-marker posts.

- Encourage contractors to recycle construction and demolition materials to the extent possible. Asphalt, concrete and rubble are often recycled into aggregate or new asphalt and concrete products. Metals—including steel—are also valuable commodities to recycle.
- Use LED bulbs in new lighting installed along the study corridor. LEDs use less electricity than traditional light bulbs, which in turn reduces the amount of fossil fuel being burned to generate electricity.
- Plant stormwater trees in the study corridor. Trees absorb stormwater and reduce erosion during a rainfall event. They also absorb CO_2 and serve as an urban canopy to reduce urban heat zones.
- Construction of the study corridor will follow WisDOT project site air quality specifications. This includes voluntarily establishing staging zones for trucks waiting to load and unload; locating staging zones where idling of diesel-powered equipment will have minimal impact on abutting properties and the general public; having trucks queue up in these zones when practicable; and encouraging drivers to shut down diesel trucks as soon as it appears likely they will be queued up for more than 10 minutes.
- Public vehicle access to and from the study corridor during construction would be maintained to the extent possible, or alternative access would be provided. If alternative access is not available, the specific construction activity would be reviewed to determine if it could occur during non-peak hours.

WisDOT will continue to coordinate with the city of Madison and Madison Metro Transit throughout design and construction to support transit service implementation and avoid and minimize transit service disruption during construction. The additional bicycle and pedestrian facilities that are part of the build alternatives would support alternative transportation choices.

Mitigation measures have been identified to minimize construction impacts (including GHG impacts) on environmental justice populations. Prior to construction, a plan would be developed to establish construction phases, estimated durations, appropriate sequencing, and community outreach and communication commitments. WisDOT would continue its targeted stakeholder outreach inclusive of minority and low-income populations. Access to and from the Interstate during construction would be maintained to the extent possible, or alternative access would be provided. If alternative access is not available, the specific construction activity would be reviewed to determine whether it could occur during non-peak hours. Section 3.9 of the EIS identifies mitigation for environmental justice communities

The mitigation measures described previously are part of the effort by FHWA to adopt practicable means to avoid and minimize environmental harm in accordance with 40 Code of Federal Regulations 1505.2 and will be further developed during final design. These collective measures would reduce or offset GHG emissions from study corridor construction and benefit all populations, including environmental justice populations, living along the study corridor.

5.4. Cumulative GHG Effects

The analysis and public disclosure of cumulative effects of the study corridor are accomplished by quantifying GHG emissions, as discussed in Section 5.1, and by providing context for understanding their effects, as discussed in Section 5.2. The GHG emissions estimates and monetized climate damages serve as a proxy for the study corridor’s potential contribution to global climate change.

GHG emissions from transportation is the largest contributor of U.S. GHG emissions and second-largest contributor of Wisconsin GHG emissions. Burning fossil fuels like gasoline and diesel releases GHG into the atmosphere, and the buildup of CO_2 and other GHGs is causing global warming, resulting in changes to the climate we are already starting to see today, as described in Section 6.1. Cumulative climate change effects are felt locally and regionally; however, climate change effects experienced at local and regional levels are not the direct result of an individual project's contributions, but the result of cumulative, global contributions. GHGs are different from other air pollutants evaluated in federal environmental reviews because their impacts are not localized or regional. GHG impacts are cumulative, global impacts. Each emission source may make a relatively small contribution to global atmospheric GHG concentrations.

Future global GHG emissions will be affected in ways that cannot be accurately accounted for at this time. Changes to various air quality regulations, technological advances that alter transportation systems, changes to how vehicles are powered and/or changes in fuels will affect GHG emissions. Likewise, acts of nature (e.g., pandemics), societal changes, market forces, economics and personal decisions could alter where and how people live, work or travel, further impacting GHG emissions.

Nonetheless, the GHG emission-reduction measures described in Section 5.3, represent federal, state and practical project-level measures that may help reduce GHG emissions on an incremental basis and could contribute in the long term to a meaningful cumulative reduction when considered across the federal-aid highway program.

6. Effects of Climate Change

Reducing GHG emissions is only one part of an approach to addressing climate change. WisDOT is also addressing effects of climate change on the state's transportation infrastructure and working to strengthen and protect the transportation infrastructure from damage from climate change, as further discussed in Section 6.2. Globally, climate change is expected to produce increased variability in precipitation, rising temperatures, rising sea levels, variability in storm surges and their intensity and in the frequency and intensity of wildfires. Flooding and erosion can damage or wash out roads, longer periods of intense heat can buckle pavement and railroad tracks and storm surges combined with rising sea levels can inundate highways. Wildfire can directly burn facilities and indirectly cause damage when rain falls on denuded slopes that landslide after a fire. Effects will vary by location and may, in the most extreme cases, require that a roadway be relocated or redesigned. Wisconsin is expected to experience higher temperatures, increased precipitation and more extreme weather events in future years, as further discussed in Section 6.1.3.

Climate change also affects people's health in many ways. As the climate changes, more people may be exposed to extreme weather like heat, floods, droughts, storms and wildfires. These events can cause illness, injury and even death. Climate change can also lead to more diseases spread by insects and ticks, and it can affect the quality and safety of air, water and food, including through the spread of harmful bacteria or viruses. In addition, hazards related to climate change can affect mental health, such as causing anxiety, depression and post-traumatic stress (EPA 2023c).

As noted in the interim guidance, most severe harms from climate change fall disproportionately upon underserved communities who are least able to prepare for and recover from heat waves, poor air quality, flooding, and other impacts. Racial and ethnic minority communities are particularly vulnerable to the greatest impacts of climate change per EPA (EPA 2021). As noted by the USDOT, the effects of climate change often have a more detrimental effect on vulnerable populations and can disproportionately impact communities of color and low-income communities (USDOT 2023). Environmental justice communities are typically exposed to a disproportionate amount of air pollution and other environmental hazards.

Section 3.9 of the EIS provides an environmental justice analysis for the study. As documented in Section 3.9 of the EIS, environmental justice populations are present in this study corridor. Section 3.9 of the EIS also describes the outreach and engagement opportunities afforded to environmental justice populations as part of this study. WisDOT will continue to provide meaningful engagement opportunities for environmental justice populations throughout final design. Environmental justice populations will be able to express any concerns about GHG impacts, and WisDOT will work with them to develop appropriate construction mitigation.

The construction impacts (including GHG emissions) when combined with proposed mitigation are similar between environmental justice populations and non-environmental justice populations. Environmental justice populations are not anticipated to experience disproportionate impacts due to GHG emissions along the study corridor.

6.1. Present and Projected Future Climate Change Effects

6.1.1. National Level

According to the Fifth National Climate Assessment, global average temperatures over the past decade (2012–2021) were close to 2 degrees Fahrenheit [°F] (1.1 degrees Celsius [°C]) warmer than the preindustrial period (1850–1899). This warming has been accompanied by several large-scale changes: loss of glaciers, ice sheet mass and sea ice; ocean warming, acidification and deoxygenation; increases in ocean heat content and marine heatwaves; increases in atmospheric humidity; shifting rainfall patterns and more frequent heavy precipitation; seasonal shifts including shorter winters and earlier spring and summer seasons and changes in the biosphere (United States Global Change Research Program [USGCRP] 2023).

Temperatures in the contiguous United States have risen by 2.5°F and temperatures in Alaska by 4.2°F since 1970, compared to a global temperature rise of around 1.7°F over the same period. There are substantial seasonal and regional variations in temperature trends across the U.S. and its territories. Winter is warming nearly twice as fast as summer in many northern states. Annual average temperatures in some areas (including parts of the southwest, upper Midwest, Alaska, and northeast) are more than 2°F warmer than they were in the first half of the 20th century, while parts of the Southeast have warmed less than 1°F.

Many eastern regions of the country are getting wetter. Average annual precipitation from 2002–2021 was 5 to 15 percent higher relative to the 1901–1960 average in the central and eastern U.S. Parts of the southwest are getting drier, recording average annual precipitation decreases between 10 and 15 percent over the same time period. The timing of precipitation is also changing. While the northeast and Midwest have seen wetter conditions in all seasons, the southeast has received more precipitation in the fall but drier conditions in spring and summer. The Pacific Northwest also experienced drier summers and wetter winters.

Observations show an increase in the severity, extent and/or frequency of multiple types of extreme events. Heatwaves have become more common and severe in the west since the 1980s. Drought risk has been increasing in the southwest over the past century, while at the same time rainfall has become more extreme in recent decades, especially east of the Rockies. Hurricanes have been intensifying more rapidly since the 1980s and causing heavier rainfall and higher storm surges. More frequent and larger wildfires have been burning in the west in the past few decades.

The impacts of climate change increase with warming, and warming is virtually certain to continue if emissions of CO_2 do not reach net zero. Rapidly reducing emissions would very likely limit future warming and the associated increases in many risks. The Paris Agreement calls for limiting the global warming level[3] to well below 3.6°F (2°C) relative to preindustrial temperatures. At a global warming level of 3.6°F (2°C), the average temperature across the U.S. is very likely to increase between 4.4°F and 5.6°F (2.4°C and 3.1°C). For every additional 1.8 °F (1°C) of global warming, the average U.S. temperature is projected to increase by around 2.5°F (1.4°C). The northern and western parts of the country are likely to experience proportionally greater warming (USGCRP 2023).

Annual precipitation since the beginning of the last century has increased across most of the northern and eastern U.S. and decreased across much of the southern and western U.S. Over the coming century, significant increases are projected in winter and spring over the Northern Great Plains, the upper Midwest and the northeast. Observed increases in the frequency and intensity of heavy precipitation events in most parts of the U.S. are projected to continue. Surface soil moisture over most of the U.S. is likely to decrease, accompanied by large declines in snowpack in the western U.S. and shifts to more

[3] *The global warming level is defined as the global average temperature change in degrees Celsius relative to preindustrial temperatures.*

winter precipitation falling as rain rather than snow (USGCRP 2018). In the U.S., projected changes in seasonal mean precipitation span the range from profound decreases to profound increases.

6.1.2. Midwest

The Midwest National Climate Assessment region covers Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Ohio and Wisconsin. The Fifth National Climate Assessment states key impacts to the Midwest region due to global warming as follows (USGCRP 2023):

- Climate change is expected to negatively impact individual and community health.
- Increasing extreme precipitation events and transitions between wet and dry conditions are expected to negatively impact agriculture.
- Increasing incidence of flooding and drought is expected to negatively affect the ecosystem.
- Increases in temperatures and extreme precipitation events are already challenging aging infrastructure and are expected to impair surface transportation, water navigation and the electrical grid.
- Shifts in the timing and intensity of rainfall are expected to disrupt transportation along major rivers and increase chronic flooding.

The Midwest is subject to extremely cold air masses from the far north, and warm, humid air masses from the Gulf of Mexico, resulting in a wide range of both temperature and precipitation extremes (NOAA 2013). The Midwest has gotten warmer, with average annual temperatures increasing over the last several decades. The annual average temperature of the Midwest National Climate Assessment region for the mid-century period of 2036-2065 relative to 1976-2005 is projected to rise 4.2°F for a lower scenario (RCP4.5) and 5.3°F for a higher scenario (RCP8.5) (USGCRP 2017). Precipitation is greatest in the eastern part of the Midwest and less toward the west. Heavy downpours are already common, but climate change is expected to intensify storms and lead to greater precipitation across the entire region during this century (NOAA 2013). Precipitation is projected to increase by about 10 to 20 percent during the winter and spring, increase by 0 to 10 percent during the fall, and decrease by 0 to 10 percent during the summer in the general Wisconsin area for 2070-2099 compared to 1976-2005 (USGCRP 2017). Projected changes in cumulative local runoff are expected to lead to increased flooding susceptibility in the winter and spring and increased flash drought potential in the summer (USGCRP 2023).

More intense precipitation in the Midwest is expected to lead to increased flood damage, strained drainage systems and reduced drinking water availability (NOAA 2013). Stormwater management systems, transportation networks and other critical infrastructure are already experiencing impacts from changing precipitation patterns and elevated flood risks (USGCRP 2018). Midwestern cities with impervious infrastructure may result in surface runoff entering combined storm and sewage drainage systems. When these systems are overloaded during intense rainstorms, raw sewage overflow can result, impacting clean water availability and human health (NOAA 2013). The annual cost of adapting urban stormwater systems to more frequent and severe storms is projected to exceed $500 million for the Midwest by the end of the century. At-risk communities, including low-income or minority communities, in the Midwest are also becoming more vulnerable to climate change impacts such as flooding, drought and increases in urban heat islands (USGCRP 2018).

6.1.3. Wisconsin

WICCI climate scientists have “down-scaled” global climate models to project how Wisconsin’s climate has been changing and how it might change in the years to come.

The decade from 2010-2019 was the wettest in Wisconsin since records began around 1900. Statewide annual average precipitation during this decade rose to 37.0 inches, a 17 percent increase over the previous long-term average. Winter precipitation has increased by over 20 percent since 1950. Extreme weather has generally increased in frequency and magnitude (including high heat, extreme amounts of rain or snow, high winds, droughts or extreme cold). Heavy daily precipitation events across Wisconsin show a rising trend in recent decades. Days with 1- to 2-inch rain events have increased the most, but 3-inch rainfalls are also increasing. From 2010 to 2019, Wisconsin experienced at least 21 rainfall events throughout the state that exceeded the 100-year event (WICCI 2021).

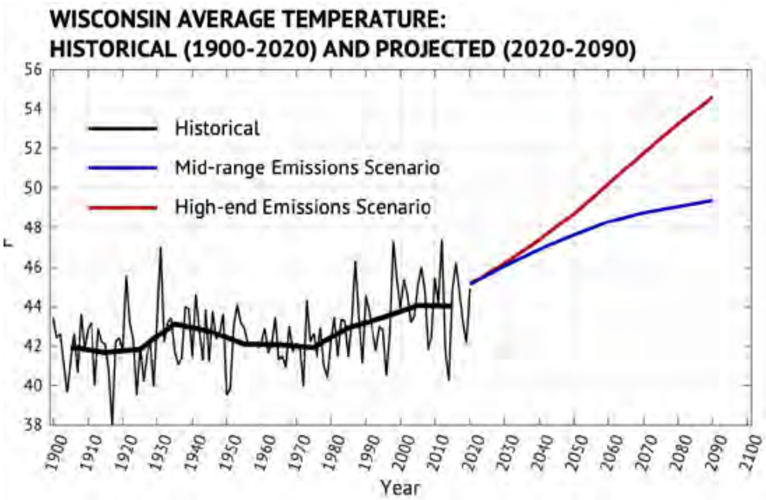
Warming trends in Wisconsin have also continued, with average temperatures in Wisconsin increasing by 3°F since the 1950s. All seasons and regions of Wisconsin are getting warmer and wetter, but winters are warming more rapidly than summers. Cold periods have been getting less common, and this trend is predicted to continue (WICCI 2021).

Extreme events in nearly every region of Wisconsin are causing disruptions and impacting health, economy and natural resources. The warmer and wetter trends are expected to continue into the future, with wide-ranging consequences throughout Wisconsin's natural and built environments. Examples of climate impacts to natural environment in Wisconsin include flooding and erosion; fewer days of ice cover on the lakes; more ticks in the woods; waterlogged soils that delay planting and harvesting; more harmful algal blooms; and habitat changes. Climate change may also affect public health and safety, forest product industry, agriculture, and tourism and outdoor recreation in the state (WDNR 2024).

The 2021 Assessment Report (WICCI 2021) analyzed Wisconsin's projected climate under two different future climate scenarios, based on a mid-range and high-end estimate of future GHG emissions. Both the high-end and mid-range emissions scenarios suggest that average temperatures in Wisconsin will be about 7 to 16°F degrees warmer compared to baseline climate conditions at the end of the 20th century. Further into the future, the emissions scenarios diverge dramatically and show a difference of 6 degrees between each other by the late 21st century (2081-2100), as shown on Figure 6-1. Wisconsin's historical warming (black line) is expected to continue into the coming century under both a high-end emissions scenario (red curve) and mid-range emissions scenario (blue curve)

Each additional degree of warming will intensify the climate impacts described in this report. These changes in average temperature will increase the frequency and magnitude of many extreme weather events. By 2050, extreme heat days over 90°F in Wisconsin will likely triple (WICCI 2021). These drastic warming rates for the high-end emissions scenario indicate the importance of mitigation for reducing impacts of climate change.

Figure 6-1: Wisconsin Historical Average Temperatures



Annual mean rainfall in Wisconsin is expected to increase by mid-century, but the change varies among models from a 5 percent decrease to a 15 percent increase (WICCI 2020). Wisconsin is likely to continue to trend toward wetter conditions, especially during winter, spring and fall. Extreme rain events will also increase significantly. Extreme precipitation events are likely to remain most common in the southern and western parts of the state, including Milwaukee County (WICCI 2021).

6.2. Resilience and Adaptation to Climate Change

Resilience is the ability to anticipate, prepare for and adapt to changing conditions and withstand, respond to and recover rapidly from disruptions (FHWA 2014). In the study area, warmer temperature and more frequent extreme precipitation events are likely to contribute to potential hazards along the study corridor under the No-Build and build alternatives .

6.2.1. Federal Effort Addressing Climate Change Effects

Under NEPA, WisDOT is obligated to comply with all applicable federal laws, regulations, policies and guidance. The Fourth National Climate Assessment, published in 2018, presents the foundational science and the “human welfare, societal, and environmental elements of climate change and variability for 10 regions and 18 national topics, with particular attention paid to observed and projected risks, impacts, consideration of risk reduction, and implications under different mitigation pathways.”

The USDOT Policy Statement on Climate Change Adaptation committed USDOT to “integrate consideration of climate change impacts and adaptation into the planning, operations, policies, and programs of DOT in order to ensure that taxpayer resources are invested wisely, and that transportation infrastructure, services and operations remain effective in current and future climate conditions” (USDOT 2011). The U.S. Department of Transportation Climate Adaptation Plan followed up with a statement of policy to “accelerate reductions in greenhouse gas emissions from the transportation sector and make our transportation infrastructure more climate change resilient now and in the future,” following this set of guiding principles (USDOT 2021):

- Use best available science
- Prioritize the most vulnerable

- Preserve ecosystems
- Build community relationships
- Engage globally

USDOT developed its climate action plan pursuant to EO 14008, "Tackling the Climate Crisis at Home and Abroad" (January 27, 2021). EO 14008 recognized the threats of climate change to national security and ordered federal government agencies to prioritize actions on climate adaptation and resilience in their programs and investments (White House 2021).

FHWA Order 5520, Transportation System Preparedness and Resilience to Climate Change and Extreme Weather Events (FHWA 2014), established FHWA policy to strive to identify the risks of climate change and extreme weather events to current and planned transportation systems. FHWA has developed guidance and tools for transportation planning that foster resilience to climate effects and sustainability at the federal, state and local levels.

6.2.2. State Strategies

The 2021 WICCI Assessment Report identifies specific steps to take to protect the communities, natural resources and the economy from climate change effects. Examples of these steps including helping local communities become more resilient by investing in flood risk reduction practices, pre-disaster mitigation programs and comprehensive planning; and designing and building infrastructure that accounts for future climate conditions (WICCI 2021).

WICCI has also released the climate science information and potential approaches for addressing the impacts in a Report to the Governor's Task Force on Climate Change: Strategies to Improve Wisconsin's Climate Resilience and Readiness (WICCI 2020). The strategy and solution for infrastructure in the report include:

- Encourage (and require where appropriate) that all new infrastructure planning and design projects specifically consider vulnerability and risk associated with future climate conditions.
- Provide new state funding for infrastructure replacement or repair projects to proactively make infrastructure more resilient to future changes.
- Provide a standardized method to evaluate and report embodied carbon emissions from the most commonly used construction materials in Wisconsin and create Environmental Product Declarations for project development, bid evaluation, etc.
- Long-term goals (4-10 years): Pursue climate bonds to accelerate green actions.

6.2.3. WisDOT Climate Resilience Goals and Objectives

Connect 2050 (WisDOT 2022) is Wisconsin's statewide, multimodal, long-range plan. To enhance the resiliency and reliability of the transportation system, and in accordance with federal requirements, Wisconsin continues to focus on resiliency with infrastructure assessments, like those in the Facilities Repeatedly Requiring Repair and Reconstruction (F4R) database. The F4R program, required by 23 CFR 667, identifies and conducts evaluations of roadways and bridges that have had catastrophic damage resulting in state emergency declarations on two or more occasions. These efforts identify and consider alternatives that will mitigate, or partially or fully resolve, the root cause of the recurring damage.
The I-39/90/94 Corridor study area is not considered Wisconsin F4R due to Emergency Events (WisDOT 2023b).

In addition to F4R, and as part of the Connect 2050 Goal 7: Maximize Transportation System Resiliency and Reliability and its objectives (WisDOT 2022), WisDOT is currently developing a flood risk assessment tool to identify locations on the state highway system with the highest risk of experiencing flooding or being significantly impacted by flooding. This tool will use data and a risk-based scoring system combined with a project prioritization method to identify high-risk flood-prone areas for improvement throughout the state at the 0.25-mile level. Extreme flooding events impact the highway system by damaging infrastructure such as roads or bridges, thus reducing mobility for people and goods. The flood risk assessment tool will enhance WisDOT's ability to implement strategic, cost-effective solutions that will increase the resiliency of the highway system. A strategy WisDOT may consider in response to potential flooding events is raising roadway embankments and bridges above flood levels based on climate projections.

WisDOT planning strategies can also make the study corridor more resilient to the climate change effects. These strategies include:

- Planning transportation infrastructure to avoid climate sensitive locations.
- Incorporating climate impacts on transportation infrastructure into broader land use planning such as developing areas to be more climate resilient.

Moving toward 2050, planning, leveraging technology and implementing cost-effective solutions will play a major role in creating a more resilient and reliable system. To be successful, WisDOT will remain vigilant in its preparation by ensuring robust data-driven consideration in the planning, design and prioritization processes and by ensuring responses to incidents such as crashes, flooding and extreme winter weather are well coordinated and efficiently and effectively implemented.

6.2.4. Study Corridor Strategies and Resilience

Flooding causing partial or full Interstate closures has impacted vital connections for commerce and emergency services and caused extensive road damage. Both I-39 and I-90/94, and WIS 33, are within the floodplains of the Wisconsin and Baraboo rivers. The Baraboo River flooding is problematic because it affects both I-90/94 and I-39. In 2008 and 2018, flooding overtopped and closed I-39 and I-90/94 in Columbia County for several days. Hundreds of thousands of vehicles had to detour several hours out of their way as a result. Based on WisDOT 2008 traffic volume data on I-39 north of the I-39 I-90/I-94 Split Interchange and on I-90/I-94 west of the split, approximately 15,000 vehicles on I-39 and 34,000 vehicles on I-90/I-94 were affected each day during the highway full closure in 2008 (WisDOT 2024). These events demonstrated resiliency challenges of the study corridors and led WisDOT to include flood minimization as an element of the study corridor's purpose and need.

As part of the I-39/90/94 Corridor Study, WisDOT prepared a resiliency study that identified flood minimization strategies in the Baraboo River and Wisconsin River area. WisDOT evaluated the costs and benefits of several options to minimize flooding. The most viable flood mitigation alternative would build more and longer bridges to move floodwater quickly under and away from the freeway. Under this alternative, I-39 would be raised about 4 feet for approximately 3 miles, and I-90/94 would be raised 4 feet for 3.5 miles around the WIS 33 Interchange. Refer to Section 3.13 of the EIS for more information about the flood minimization studies and impacts.

To withstand the climate change effects, especially the effects due to increased temperature and precipitation, the following strategies may be considered during the study corridor final design:

- Revising pavement composition and design to withstand higher temperatures. Due to the projected increased temperatures and frequency of extreme temperatures, increasing the critical threshold for selecting asphalt binder would be considered for the build alternatives.
- Revising highway drainage design standards for local drainage features to withstand increased precipitation intensity and more frequent extreme precipitation events for the build alternatives.
- Using remote sensing technologies such as pavement temperature, water elevations and flow rates, and wind speeds during highway closure events.
- Developing pre-identified detour routes and providing real-time information to all users, vehicle navigation systems and other vehicle communication systems.

In addition to the design strategies, planning strategies would also make the study corridor more resilient to the climate change effects. In the event of extreme storms and roadway closures, advance preparation would help WisDOT quickly respond and recover from potential climate change hazards. Advanced preparation and planning strategies can include infrastructure assessments after storm or other climate events and the development of extreme weather risk frameworks. Planning strategies may include:

- Developing asset management and maintenance programs to ensure the study corridor infrastructure elements are monitored and remain in good condition for all alternatives.
- Evaluating the resiliency of the detour routes to minimize distance traveled during road closure events.

7. Incomplete or Unavailable Information for Specific Climate Change Impacts

The GHG and climate change effects presented in this memorandum were evaluated based on the best available data; the outcomes are affected by limitations in the data available and uncertainties that limit the accuracy of the tools used.

A level of uncertainty exists in the estimation of a project's impact on GHG emissions. Estimates of future GHG emissions can be developed using travel demand, traffic analysis and emissions estimation tools. These tools extrapolate from observed relationships between demographics, economic activity, vehicle and transit usage, emissions under various travel conditions by different vehicle type and available transportation facilities. All of those relationships will evolve in the future, and analysts must inevitably make reasonable assumptions about future growth, shifts in vehicle technology and future project investments. For that reason, "forecasts" are not "predictions" in that they are always contingent on things continuing as we suppose they will, and there is always the possibility that they will not.

In addition, climate models are complex and incorporate many different assumptions. Climate projections can be affected by the limitations in the data and can limit the accuracy of the projections. Some limitations of the GHG emission scenario models are that the scenarios reflect the societal choices over the next century. Future scenarios could change based on different economic, technologic, demographic and policies in the future.

Although there is uncertainty inherent in the analysis, the analysis was conducted using the best available information and tools and provides reasonable comparisons of the GHG and associated impacts between the alternatives.

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APPENDIX A:

Technical Memorandum: I-39/90/94 Study – MSAT Analysis Impacted Links Methodology and VMT/VHT Results

I-39/90/94 Study – MSAT Analysis Impacted Links Methodology and VMT/VHT Results

Date:	June 3, 2024
Topic:	Methodology to Select Impacted Links for Inclusion in MSAT Quantitative Analysis with VMT/VHT Results
From:	CDMCT

Introduction

This technical memorandum presents the methodology for selecting roadway segments for inclusion in Mobile Source Air Toxics (MSAT) analysis as part of the environmental documentation of the Interstate 39/90/94 Corridor Study. The MSAT analysis will be quantitative in nature using the Motor Vehicle Emissions Simulator (MOVES) model.

The Interstate 39/90/94 Corridor consists of 67 miles of Instate facility in Columbia, Dane, Juneau and Sauk counties in south-central Wisconsin. The project includes the Interstate facility from north of the US 12 (Beltline) interchange in Dane County to north of the US 12/WIS 16 interchange in Juneau County, along with short segments of I-39 north of I-90/94 in Columbia County and I-94 east of I-39/90 in Dane County.

FHWA Recommendations for Determining Affected Network

The Federal Highway Administration (FHWA) provides recommendations for conducting MSAT analysis. https://www.fhwa.dot.gov/environment/air_quality/air_toxics/policy_and_guidance/msat/fhwa_nepa_msat_faq_moves3_.pdf

Question 2 in the recommendations document addresses how to define the affected environment:

"NEPA documentation should focus on the impacts of the proposed project on the affected environment. Traffic analysis normally performed for NEPA (purpose and need, scope, design, etc.) should be the basis of the MSAT analysis and defining the affected environment. MSAT analyses are intended to capture the anticipated changes in emissions within an affected environment, defined as the transportation network directly affected by the project. Analyzing MSATs only within a geographically-defined "study area" will not capture the emissions effects of changes in traffic on roadways outside of that area, which is particularly important where the proposed project would create an alternative route or divert traffic from one roadway class to another. At the other extreme, analyzing a metropolitan area's entire roadway network will result in emissions estimates for many roadway links not affected by the project, diluting the results of the analysis.

The FHWA recommends analyzing all segments associated with the project, plus those segments expecting meaningful changes in emissions due to the project (e.g., ± 10 percent or more). Define the affected network based on available project-specific information in the environmental document's traffic analysis, considering changes in such metrics as:

- *± 5 percent or more in annual average daily traffic (AADT) on congested highway links of level of service (LOS) D or worse;*

- *± 10 percent or more in AADT on uncongested highway links of LOS C or better;*
- *± 10 percent or more in travel time; or*
- *± 10 percent or more in intersection delay.*

These recommendations are not a substitute for project-specific knowledge and consideration of local circumstances. For example, if traffic modeling shows that some low-volume links far removed from the project area show a meaningful change in traffic, one would have to consider whether this is a real effect, or a modeling artifact. Likewise, when analyzing a project that has no meaningful alternative routes (e.g., upgrading an isolated river crossing), it may not be necessary to evaluate traffic changes on other routes. Any such deviation from these recommendations should include documentation in the project file explaining what segments were included or excluded from the affected area and why."

Defining the Affected Environment for the I-39/90/94 Corridor Study MSAT Analysis

Traffic forecasts for the I-39/90/94 Corridor Study have been developed using the travel demand models of record for the respective geographies. The Wisconsin statewide travel demand model (STDM) is a daily travel demand model which covers the entire state of Wisconsin including the limits of the I-39/90/94 Corridor Study. As there is no metropolitan planning organization or regional planning commission model for Columbia, Juneau or Sauk counties, the STDM, which is maintained by Wisconsin Department of Transportation (WisDOT) is used as the model of record for these three counties.

The Dane County travel demand model (DCTDM) covers Dane County including a portion of the I-39/90/94 Corridor study limits. The DCTDM is maintained by the Greater Madison Metropolitan Planning Organization in conjunction with WisDOT. The DCTDM is a more robust model compared to the STDM, including four peak periods (in lieu of one 24-hour model timeframe), transit and non-motorized travel.

The EIS document discusses two build alternatives for the Dane County area between US 12/18 and WIS 19 including Modernization Plus Added General-Purpose Lane and Modernization Hybrid. The Modernization Hybrid employs a managed shoulder lane which would be opened for active traffic use when traffic demands warrant its use. The DCTDM was run with both concepts with only minor changes in daily traffic volumes and vehicle miles traveled (VMT) predicted, almost entirely in the midday period (9 AM to 3 PM). The largest volume difference on a specific roadway segment was 565 daily vehicles, with 561 in the midday period. VMT differed by 0.12% between the two modeled concepts. These modeled differences are conservative as the hybrid lane could be opened during portions of the midday to accommodate traffic demands however the DCTDM can only assume the lane is either open or closed throughout the duration of the period. Traffic forecasts have used the traffic demands from the Modernization Plus Added General-Purpose Lane.

Within both the DCTDM and STDM, the links within the immediate limits of the project (Interstate links and the interchanges) were flagged for inclusion within the MSAT analysis.

Both the DCTDM and STDM include a post-processing application that calculates a level of service (LOS) based on the assigned traffic volume and a number of roadway attributes including number of lanes, functional classification, median type and area type. The LOS should be considered a planning-level as no specific Highway Capacity Manual level of analysis was conducted for this effort. This planning-level LOS provides a consistent estimate of LOS for every roadway segment included within either of the two travel demand models.

The LOS process was conducted using 2050 traffic assignments for both the DCTDM and STDM models. 2050 is the only year that housing and employment data was projected for the STDM and is the year that both the STDM and DCTDM were executed for developing traffic forecasts for the I-39/90/94 Corridor Study. Therefore, the most accurate comparison of impacts was deemed to occur using the 2050 traffic model outputs. The No Build and Build model assignment outputs were compared based on the FHWA guidance noted above, with the planning-level LOS used along with the difference in model traffic assignments (in lieu of forecasted average annual daily traffic which would require an observed traffic count on every model link) to determine each model link's inclusion for the following two criteria:

- *± 5 percent or more in annual average daily traffic (AADT) on congested highway links of level of service (LOS) D or worse;*
- *± 10 percent or more in AADT on uncongested highway links of LOS C or better;*

Link-specific congested travel times were directly output from the STDM. Daily average congested travel times were calculated from the DCTDM by summarizing total daily vehicle hours traveled across the various model time periods and dividing by the total daily vehicle miles traveled across those same model time periods. This data was used to determine each model link's inclusion for the following criteria:

- *± 10 percent or more in travel time;*

The final criteria noted by FHWA uses intersection delay to determine inclusion into the analysis. This criteria was not accommodated as neither the STDM nor DCTDM generate intersection delays as outputs of their modeling process. Given the size of the potential affected area beyond the geographic limits of the corridor, the estimation of the data to evaluate links by this criteria is not reasonable.

Resulting Affected Links for MSAT Analysis

All roadways within the I-39/90/94 corridor study limits were flagged for inclusion. Figure 1ow shows the limits of the study in orange overlaid on the DCTDM network.

Figure 1: Dane County Travel Demand Model Network

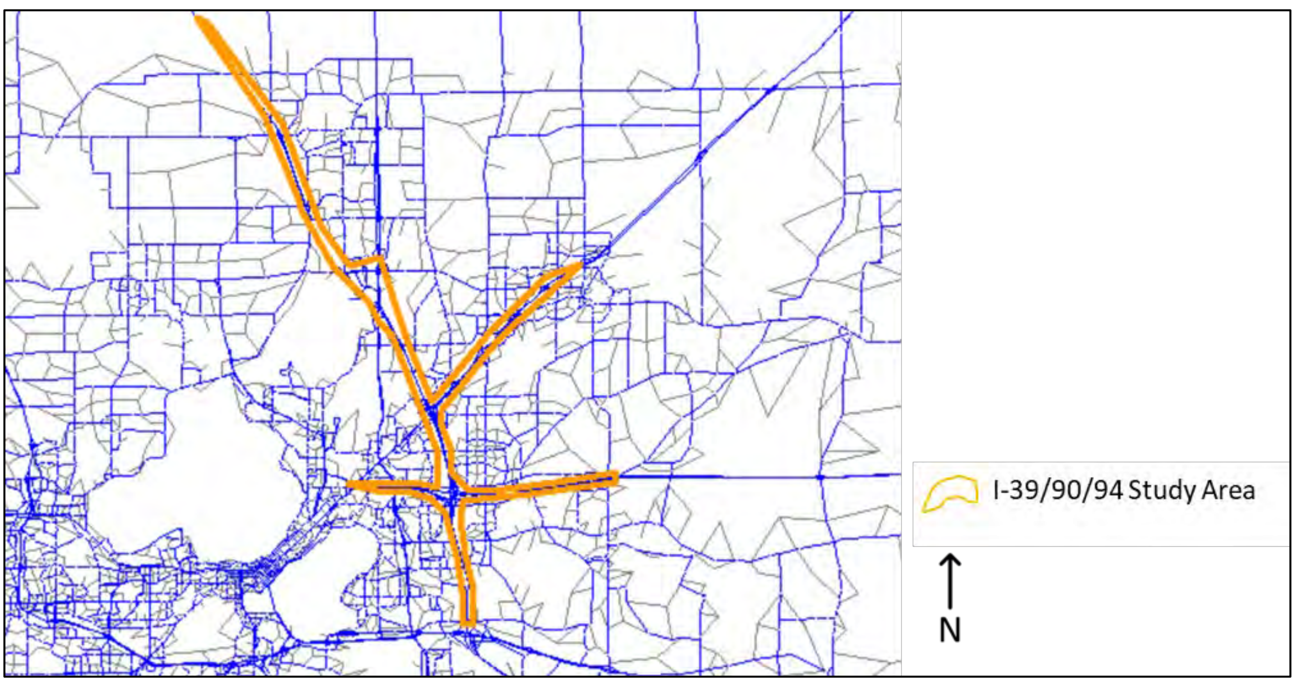
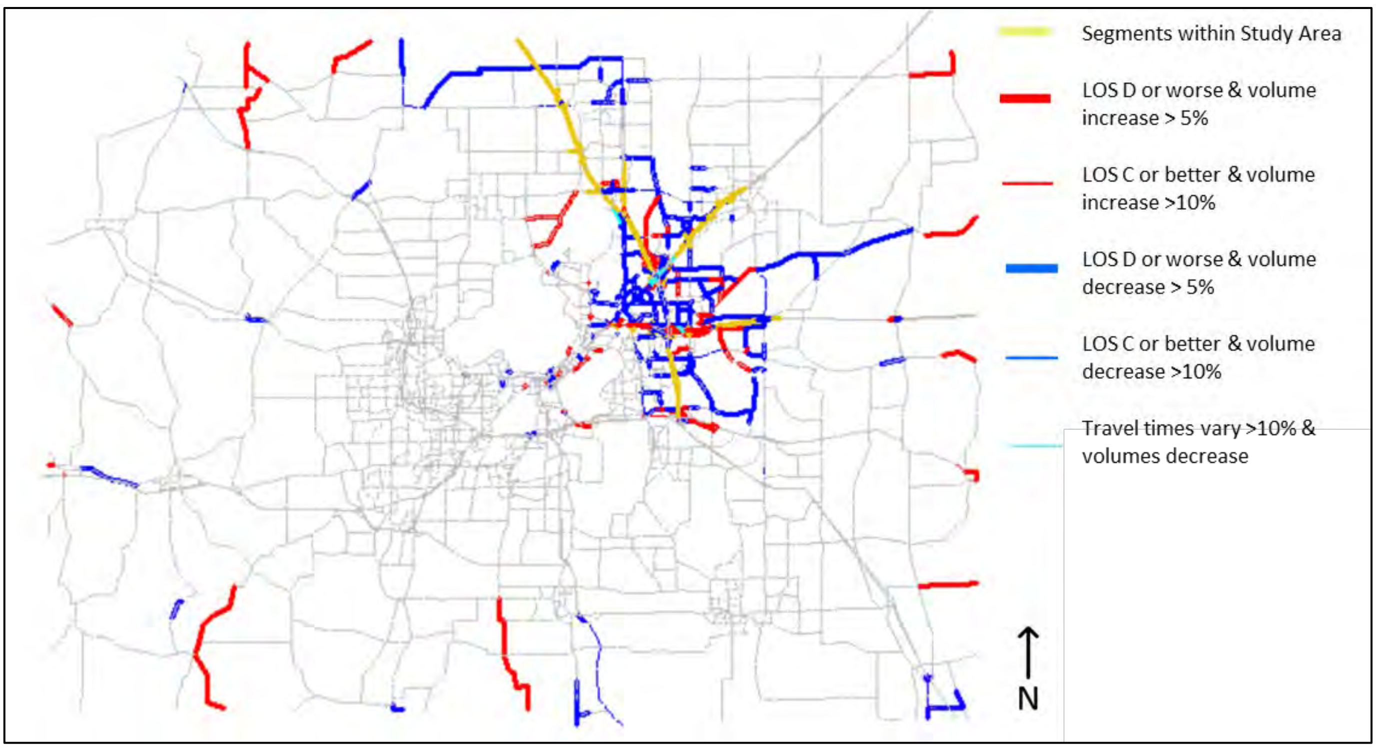


Figure 2 shows the links that met one of the criteria to be included in the MSAT analysis for Dane County.

- Yellow links are within the immediate study area.
- Thick red links have LOS D or worse in the Build model and have travel demand model estimated traffic volume assignments more than five percent higher than the No Build model.
- Thin red links have LOS C or better in the Build model and have travel demand model estimated traffic volume assignments more than ten percent higher than the No Build model.
- Thick blue links have LOS D or worse in the Build model and have travel demand model estimated traffic volume assignments more than five percent lower than the No Build model.
- Thin blue links have LOS C or better in the Build model and have travel demand model estimated traffic volume assignments more than ten percent lower than the No Build model.
- There were no instances in the DCTDM where links have model-estimated travel times that vary by more than 10 percent compared to the No Build model and Build assignments are higher than No Build assignments.
- Aqua blue links have travel demand model-estimated travel times that vary by more than 10 percent compared to the No Build model and Build assignments are lower than No Build assignments.

Figure 2: Segments that Meet Criteria for Inclusion in MSAT Analysis in Dane County



The FHWA guidance on determining affected links does allow for judgement on including links that appear to be significantly far from the study area and are flagged as an artifact of the travel demand model. Given the manageable size of the DCTDM, all flagged links within the limits of the DCTDM were determined to be included for MSAT analysis.

The determination of affected links for Columbia, Juneau and Sauk counties used the STDM. The same criteria were used for the STDM as were done for DCTDM. All links within Dane County were omitted from consideration by the STDM to avoid double-counting. Figure 4 shows Columbia, Juneau and Sauk counties limits of the I-39/90/94 Corridor Study in orange overlaid within the STDM network. Note the black links representing Dane County.

Figure 4: Statewide Travel Demand Model and Columbia, Sauk, and Juneau Counties Study Area

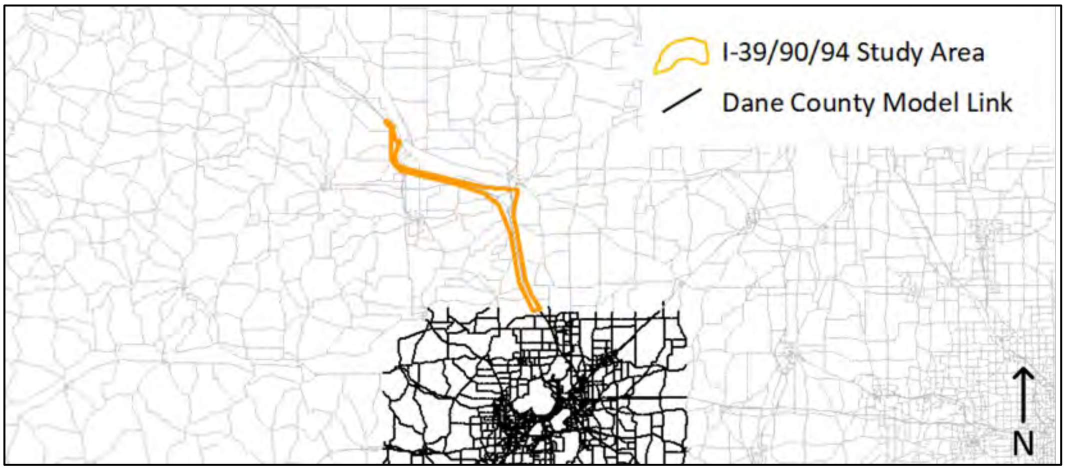


Figure 5 shows the links that met one of the criteria to be included in the MSAT analysis for Columbia, Juneau and Sauk counties or beyond.

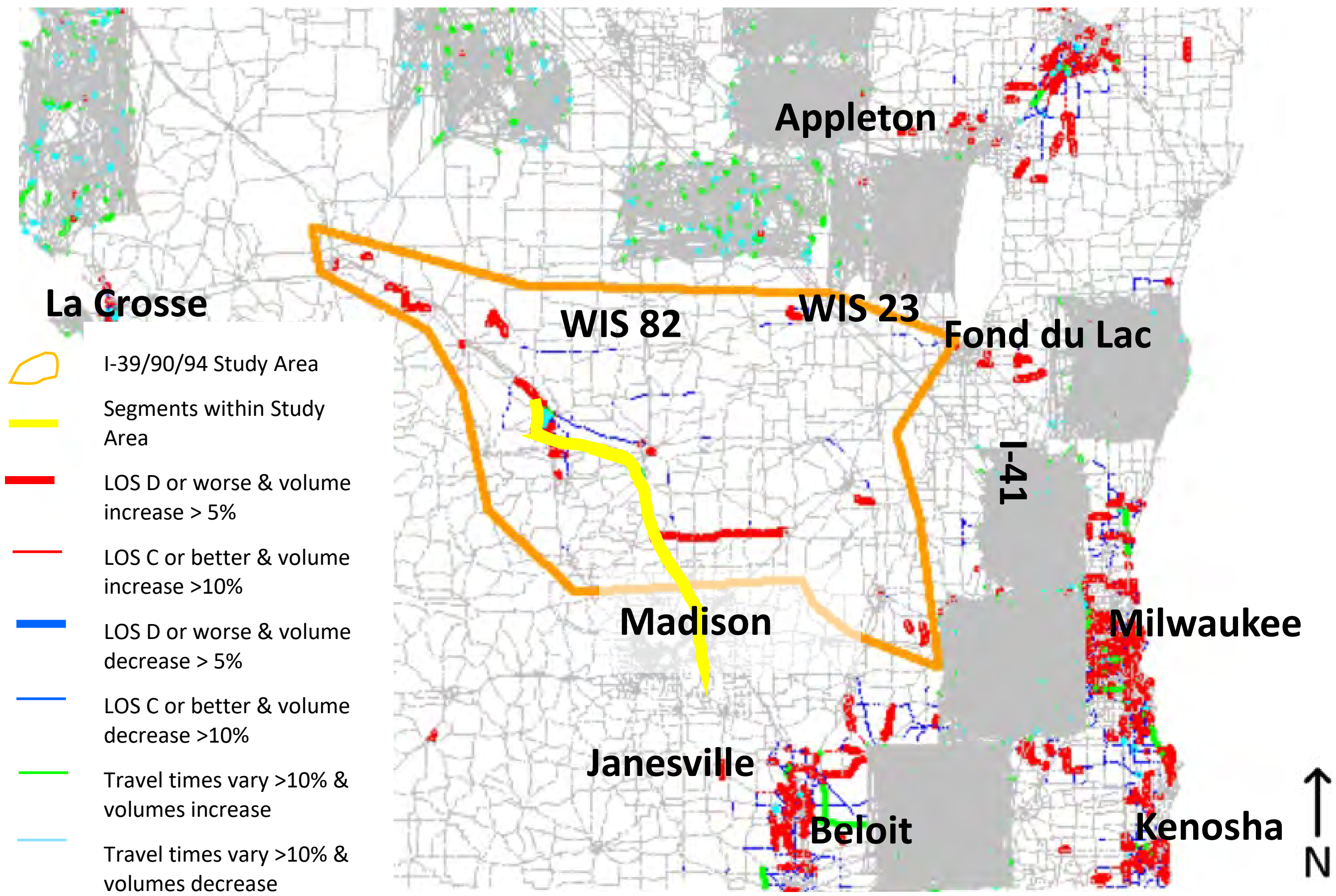
- Yellow links are within the immediate study area.
- Thick red links have LOS D or worse in the Build model and have travel demand model estimated traffic volume assignments more than five percent higher than the No Build model.
- Thin red links have LOS C or better in the Build model and have travel demand model estimated traffic volume assignments more than ten percent higher than the No Build model.
- Thick blue links have LOS D or worse in the Build model and have travel demand model estimated traffic volume assignments more than five percent lower than the No Build model.
- Thin blue links have LOS C or better in the Build model and have travel demand model estimated traffic volume assignments more than ten percent lower than the No Build model.
- Green links have travel demand model-estimated travel times that vary by more than 10 percent compared to the No Build model and Build assignments are higher than No Build assignments.
- Aqua blue links have travel demand model-estimated travel times that vary by more than 10 percent compared to the No Build model and Build assignments are lower than No Build assignments

Note the orange boundary excludes the links within Dane County but does include roadways east of Dane County.

The impacts generally extend north to WIS 82 and WIS 23 which connect Mauston and Fond du Lac. This is a logical northern boundary given Mauston's location north of the limits of the proposed expansion of I-90/94 and Fond du Lac's location along I-41.

The major metropolitan areas of Milwaukee, Appleton, La Crosse, Janesville and Beloit all show many links that meet the criteria noted above. The exact location in the area between Madison, Janesville, Beloit and Milwaukee where the impacts are truly a product of the I-39/90/94 corridor study improvements versus being an artifact of using a statewide model is not clear. FHWA's guidance notes the potential of travel demand models to produce results indicating "[when] *links far removed from the project area show a meaningful change in traffic, one would have to consider whether this is a real effect, or a modeling artifact*" It would seem illogical that roadways within distant metro areas 30 or more miles away from the project such as Janesville would be influenced by the changes within the project when the major roadways connecting these distant metro areas to the project (I-39/90 in this case) are not themselves flagged as being impacted by the project.

Figure 5: Segments that Meet Criteria for Inclusion in MSAT Analysis in Columbia, Sauk, and Juneau Counties



Travel Demand Model Outputs for MSAT Analysis using MOVES

Analysis years were established based on MSAT analysis needs. The year of the environmental document's notice of intent is commonly deemed the base year for MSAT analysis, in this case 2023. The beginning of construction is commonly analysis year and is anticipated for 2030. Due to the magnitude of the project, construction is anticipated to last for 10 years. The final analysis year is commonly 20 year after construction, in this case year 2060. These MSAT analysis years (2023, 2030 and 2060) were developed by interpolating between model base year (2016 for DCTDM and 2017 for STDM) and the 2050 horizon year trip tables. These additional MSAT analysis trip tables were then assigned to the 2050 no build and build networks. The values of traffic volume, traffic travel time and their surrogates of vehicle miles traveled (VMT) and vehicle hours traveled (VHT) are then summed for all links deemed to be included in the analysis as described previously. A link that is deemed to be included based on 2050 model results is then included in the summation of VMT and VHT for all analysis years (2023, 2030 and 2060).

Travel demand model generated VMT and VHT is first sub-aggregated based on the following criteria:

- Rural Restricted Access
- Urban Restricted Access
- Rural Unrestricted Access
- Urban Unrestricted Access

The average daily congested speed is then used to sub-divide the demand model generated VMT and VHT. The VMT and VHT is reported within 5 mile per hour bins, such as 0-5 mph, 5-10 mph and so on through 60-65 mph and 65+ mph. The data is finally sub-divided into automobile and truck values to be incorporated into the MOVES modeling for the MSAT analysis.

VMT/VHT Summary

Tables below show the total 2060 VMT for Dane and the Statewide model areas respectively. Note the total vehicles miles traveled increases from the no build to the Modernization Plus Added General-Purpose Lanes (build) condition by four percent for the Dane affected links and just over one percent for the statewide model area affected links.

Dane

2060			
TOTAL	No Build	Build (Added GP Lane)	
Speed Range			
(mph)	VMT	VMT	Delta
0-5	10	9	-1
5-10	180	172	-9
10-15	608	579	-29
15-20	2,524	2,566	42
20-25	22,943	18,591	-4,352
25-30	86,780	92,774	5,994
30-35	348,800	304,360	-44,440
35-40	550,827	537,953	-12,874
40-45	174,329	156,244	-18,085
45-50	420,115	314,813	-105,302
50-55	140,656	232,795	92,139
55-60	45,122	219,799	174,677
60-65	637,971	438,141	-199,829

65-70	1,843,622	2,132,328	288,705
	4,274,487	4,451,123	176,637

Statewide

2060			
TOTAL	No Build	Build	
Speed Range			
(mph)	VMT	VMT	Delta
0-5	0	0	0
5-10	0	0	0
10-15	0	0	0
15-20	0	0	0
20-25	202	203	1
25-30	19,651	18,126	-1,525
30-35	115,436	112,399	-3,037
35-40	80,708	89,571	8,864
40-45	230,985	222,194	-8,791
45-50	215,089	151,376	-63,713
50-55	150,741	136,164	-14,577
55-60	305,971	0	-305,971
60-65	1,201,571	0	-1,201,571
65-70	368,986	2,062,352	1,693,366
	2,689,339	2,792,385	103,045

APPENDIX B:

GHG Emissions and Social Cost Calculations and Summaries

GHG Emissions Summary

Lifecycle CO_2e Greenhouse Gas (GHG) Emissions (Modeled using ICE 2.2.8) [1]

Year	Annualized Emissions (over 30-years of analysis period)			Cumulative Emissions (over 30-years of analysis period)		
Scenario	No-Build	Build Alternative - GP Lane	Build Alternative - Hybrid	No-Build	Build Alternative - GP Lane	Build Alternative - Hybrid
Units	metric tons/year	metric tons/year	metric tons/year	metric tons/year	metric tons/year	metric tons/year
Construction						
Bridges_Overpasses	0	2,330	2,330	0	69,897	69,897
Lighting	41	96	96	1,238	2,889	2,889
Roadways (Construction and O&M)	4,154	17,316	17,316	124,616	519,491	519,491
Signage	0	210	210	0	6,297	6,297
Vehicle_Ops_ConstructionDelay	0	405	405	0	12,144	12,144
Vehicle_Ops_VMT Operations	1,062,622	1,096,127	1,095,422	31,878,667	32,883,810	32,862,652
Total Construction and Operation	1,066,817	1,116,484	1,115,779	32,004,522	33,494,527	33,473,369
Difference Build vs No-Build	N/A	49,667	48,962	N/A	1,490,005	1,468,847
Difference Build vs No-Build %	N/A	4.7%	4.6%	N/A	4.7%	4.6%

Notes:

NA = not applicable

1. GHG emission results were obtained from the ICE Version 2.2.8 Tool, tab "Summary Results", except the Vehicle_Ops_ConstructionDelay and the Vehicle Ops_VMT Operations which were both obtained from the tab "Vehicles_Ops".

Daily Vehicle Miles Traveled (VMT) during Operation (Vehicle_Ops_VMT Operations) [1]

	2023	2030					2060				
	Existing	No-Build	Build Alternative - GP Lane	% Increase GP Lane Vs No-Build	Build Alternative - Hybrid	% Increase Hybrid Vs No-Build	No-Build	Build Alternative - GP Lane	% Increase GP Lane Vs No-Build	Build Alternative - Hybrid	% Increase Hybrid Vs No-Build
Dane County	3,038,897	3,273,163	3,329,251	1.7%	3,328,045	1.7%	4,274,487	4,451,123	4.1%	4,440,927	3.9%
Other Counties	2,155,341	2,308,057	2,315,426	0.3%	2,315,426	0.3%	2,689,339	2,792,385	3.8%	2,792,385	3.8%
Total Project-wide	5,194,238	5,581,220	5,644,677	1.1%	5,643,471	1.1%	6,963,826	7,243,508	4.0%	7,233,312	3.9%

Notes:

1. VMT data during project operation were obtained from CDMCT memorandum "I-39/90/94 Study – MSAT Analysis Impacted Links Methodology and VMT/VHT Results" (CDMCT 2024).

Comparisons of Daily Vehicle Miles Traveled (VMT) during Operation (Vehicle_Ops_VMT Operations)

	2023	2030			2060		
	Existing	No-Build	Build Alternative - GP Lane	Build Alternative - Hybrid	No-Build	Build Alternative - GP Lane	Build Alternative - Hybrid
Dane County	58.5%	58.6%	59.0%	59.0%	61.4%	61.4%	61.4%
Other Counties	41.5%	41.4%	41.0%	41.0%	38.6%	38.6%	38.6%

Daily Vehicle Miles Traveled (VMT) Impacted during Construction (Vehicle_Ops_ConstructionDelay) [1,2]

	2030			2040		
	No-Build	Build Alternative - GP Lane	Build Alternative - Hybrid	No-Build	Build Alternative - GP Lane	Build Alternative - Hybrid
Impacted Average Daily VMT	0	468,516	468,516	0	468,516	468,516

Notes:

1. VMT data during project operation were obtained from CDMCT memorandum "I-39/90/94 Study – VMT and VHT Data for Greenhouse Gas Analysis" (CDMCT 2023).
2. Impacted VMT were assumed to be the same in 2030 and 2040.

Lifecycle GHG Emissions Summary - Year by Year GHG Emissions

Annualized CO_2e Greenhouse Gas (GHG) Emissions [1]

	Operation VMT Emissions (CO_2e MT/year) [1]			Construction and O&M Emissions (CO_2e MT/year) [2]			Estimated Year by Year GHG Emissions (CO2e MT/year)		
Year	**No-Build**	**Build Alternative - GP Lane**	**Build Alternative - Hybrid**	**No-Build**	**Build Alternative - GP Lane**	**Build Alternative - Hybrid**	**No-Build**	**Build Alternative - GP Lane**	**Build Alternative - Hybrid**
2030	1,088,206	1,099,620	1,099,440	4,060	19,701	19,701	1,092,266	1,119,321	1,119,140
2031	1,084,138	1,096,950	1,096,785	4,060	19,701	19,701	1,088,198	1,116,651	1,116,485
2032	1,080,070	1,094,280	1,094,130	4,060	19,701	19,701	1,084,129	1,113,981	1,113,830
2033	1,076,001	1,091,610	1,091,475	4,060	19,701	19,701	1,080,061	1,111,310	1,111,176
2034	1,071,933	1,088,940	1,088,820	4,060	19,701	19,701	1,075,993	1,108,640	1,108,521
2035	1,067,865	1,086,270	1,086,165	4,060	19,701	19,701	1,071,924	1,105,970	1,105,866
2036	1,063,796	1,083,600	1,083,510	4,060	19,701	19,701	1,067,856	1,103,300	1,103,211
2037	1,059,728	1,080,930	1,080,856	4,060	19,701	19,701	1,063,788	1,100,630	1,100,556
2038	1,055,660	1,078,259	1,078,201	4,060	19,701	19,701	1,059,720	1,097,960	1,097,901
2039	1,051,591	1,075,589	1,075,546	4,060	19,701	19,701	1,055,651	1,095,290	1,095,246
2040	1,047,523	1,072,919	1,072,891	4,060	19,701	19,701	1,051,583	1,092,620	1,092,592
2041	1,043,455	1,070,249	1,070,236	4,060	19,701	19,701	1,047,515	1,089,950	1,089,937
2042	1,039,386	1,067,579	1,067,581	4,060	19,701	19,701	1,043,446	1,087,280	1,087,282
2043	1,035,318	1,064,909	1,064,926	4,060	19,701	19,701	1,039,378	1,084,610	1,084,627
2044	1,031,250	1,062,239	1,062,271	4,060	19,701	19,701	1,035,310	1,081,939	1,081,972
2045	1,027,181	1,059,569	1,059,617	4,060	19,701	19,701	1,031,241	1,079,269	1,079,317
2046	1,023,113	1,056,899	1,056,962	4,060	19,701	19,701	1,027,173	1,076,599	1,076,662
2047	1,019,045	1,054,229	1,054,307	4,060	19,701	19,701	1,023,105	1,073,929	1,074,007
2048	1,014,977	1,051,559	1,051,652	4,060	19,701	19,701	1,019,036	1,071,259	1,071,353
2049	1,010,908	1,048,888	1,048,997	4,060	19,701	19,701	1,014,968	1,068,589	1,068,698
2050	1,006,840	1,046,218	1,046,342	4,060	19,701	19,701	1,010,900	1,065,919	1,066,043
2051	1,002,772	1,043,548	1,043,687	4,060	19,701	19,701	1,006,831	1,063,249	1,063,388
2052	998,703	1,040,878	1,041,033	4,060	19,701	19,701	1,002,763	1,060,579	1,060,733
2053	994,635	1,038,208	1,038,378	4,060	19,701	19,701	998,695	1,057,909	1,058,078
2054	990,567	1,035,538	1,035,723	4,060	19,701	19,701	994,626	1,055,239	1,055,423
2055	986,498	1,032,868	1,033,068	4,060	19,701	19,701	990,558	1,052,568	1,052,768
2056	982,430	1,030,198	1,030,413	4,060	19,701	19,701	986,490	1,049,898	1,050,114
2057	978,362	1,027,528	1,027,758	4,060	19,701	19,701	982,422	1,047,228	1,047,459
2058	974,293	1,024,858	1,025,103	4,060	19,701	19,701	978,353	1,044,558	1,044,804
2059	970,225	1,022,187	1,022,448	4,060	19,701	19,701	974,285	1,041,888	1,042,149
2060	1,002,198	1,056,695	1,055,488	4,060	19,701	19,701	1,006,258	1,076,396	1,075,189
Total	31,878,667	32,883,810	32,883,810	125,855	610,717	610,717	32,004,522	33,494,527	33,494,527

Notes:

NA = not applicable

1. Year by year GHG emissions were estimated based on ICE Version 2.2.8 Tool outputs. The vehicle operation emissions for 2030 and 2060 were MOVES4 modeling and adjusted with a lifecycle factor obtained from the ICE tool tab "Vehicle_Ops". Emissions between these 2 years were interpolated using the emissions from these 2 years and adjusted based on the cumulative emissions between 2030 and 2060.

2. Construction related emissions for each year were calculated by dividing the total construction and vehicle delay emissions by 31 years, to be consistent with the years used for the vehicle operation emissions. This approach is used to ensure that the cumulative GHG emissions between 2030 and 2060 are consistent with the ICE Version 2.2.8 Tool results.

3. The data point of 2060 was used to adjust the year by year emissions to match the overall cumulative GHG emission, and may show slight different trend compared to other years. This does not affect the cumulative GHG emissions as shown.

Social Cost GHG Emissions Summary

Unit Social Cost for GHG (2020 dollars per metric ton of GHG) [1,2]

Pollutant	Emissions Year	Discount Rate		
		2.5%	2.0%	1.5%
CO_2	2020	120	190	340
	2030	140	230	380
	2031	*143*	*234*	*385*
	2032	*146*	*238*	*390*
	2033	*149*	*242*	*395*
	2034	*152*	*246*	*400*
	2035	*155*	*250*	*405*
	2036	*158*	*254*	*410*
	2037	*161*	*258*	*415*
	2038	*164*	*262*	*420*
	2039	*167*	*266*	*425*
	2040	170	270	430
	2041	*173*	*274*	*435*
	2042	*176*	*278*	*440*
	2043	*179*	*282*	*445*
	2044	*182*	*286*	*450*
	2045	*185*	*290*	*455*
	2046	*188*	*294*	*460*
	2047	*191*	*298*	*465*
	2048	*194*	*302*	*470*
	2049	*197*	*306*	*475*
	2050	200	310	480
	2051	*203*	*314*	*485*
	2052	*206*	*318*	*490*
	2053	*209*	*322*	*495*
	2054	*212*	*326*	*500*
	2055	*215*	*330*	*505*
	2056	*218*	*334*	*510*
	2057	*221*	*338*	*515*
	2058	*224*	*342*	*520*
	2059	*227*	*346*	*525*
	2060	*230*	*350*	*530*

Notes:

1. Source: Supplementary Material for the Regulatory Impact Analysis for the Final Rulemaking, "Standards of Performance for New, Reconstructed, and Modified Sources and Emissions Guidelines for Existing Sources: Oil and Natural Gas Sector Climate Review" EPA Report on the Social Cost of Greenhouse Gases: Estimates Incorporating Recent Scientific Advances (EPA 2023).

2. Italicized unit social cost emission factors were linearly interpolated because they were not available from the primary source.

Total Social Cost for Construction, O&M, and Operation (2020 dollars)

	2.5% Discount Rate			2.0% Discount Rate			1.5% Discount Rate		
Year	No-Build	Build Alternative - GP Lane	Build Alternative - Hybrid	No-Build	Build Alternative - GP Lane	Build Alternative - Hybrid	No-Build	Build Alternative - GP Lane	Build Alternative - Hybrid
2030	$152,917,250	$156,704,898	$156,679,624	$251,221,196	$257,443,761	$257,402,240	$415,061,106	$425,341,866	$425,273,266
2031	$155,612,279	$159,681,037	$159,657,399	$254,638,274	$261,296,243	$261,257,562	$418,956,135	$429,910,485	$429,846,843
2032	$158,282,898	$162,641,156	$162,619,244	$258,022,806	$265,127,363	$265,091,645	$422,810,480	$434,452,402	$434,393,872
2033	$160,929,107	$165,585,254	$165,565,160	$261,374,791	$268,937,123	$268,904,489	$426,624,142	$438,967,618	$438,914,351
2034	$163,550,906	$168,513,331	$168,495,147	$264,694,229	$272,725,522	$272,696,094	$430,397,120	$443,456,134	$443,408,282
2035	$166,148,295	$171,425,388	$171,409,205	$267,981,121	$276,492,561	$276,466,460	$434,129,416	$447,917,948	$447,875,665
2036	$168,721,274	$174,321,424	$174,307,334	$271,235,466	$280,238,238	$280,215,587	$437,821,028	$452,353,062	$452,316,498
2037	$171,269,844	$177,201,440	$177,189,533	$274,457,265	$283,962,555	$283,943,475	$441,471,957	$456,761,475	$456,730,784
2038	$173,794,003	$180,065,435	$180,055,803	$277,646,517	$287,665,512	$287,650,124	$445,082,204	$461,143,187	$461,118,520
2039	$176,293,753	$182,913,409	$182,906,144	$280,803,223	$291,347,107	$291,335,535	$448,651,766	$465,498,198	$465,479,708
2040	$178,769,093	$185,745,363	$185,740,556	$283,927,382	$295,007,342	$294,999,706	$452,180,646	$469,826,508	$469,814,347
2041	$181,220,022	$188,561,297	$188,559,038	$287,018,995	$298,646,216	$298,642,638	$455,668,843	$474,128,117	$474,122,437
2042	$183,646,542	$191,361,210	$191,361,591	$290,078,061	$302,263,729	$302,264,332	$459,116,356	$478,403,025	$478,403,979
2043	$186,048,652	$194,145,102	$194,148,216	$293,104,581	$305,859,882	$305,864,786	$462,523,186	$482,651,232	$482,658,972
2044	$188,426,353	$196,912,974	$196,918,910	$296,098,554	$309,434,674	$309,444,002	$465,889,333	$486,872,738	$486,887,416
2045	$190,779,643	$199,664,825	$199,673,676	$299,059,981	$312,988,105	$313,001,979	$469,214,797	$491,067,544	$491,089,312
2046	$193,108,523	$202,400,656	$202,412,513	$301,988,861	$316,520,175	$316,538,717	$472,499,578	$495,235,648	$495,264,658
2047	$195,412,993	$205,120,466	$205,135,420	$304,885,194	$320,030,885	$320,054,215	$475,743,675	$499,377,052	$499,413,457
2048	$197,693,054	$207,824,256	$207,842,398	$307,748,981	$323,520,234	$323,548,475	$478,947,090	$503,491,754	$503,535,706
2049	$199,948,705	$210,512,025	$210,533,447	$310,580,221	$326,988,222	$327,021,496	$482,109,821	$507,579,756	$507,631,407
2050	$202,179,945	$213,183,774	$213,208,567	$313,378,915	$330,434,849	$330,473,278	$485,231,869	$511,641,057	$511,700,560
2051	$204,386,776	$215,839,502	$215,867,757	$316,145,062	$333,860,116	$333,903,821	$488,313,233	$515,675,657	$515,743,163
2052	$206,569,197	$218,479,209	$218,511,018	$318,878,663	$337,264,022	$337,313,125	$491,353,915	$519,683,556	$519,759,218
2053	$208,727,208	$221,102,896	$221,138,350	$321,579,718	$340,646,567	$340,701,191	$494,353,914	$523,664,754	$523,748,725
2054	$210,860,809	$223,710,563	$223,749,753	$324,248,225	$344,007,752	$344,068,017	$497,313,229	$527,619,251	$527,711,682
2055	$212,970,000	$226,302,208	$226,345,227	$326,884,186	$347,347,576	$347,413,604	$500,231,861	$531,547,047	$531,648,091
2056	$215,054,781	$228,877,834	$228,924,771	$329,487,601	$350,666,039	$350,737,952	$503,109,810	$535,448,143	$535,557,951
2057	$217,115,153	$231,437,438	$231,488,387	$332,058,469	$353,963,141	$354,041,062	$505,947,076	$539,322,537	$539,441,263
2058	$219,151,114	$233,981,022	$234,036,073	$334,596,791	$357,238,882	$357,322,932	$508,743,658	$543,170,231	$543,298,026
2059	$221,162,666	$236,508,586	$236,567,830	$337,102,566	$360,493,263	$360,583,564	$511,499,558	$546,991,223	$547,128,240
2060	$231,439,342	$247,571,035	$247,293,455	$352,190,304	$376,738,532	$376,316,127	$533,316,745	$570,489,776	$569,850,135
Cumulative Total	$5,892,190,180	$6,178,295,014	$6,178,341,546	$9,243,116,199	$9,689,156,188	$9,689,218,230	$14,514,313,546	$15,209,688,982	$15,209,766,534

Social Cost Differences between Build and No-Build - Cumulative SC-GHG 2030-2060

	No-Build	Build Alternative - GP Lane	Change (GP Lane vs No-Build)	% Change (GP Lane vs No-Build)	Build Alternative - Hybrid	Change (Hybrid vs No-Build)	% Change (Hybrid vs No-Build)
2.5%	$5,892,190,180	$6,178,295,014	$286,104,834	4.9%	$6,178,341,546	$6,178,295,014	4.9%
2.0%	$9,243,116,199	$9,689,156,188	$446,039,989	4.8%	$9,689,218,230	$9,689,156,188	4.8%
1.5%	$14,514,313,546	$15,209,688,982	$695,375,436	4.8%	$15,209,766,534	$15,209,688,981	4.8%

Social Cost Differences between Build and No-Build - Snap Shot for 2030 and 2060 Emissions [1]

	2030							2060						
	No-Build	Build Alternative - GP Lane	Change (GP Lane vs No-Build)	% Change (GP Lane vs No-Build)	Build Alternative - Hybrid	Change (Hybrid vs No-Build)	% Change (Hybrid vs No-Build)	No-Build	Build Alternative - GP Lane	Change (GP Lane vs No-Build)	% Change (GP Lane vs No-Build)	Build Alternative - Hybrid	Change (Hybrid vs No-Build)	% Change (Hybrid vs No-Build)
2.5%	$152,917,250	$156,704,898	$3,787,648	2.5%	$156,679,624	$3,762,375	2.5%	$231,439,342	$247,571,035	$16,131,693	7.0%	$247,293,455	$15,854,112	6.9%
2.0%	$251,221,196	$257,443,761	$6,222,565	2.5%	$257,402,240	$6,181,044	2.5%	$352,190,304	$376,738,532	$24,548,228	7.0%	$376,316,127	$24,125,823	6.9%
1.5%	$415,061,106	$425,341,866	$10,280,760	2.5%	$425,273,266	$10,212,160	2.5%	$533,316,745	$570,489,776	$37,173,031	7.0%	$569,850,135	$36,533,389	6.9%

Notes:

1. Snap shot emissions for 2030 and 2060 include the vehicle operation emissions in each of these two years (from the corresponding VMT in each year) and the annualized construction/O&M emissions.

Annualized GHG Emissions Equivalency for GHG Emissions Increases From Build (Compared to No-Build)

	Build Alternative - GP Lane	Build Alternative - Hybrid
Annualized GHG Emissions Increase (Build vs No-Build, MT/year)	49,667	48,962
GHG Equivalency (/year) [1]		
barrels of crude oil consumed	114,979	113,346
gasoline powered passenger vehicles driven for one year	11,821	11,653
Tanker truck's worth of gasoline	656	646
Natural Gas Fired Power Plan in One Year	0.15	0.15

Notes:

1. Data source: EPA (https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator)

1000 MT CO2e is equivalent to

2,315	barrels of oil consumed
238	gasoline powered passenger vehicles driven for one year
13.2	Tanker truck's worth of gasoline
0.003	Natural Gas Fired Power Plan in One Year

MOVES4 Modeling Results

Tailpipe GHG Emissions during Project Operation by MOVES4

Build Alternative - GP Lane

	Tailpipe Emissions (metric tons/year)														
	Dane					Other Counties					Total				
	2023	2030	2030	2060	2060	2023	2030	2030	2060	2060	2023	2030	2030	2060	2060
Pollutant	EC	NB	B GP Lane	NB	B GP Lane	EC	NB	B GP Lane	NB	B GP Lane	EC	NB	B GP Lane	NB	B GP Lane
Atmospheric CO_2	424,499.01	376,489.95	382,063.33	365,267.27	378,851.47	482,287.34	450,757.50	453,867.60	394,660.09	422,254.90	906,786.35	827,247.46	835,930.93	759,927.36	801,106.37
Methane (CH_4)	17.11	12.67	12.76	16.92	17.07	22.27	20.45	20.54	30.05	29.29	39.37	33.12	33.30	46.97	46.36
Nitrous Oxide (N_2O)	12.45	13.26	13.41	15.27	15.73	34.88	40.08	40.48	38.98	42.22	47.33	53.33	53.89	54.25	57.95
CO_2e	428,632.38	380,754.34	386,374.50	370,235.63	383,959.84	493,229.39	463,207.44	466,439.38	407,022.33	435,563.50	921,861.77	843,961.78	852,813.88	777,257.96	819,523.34

Tailpipe GHG Emissions from Impacted VMT - Construction Delay by MOVES4 - GP Lane

	Tailpipe Emissions (metric tons/year)					
	Dane	Dane	Columbia	Columbia	All	All
	2030	2030	2030	2030	2030	2030
Pollutant	45 MPH	70 MPH	45 MPH	70 MPH	45 MPH	70 MPH
Atmospheric CO_2	33,292.48	33,753.58	32,864.91	33,328.55	66,157.38	67,082.13
Methane (CH_4)	1.67	1.09	1.74	1.11	3.41	2.21
Nitrous Oxide (N_2O)	1.71	1.71	2.12	2.13	3.83	3.84
CO_2e	33,843.91	34,290.85	33,539.43	33,989.47	67,383.34	68,280.32

GHG Increase Due to Impacted VMT - Construction Delay - GP Lane

	Tailpipe Emissions (metric tons/year)		
	Dane	Columbia	All
Pollutant	2030	2030	2030
Atmospheric CO_2	461.10	463.65	924.75
Methane (CH_4)	-0.58	-0.63	-1.20
Nitrous Oxide (N_2O)	0.0004	0.01	0.01
CO_2e	446.93	450.04	896.98

Build Alternative - Hybrid

	Tailpipe Emissions (metric tons/year)														
	Dane					Other Counties					Total				
	2023	2030	2030	2060	2060	2023	2030	2030	2060	2060	2023	2030	2030	2060	2060
Pollutant	EC	NB	B Hybrid	NB	B Hybrid	EC	NB	B Hybrid	NB	B Hybrid	EC	NB	B Hybrid	NB	B Hybrid
Atmospheric CO_2	424,499.01	376,489.95	381,924.84	365,267.27	377,930.02	482,287.34	450,757.50	453,867.60	394,660.09	422,254.90	906,786.35	827,247.46	835,792.44	759,927.36	800,184.91
Methane (CH_4)	17.11	12.67	12.76	16.92	17.03	22.27	20.45	20.54	30.05	29.29	39.37	33.12	33.30	46.97	46.33
Nitrous Oxide (N_2O)	12.45	13.26	13.40	15.27	15.68	34.88	40.08	40.48	38.98	42.22	47.33	53.33	53.88	54.25	57.90
CO_2e	428,632.38	380,754.34	386,234.50	370,235.63	383,023.85	493,229.39	463,207.44	466,439.38	407,022.33	435,563.50	921,861.77	843,961.78	852,673.87	777,257.96	818,587.35

Tailpipe GHG Emissions from Impacted VMT - Construction Delay by MOVES4 - Hybrid

	Tailpipe Emissions (metric tons/year)					
	Dane	Dane	Columbia	Columbia	All	All
	2030	2030	2030	2030	2030	2030
Pollutant	45 MPH	70 MPH	45 MPH	70 MPH	45 MPH	70 MPH
Atmospheric CO_2	33,292.48	33,753.58	32,864.91	33,328.55	66,157.38	67,082.13
Methane (CH_4)	1.67	1.09	1.74	1.11	3.41	2.21
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Introduction to the Infrastructure Carbon Estimator (ICE), version 2.2

Infrastructure Carbon Estimator (ICE) version 2.2.8. Final Tool. 5/17/2023.

Note: This tool is designed to allow users to create screening-level estimates of energy and GHG emissions using limited data inputs. It asks for limited data to estimate lifecycle energy use emissions from a single or group of projects. <u>The tool is not appropriate to inform engineering analysis, including for pavement selection</u>. Other tools should be consulted for those purposes. More details about suggested uses for the tool are provided in the accompanying ICE User's Guide.

Project Inputs Page

Summary Results Page

OVERVIEW

The Infrastructure Carbon Estimator (ICE) estimates the lifecycle energy and greenhouse gas (GHG) emissions from the construction and maintenance of transportation facilities. The ICE tool was created to solve the problem of “planning level” estimation of embodied carbon emissions in transportation infrastructure. Without the need for any engineering studies, ICE helps answer this question: How much carbon will be embodied in the building, modification, maintenance, and/or use of this transportation project (or group of projects)?

ICE evaluates energy use and greenhouse gas emissions at the project- or planning-level. The tool uses the term “project-level” to generally refer to a single project type, with access to some additional details and project customization. “Planning-level” analyses are designed to support a suite of projects together, but with limited customization.

The tool estimates emissions for the following types of facilities and projects:

1. Bridges and Overpasses
2. Bus Rapid Transit (BRT)
3. Culverts
4. Interchanges
5. Light Rail
6. Lighting
7. Heavy Rail
8. Parking
9. Pathways
10. Roadways
11. Signage
12. Vehicle Operations
13. Standalone Maintenance Projects on Existing Roadways (Roadway Rehabilitation)
14. Custom Pavement Projects with Data Imported from External Tools

(Please note Types 13 and 14 address specific and limited applications. These are discussed in the individal tabs and the User's Guide.)

For each type of facility, the tool calculates both mitigated results that take into account the effect of various energy/GHG reduction strategies and unmitigated results.

USER'S GUIDE

Refer to the accompanying User's Guide for further instructions, detailed descriptions of factors, and assumptions regarding this tool.

Find the current version of the users guide here: https://edocs-public.dot.state.mn.us/edocs_public/DMResultSet/download?docId=11949837

USING THE TOOL

Color Scheme

ICE uses the following color scheme to describe the function of each cell:

Description Cells
Computed Value Cells
Cell value is not relevant (Cell is NA)
Data Entry Cells
Action Cell
Command button - on
Command button - off
Command button - disabled

The tool provides users the ability to display results in 508 compliant format, which among other features, will add data labels to all results charts. The color scheme when 508 compliant is activated deviates slightly from when the format is turned off.

Analysis Mode

The tool can be used in either *Planning* or *Project* mode. This is set at the top of the *Project Inputs* page.

Planning mode allows multiple infrastructure types to be analyzed together. Planning Mode reveals all facility types on one page. Using the buttons at the top of the screen allows you to add or remove facilities from your analysis. Individual facility details can be viewed via the links below the input table or by navigating the separate tabs for each infrastructure type. Clicking the hyperlinks above and below each infrastructure type's inputs in the Project Inputs page navigates to the various sections in each analysis page for that infrastructure type. The relevant analysis page(s), Mitigation Strategies page, and the Summary Results page will be shown when an infrastructure type is selected. Buttons on the analysis pages carry the user to specify mitigation measures and back to the analysis pages. Most uses of the tool use *Planning* mode.

The *Project mode* allows additional details but is limited to a single infrastructure type. It operates similarly, but for a single infrastructure type. In the Project mode, the user has the option to view all inputs or have ICE walk the user through each step. In walkthrough mode, green action cells direct the user through each step.

TABS & NAVIGATION

The tool can be navigated in multiple ways. Users will start by describing their project on the *Project Inputs* page. This includes the infrastructure type(s), analysis lifetime, location, and analysis mode. Hyperlinks carry users through the various tabs. Three comment boxes allow the user to input descriptive text that will be carried through to the output pages. This could include analysis date, analyst, project descriptions, or other information the analyst may want to include in their report.

First, select your level of analysis (Project or Planning) and input the requested information for your project on the *Project Inputs* page. Input the US state for your analysis, the project analysis lifetime (in years), and whether the impacts of a custom electricity emission program, such as a state Renewable Portfolio Standard (RPS), are to be included. Answering "yes" on the latter will open the *Annual Electricity Emissions* tab for populating. Note that due to data limitations, 2060 emissions factors are used for all calculations after 2060.

If using the Planning level of analysis, "turn on" all infrastructure types to be analyzed on the *Project Inputs* page. If using the *Project* level of analysis, then select the single infrastructure type to analyze.

Hyperlinks from the *Project Inputs* page will take you to the *analysis page* for your project type(s). (The project analysis pages are titled according to the infrastructure type.) Here some additional inputs for your project may be requested. At the top of each analysis page is a hyperlink that carries you to the *Mitigation Strategies* page.

Each *analysis page* includes the following sections:

- Specifications – Fixed and input values describing the project
- Baseline Energy Use and GHG Emissions – Total energy use and GHG emissions over the project's lifetime
- Mitigated Results – Annualized energy use and GHG emissions for the project without (baseline) and with (both business as usual and control scenario) mitigations applied.
- Results - Charts – Summary charts and tables of the mitigated and unmitigated energy use and emissions by emission category, material, and individualized mitigation effects. Results can be viewed for GHG emissions or energy consumption either as annualized values or cumulative over the analysis period.

On the *Mitigation Strategies* page, you have the option to input certain strategies that reduce energy and GHG emissions for your project. Only relevant strategies are shown. Hyperlinks at the top return you to the *analysis page* for your project type.

Below the project specifications in each *analysis page,* the calculated, annualized baseline, business-as-usual (BAU), and mitigated levels of energy or GHG emissions for your project type(s) are displayed. This shows results by the five emission categories and by material for both mitigated and unmitigated cases. It also shows emission or energy reductions by mitigation measure.

The *Summary Results* page displays a summary of results for all infrastructure types analyzed. If the analysis is at the *Project* level, this display is nearly identical to that on the *analysis page.* For *Planning* level, buttons appear allowing the user to turn on or off the different project types included in the combined results. The "Show" dropdown menu selects the results displayed: Annualized Greenhouse Gas Emissions, Annualized Energy Use, Cumulative Greenhouse Gas Emissions, and Cumulative Energy Use. An additional chart in the *Summary Results* page, not available in the individual *analysis pages*, displays values by infrastructure type.

If the use phase of vehicles is considered in your project, you must include the *Vehicle Operations* project type. Resulting energy and emissions from project use will be added to the summary charts on the *Summary Results* page. Note this is limited to roadway infrastructure. This project type also includes the ability to estimate additional emissions related to construction delay and to directly use results computed in a seperate analysis.

Similarly, ICE remains pavement material neutral. In order to consider lifecycle implications of specific pavement configurations, you must use another tool, such as FHWA's LCA PAVE. Emission factors from such an analysis may be input directly into ICE via the *Custom Pavements* infrastructure type.

At any time, the user can view overall results in the *Summary Results* page or enter a custom mitigation approach for energy and GHG emissions on the *Mitigation Strategies* page. The user can switch directly between various pages indicated in Excel tabs at any time. The *Print Results* tab collects outputs and formats them for standard printing, either to an electronic or paper copy for archiving the outputs of your simulation. This can be used to compare multiple simulations, such as for a Build vs. No-Build analysis.

Units and Time Periods

ICE requests the analysis timeframe (in years) from the user. It produces lifecycle (to end-of-life) estimates of energy use and/or GHG emissions. Both values can be reported on an annualized or total lifespan basis. The standard reporting unit for energy is "mmBTU", or millions of British Thermal Units. The standard reporting unit for greenhouse gas emissions is "MT CO2e", or metric tons of CO2-equivalent gases. 1 metric ton = 1,000 kg. CO2 equivalency is defined by a global-warming potential basis.

A Note about Energy and Emission Factors

It is important to note that ICE uses MOVES for projections of the vehicle fleet mix and downstream (tank to wheels) energy consumption rates along with fuel-vehicle full lifecycle energy and emission factors from GREET. These are combined to deiver full lifecycle (well to wheels) fuel energy and emission rates. ICE2.2 uses rates from MOVES3, which is the current version of the tool as of the time of ICE2.2 release.
It is important to note that MOVES3 includes the SAFE rule what has been repealed resulting in more stringent GHG reductions for future vehicle model years, does not account for expected future Heavy-Duty Vehicle rulemakings, and assumes negligible electric vehicle penetration in the fleet, among other limitations. ICE may be updated at a future date when improved vehicle energy rate projections are available. See the User's Guide for more information.

ESTIMATED EMISSIONS SOURCES

Construction and maintenance activities covered by the tool are broken into five categories:

Materials
Upstream Energy and Emissions associated with project materials:

1. Energy and fuel used in raw material extraction
2. Energy and fuel used in material production*
3. Chemical reactions in material production**
4. Energy and fuel used in raw material transportation

Transportation
Upstream Energy and Emissions associated with:

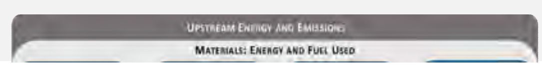
1. Fuel used in transportation of materials to site

Construction

1. Energy and fuel used in construction equipment

Operations and Maintenance (O&M)
Routine Maintenance, including:

1. Fuel used in snow removal equipment



2. Fuel used in vegetation management equipment
3. Fuel used in other routine maintenance***
4. Energy and emissions from roadway repair and rehabilitation
5. Net energy and emissions from pavement preservation activities (optional)

Usage

Energy and Emissions associated with:

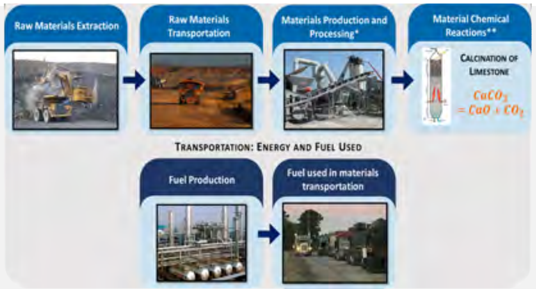
1. Vehicle operations on roadways, including delay during construction

*e.g. crushing of aggregate, asphalt batch plants

**e.g CO2 emitted from calcination of limestone

***activities include sweeping, stripping, bridge deck repair, litter pickup, and maintenance of appurtenances

ICE does not include energy or emissions associated with land use change from the project.



Project Inputs

Planning Summary of Inputs - See Individual Tabs for Details

Display result in 508 compliant format:	
Hide Instructions	No

INSTRUCTIONS

1. Populate location (state) and lifetime (years) for your analysis.
2. Select operating mode (*Project* or *Planning*) for your analysis. (The tool can analyze individual projects (*Project* mode) or a suite of projects in a comprehensive plan (*Planning* mode). Most analyses using *Planning* mode.
3. Select the infrastructure type(s) to analyze. Input all requested data using information from the project or plan you want to analyze. Then navigate to the relevant *analysis page(*s) for your project or the individual project(s) in your plan and complete the analysis for each infrastructure type by entering information in all cells that are shaded yellow. Blue and gray cells display fixed values and results; do not change the information in these cells.
4. Apply any selected mitigation measures on the *Mitigation Strategies* tab.
5. Review outputs on the *Summary Results* tab.
6. For further instructions, refer to the accompanying User Guide for detailed descriptions of factors and assumptions used in this tool.

Infrastructure location (state)	WI
Analysis period of your plan or project (years)	30
Year construction starts	2030
Use custom electric emission profile (RPS)?	No

Tool Use	Planning

Infrastructure Types

Roadways	BRT	Heavy Rail	Light Rail	Parking	Signage	
Bridges & Overpasses	Culverts	Interchanges	Lighting	Pathways	Vehicle Operations	Custom Pavement

	Title:	I39/90/94 GHG Analysis	Title:	No Build	Title:	
Enter comments and comment titles. These will be displayed on the Summary Results worksheet.	I30/90/94 GHG Analysis_No Build		This anlaysis included emissions from project construction between 2030-2040, maintenance, and vehicle operation emissions due to delay caused by the construction. Vehicle operation emissions covered the period of 2030 to 2060			

Roadways

Roadways

The Roadways module in ICE accounts for the full roadway lifespan, including construction, rehabilitation, routine maintenance, and preventive maintenance for new and existing roadways. Separate inputs are required for construction, rehabilitation, and effects of preventative maintenance. Module inputs include those for both the existing and new construction. As noted, some inputs are lane miles; some are centerline miles. See the Roadways sheet and User's Guide for more information.

Source: https://commons.wikimedia.org/wiki/File:Veterans_Memorial_Parkway,_London,_Ontario.jpg

Roadway System

Total existing centerline miles	182.14
Total newly constructed centerline miles	0

Roadway Projects

Facility type	Roadway System	Roadway Construction				
	Existing Roadway (lane miles)	New Roadway (lane miles)	Construct Additional Lane (lane miles)	Realignment (lane miles)	Lane Widening (lane miles)	Shoulder Improvement (centerline miles)
Rural Interstates	268.3					
Rural Principal Arterials	0					
Rural Minor Arterials	17.19					
Rural Collectors	11.97					
Urban Interstates / Expressways	116.88					
Urban Principal Arterials	8.93					
Urban Minor Arterials / Collectors	15.51					

Include roadway rehabilitation activities (reconstruct and resurface)	Yes

% roadway construction on rocky / mountainous terrain	0%

Specification
Baseline Energy Use and GHG Emissions
Mitigated Results

[Results - Charts](#)

Lighting

[Lighting](#)

The Lighting module estimates the energy and GHG emissions associated with roadway lighting projects. ICE considers LED and HPS type lights and state-specific energy factors. See the Lighting sheet and User's Guide for more information. Module inputs include average number of lights per roadway mile by type and luminosity.

Source: http://www.sanengineeringllc.com/Projects/Structural-Engineering-NMDOT.php

Number of roadway miles	182.14

Lighting Structures Support Structure Type	Lumen Range	Ave. number of HPS lights per roadway mile	Ave. number of LED lights per roadway mile
Vertical	4000 5000		
Vertical	7000 8800		
Vertical	8500 11500		
Vertical	11500-14000		
Vertical	21000-28000		
Vertical and Vertical with 8 Arm	4000 5000		
Vertical and Vertical with 8 Arm	7000 8800		
Vertical and Vertical with 8 Arm	8500 11500		
Vertical and Vertical with 8 Arm	11500-14000		0.5765
Vertical and Vertical with 8 Arm	21000-28000		
High Mast	28800 - 42000		
High Mast	46500-52800		
High Mast	52500-58300		

Specification
Baseline Energy Use and GHG Emissions
Mitigated Results
Results - Charts

Vehicle Ops

Vehicle_Ops

The Vehicle Operations module estimates on roadway infrastructure from vehicle operations. It addresses both ongoing vehicle operations and additional emissions from construction delay.
ICE2.2 includes two approaches: 1) The preferred approach is for the user to enter custom emission amounts directly from a seperate calculation. ICE then combines this with any other infrastructure included. 2) The alternative approach estimates these values from user inputs of VMT, speed, and optional vehicle type. Note ICE2.2 uses MOVES3 projections of vehicle energy consumption and fleet mix.
See the Vehicle_Ops sheet and User's Guide for more information.

Source: https://www.greencarreports.com/news/1093560_1-2-billion-vehicles-on-worlds-roads-now-2-billion-by-2035-report

Enter results from external model?	Yes

Vehicle Operating Emissions

Custom emissions represent:	Tailpipe - upscale to full lifecycle	
	Year	kg CO2e/year from roadway network
Start year	2030	843961780
End Year	2060	777257958

Construction Delay, Additional Emissions

Custom emissions represent:	Tailpipe - upscale to full lifecycle	
	Year	Increased emissions (kg CO2e/year)
Start year		
End Year		

Summary Results

Roadways	BRT	Heavy Rail	Light Rail	Parking	Signage	
Bridges & Overpasses	Culverts	Interchanges	Lighting	Pathways	Vehicle Operations	Custom Pavement

Show	Cumulative Greenhouse Gas Emissions	Units	MT CO2e

I39/90/94 GHG Analysis

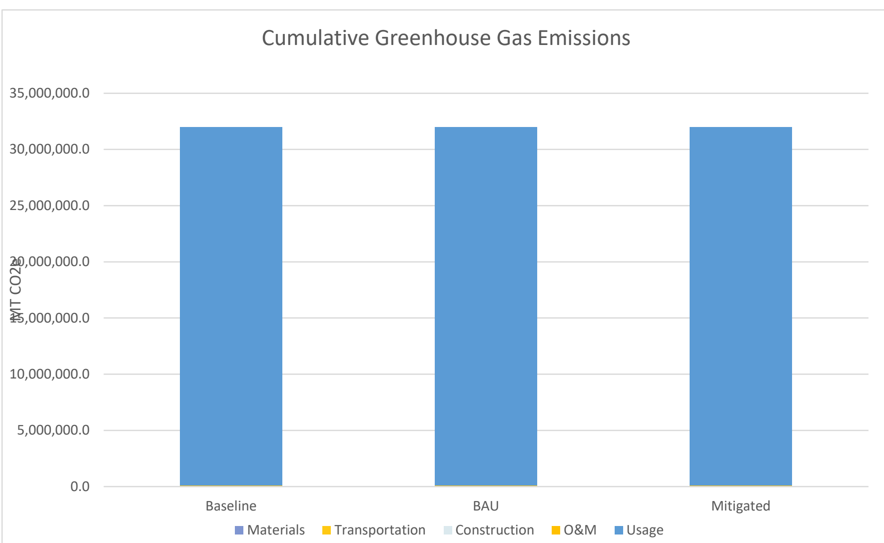
I30/90/94 GHG Analysis_No Build

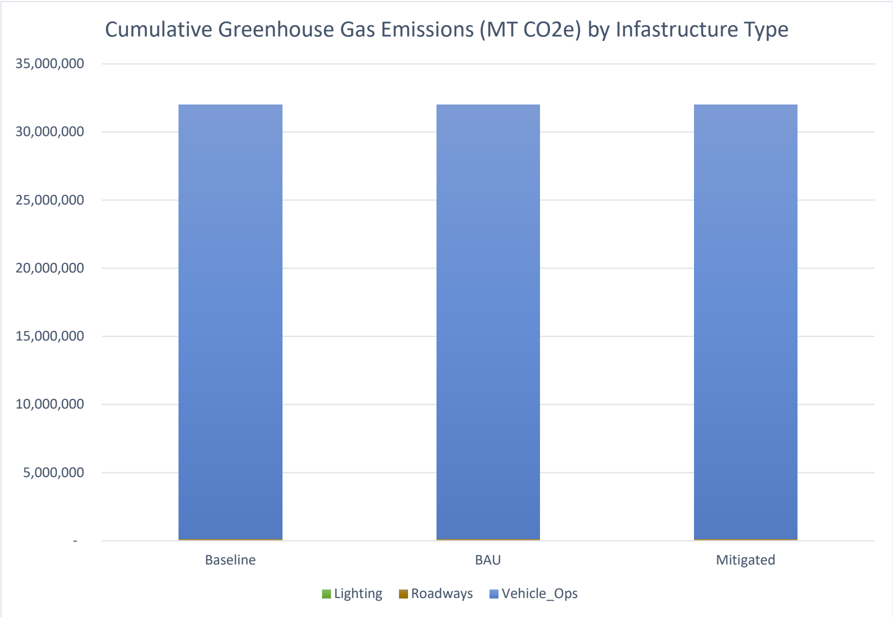
No Build

This anlaysis included emissions from project construction between 2030-2040, maintenance, and vehicle operation emissions due to delay caused by the construction. Vehicle operation emissions covered the period of 2030 to 2060

	Cumulative Greenhouse Gas Emissions (MT CO2e) by Infastructure Type		
	MT CO2e	MT CO2e	MT CO2e
	Baseline	BAU	Mitigated
Lighting	1,238	1,238	1,238
Roadways	124,616	124,616	124,616
Vehicle_Ops	31,878,667	31,878,667	31,878,667
Total	**32,004,522**	**32,004,522**	**32,004,522**

Summary Results - Charts





Summary Results Tables

	Cumulative Greenhouse Gas Emissions		
	MT CO2e	MT CO2e	MT CO2e
	Baseline	BAU	Mitigated
Materials	73	73	73
Transportation	1	1	1
Construction	-	-	-
O&M	125,781	125,781	125,781
Usage	31,878,667	31,878,667	31,878,667
Total	**32,004,522**	**32,004,522**	**32,004,522**

	Cumulative Greenhouse Gas Emissions Per Material Type		
	MT CO2e	MT CO2e	MT CO2e
	Baseline	BAU	Mitigated
Aggregate	0	0	0
Cement	15	15	15
Steel	58	58	58
Water	0	0	0
Transportation Fuel	1	1	1
O&M Electricity (kWh)	1,165	1,165	1,165
O&M fuel (DGEs)	28,785	28,785	28,785

O&M Roadway Rehabilitation	95,832	95,832	95,832
Usage	31,878,667	31,878,667	31,878,667
Total	**32,004,522**	**32,004,522**	**32,004,522**

	Cumulative Greenhouse Gas Emissions Reductions Relative to BAU				
	MT CO2e	MT CO2e	MT CO2e	MT CO2e	MT CO2e
	Materials	Transportation	Construction	O&M	TOTAL
Total	-	-	-	-	-

	nulative Greenhouse Gas Emissions (MT CO2e) by Infastructure T		
	MT CO2e	MT CO2e	MT CO2e
	Baseline	BAU	Mitigated
Lighting	1,238	1,238	1,238
Roadways	124,616	124,616	124,616
Vehicle_Ops	31,878,667	31,878,667	31,878,667
Total	**32,004,522**	**32,004,522**	**32,004,522**

Mitigation Strategies

Return To Summary

Instructions: Follow the steps below to calculate the impact of energy and GHG mitigation strategies:

The user will enter both the business as usual (BAU) deployment (i.e., the extent to which the strategy is deployed through standard agency practices) in Column F and the planned deployment (i.e., the extent to which the strategy will be deployed in the project that you are examining) in Column G. (Baseline refers to values without any mitigations.) For Pavement Preservation strategies, enter both the schedule change and application frequency.

Column H displays the increase in deployment from implementation of the strategy. Some reduction strategies (e.g., Switch from diesel to Soybean-based Biodiesel and biodiesel/hybrid maintenance vehicles and equipment) may be incompatible. The user should take care that inputs do not describe a total deployment greater than 100% for overlapping strategies. The tool will warn if "excess" energy savings from mitigation are predicted or incompatible strategies are selected.

For a more refined mitigation analysis, please refer to FHWA's upcoming Pavement LCA Tool.

						BAU Reductions		Planned Reductions	
Strategy	**BAU deployment**	**Planned deployment**	**Deployment increase**	**Energy reduction factor**	**GHG reduction factor**	**Energy reductions**	**GHG reductions**	**Energy reductions**	**GHG reductions**
Alternative fuels and vehicle hybridization									
Sw tch from diesel to Soybean based B odiesel			0.0%	26%	14%	0.0%	0.0%	0.0%	0.0%
Sw tch from diesel to Soybean based RDII 100			0.0%	28%	65%	0.0%	0.0%	0.0%	0.0%
Sw tch from diesel to Forest Residue based RDII 100			0.0%	67%	73%	0.0%	0.0%	0.0%	0.0%
Sw tch from diesel to E Diese , Corn			0.0%	5%	14%	0.0%	0.0%	0.0%	0.0%
Sw tch from diesel to PHEV: Diesel and E ectr city (State M x)			0.0%	18%	24%	0.0%	0.0%	0.0%	0.0%
Sw tch from diesel to Hybrid D esel			0.0%	11%	11%	0.0%	0.0%	0.0%	0.0%
Sw tch from diesel to Electricity			0.0%	56%	63%	0.0%	0.0%	0.0%	0.0%
Sw tch from diesel to CNG, from NG			0.0%	9%	11%	0.0%	0.0%	0.0%	0.0%
Sw tch from diesel to LNG, from NG			0.0%	13%	8%	0.0%	0.0%	0.0%	0.0%
Sw tch from diesel to Convent onal Diesel (BD20)			0.0%	5%	14%	0.0%	0.0%	0.0%	0.0%
Sw tch from diesel to Hydrogen (from NG)			0.0%	40%	52%	0.0%	0.0%	0.0%	0.0%
Sw tch from diesel to Biodiesel (from corn)			0.0%	88%	90%	0.0%	0.0%	0.0%	0.0%
Sw tch from diesel to RDII (from corn)			0.0%	81%	87%	0.0%	0.0%	0.0%	0.0%
Sw tch from diesel to CNG (from Landfill, Off site Refuel ng)			0.0%	2%	17%	0.0%	0.0%	0.0%	0.0%
Sw tch from diesel to Renewab e CNG (from Wastewater Treatment, Off site refuel ng)			0.0%	62%	136%	0.0%	0.0%	0.0%	0.0%
Hybrid maintenance vehic es and equipment			0.0%	11%	11%	0.0%	0.0%	0.0%	0.0%
Combined hybridization/B20 in maintenance vehic es and equipment			0.0%	1%	27%	0.0%	0.0%	0.0%	0.0%
Hybrid construction vehicles and equipment			0.0%	11%	11%	0.0%	0.0%	0.0%	0.0%
Combined hybridization/B20 in construction veh cles and equipment			0.0%	1%	27%	0.0%	0.0%	0.0%	0.0%
Vegetation management									
A ternative vegetation management strategies (hardscaping, alternative mowing, integrated roadway/vegetation management)			N/A	25%	25%	0.0%	0.0%	0.0%	0.0%
Snow fencing and removal strategies									
A ternative snow removal strategies (snow fencing, wing plows)			N/A	50%	50%	0.0%	0.0%	0.0%	0.0%
In place roadway recycling									
Cold In place recycling			0.0%	33%	37%	0.0%	0.0%	0.0%	0.0%
Fu depth reclamation			0.0%	68%	68%	0.0%	0.0%	0.0%	0.0%
Warm-mix asphalt									
Warm mix asphalt			0.0%	37%	37%	0.0%	0.0%	0.0%	0.0%
Recycled and reclaimed materials									
Use recycled asphalt pavement as a substitute for virg n asphalt aggregate			0.0%	12%	12%	0.0%	0.0%	0.0%	0.0%
Use recycled asphalt pavement as a substitute for virg n asphalt bitumen			0.0%	84%	84%	0.0%	0.0%	0.0%	0.0%
Use industria byproducts as substitutes for Portland cement			0.0%	59%	59%	0.0%	0.0%	0.0%	0.0%
Use recycled concrete aggregate as a substitute for base stone			0.0%	58%	58%	0.0%	0.0%	0.0%	0.0%
Pavement preservation									
Pavement preservation extends roadway maintenance activities by (%)			0.0%	N/A	N/A	N/A	N/A	N/A	N/A
Pavement preservation frequency (every N years, for entire roadway system)			N/A	N/A	N/A	N/A	N/A	N/A	N/A

Roadways

Roadway example.
Source: https://commons.wikimedia.org/wiki/File:Veterans_Memorial_Parkway,_London,_Ontario.jpg

ICE accounts for the full roadway lifespan, including construction, rehabilitation, routine maintenance, and preventive maintenance. ICE handles these activities in different ways. Separate inputs are required for construction, rehabilitation, and effects of preventative maintenance. Specifically:

- New construction – The user enters lane miles of construction (or centerline miles of shoulder improvement) projects. Separately, the user indicates what fraction of roadway construction is in difficult terrain.
- Roadway rehabilitation – The user enters expected lane miles for reconstruction and resurfacing projects the length of the analysis period. Separately, the user enters a rehabilitation schedule. (Defaults are provided and used if no values are entered.) As a general rule of thumb, new roadways require resurfacing after 15 years and reconstruction after 30 years. Note that roadway rehabilitation applies to both existing and new roadways.
- Preventive maintenance – Preventive maintenance is pavement preservation techniques, such as crack sealing, patching, chip seals, and micro-surfacing, that prolong the life of the pavement. In ICE2.0, the user has the option to specify an extension of the roadway rehabilitation schedule due to implementation of a (generic) preventive maintenance program. Application of preventative maintenance is accessible on the *Mitigation Strategies* tab. Note that the energy and emissions "cost" of a preventative maintenance program is based on an average of several potential strategies from different studies. More specific values may be obtainable from FHWA's Pavement LCA tool (when it becomes available).

Emissions and energy associated with routine maintenance (sweeping, striping, bridge deck repair, litter pickup, and maintenance of appurtenances) and roadway rehabilitation is automatically estimated per lane mile of both new and existing roadways associated with your project. To estimate associated use-phase emissions, visit the Vehicle Operations tab.

Note that roadway projects do not include sidewalks. If your project or plan includes constructing sidewalks, they should be entered separately in the Rail, Bus, Bicycle, and Pedestrian Facilities section of the tool.

Note that ICE2.0 does not calculate energy or GHG emissions savings from pavement smoothness effects related to any resurfacing and reconstruction projects.

ICE also does not intrinsically allow customized pavement configurations. Most analyses should use this Roadway tab and ICE's internal pavement configuration. The Custom Pavement analysis relies on external data rather than ICE's calculations to estimate lifecycle values for different configurations. Please see the Custom Pavement tab for more information. Users should not enter both Roadway and Custom Pavement values for the same project.

Example: The user enters new construction of 10 lane miles of new freeway, with an analysis period of 40 years. Assuming that all construction takes place in year 1, the user enters 10 lane miles of freeway resurfacing (assumed to take place in year 15) and 10 lane miles of freeway reconstruction (assumed to take place in year 30). The tool automatically includes routine maintenance of the 10 newly constructed lane miles. The user has the option of specifying a generic preventive maintenance program, which will increase the longevity of the pavement surface and therefore reduce the amount of energy and emissions associated with resurfacing and rehabilitation.

Specification

Select Mitigation Strategies

Roadway System	Existing	New	Total
Total centerline miles	182	0	182
Total lane miles	434	0	434

		Facility type						
		Rural Interstates	Rural Principal Arterials	Rural Minor Arterials	Rural Collectors	Urban Interstates / Expressways	Urban Principal Arterials	Urban Minor Arterials / Collectors
Roadway Lane Width (feet) (before construction)	Default	12	11	11	11	12	11	11

Include roadway rehabilitation activities (reconstruct and resurface)	Yes
% roadway construction on rocky / mountainous terrain	0%

Baseline Energy Use and GHG Emissions

Materials Transportation	Construction	Energy use (mmBTU)	GHG emissions (MT CO2e)	O&M Roadway Rehabilitation	Energy use (mmBTU)	GHG emissions (MT CO2e)
Transportation fuel (DGEs)		0	0		85,499	6,883
Total		0	0		85,499	6,883

Mitigated Results

Construction

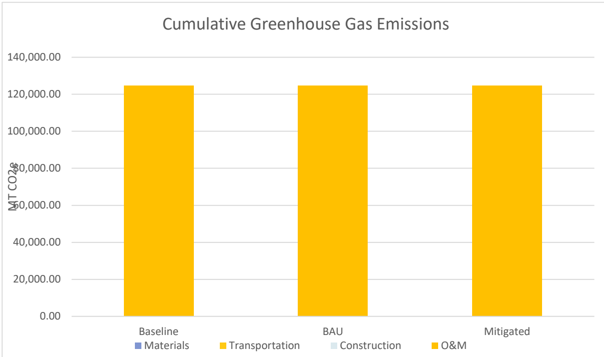
30 year Annualized Results	Annualized Energy Use – Baseline: Energy use (mmBTU)	Annualized Energy Use – BAU: Energy use (mmBTU)	Annualized Energy Use – Mitigated: Energy use (mmBTU)	Annualized Greenhouse Gas Emissions – Baseline: GHG emissions (MT CO2e)	Annualized Greenhouse Gas Emissions – BAU: GHG emissions (MT CO2e)	Annualized Greenhouse Gas Emissions – Mitigated: GHG emissions (MT CO2e)
Aggregate	-	-	-	-	-	-
Bitumen (Asphalt Binder)	-	-	-	-	-	-
Cement	-	-	-	-	-	-
Steel	-	-	-	-	-	-
Water	-	-	-	-	-	-
Transportation Fuel	-	-	-	-	-	-
Construction Fuel	-	-	-	-	-	-
O&M fuel (DGEs)	11,919	11,919	11,919	959	959	959
O&M Roadway Rehabilitation	37,715	37,715	37,715	3,194	3,194	3,194
Materials subtotal	-	-	-	-	-	-
Transportation subtotal	-	-	-	-	-	-
Construction subtotal	-	-	-	-	-	-
Operations & Maintenance subtotal	49,634	49,634	49,634	4,154	4,154	4,154
Total	49,634	49,634	49,634	4,154	4,154	4,154

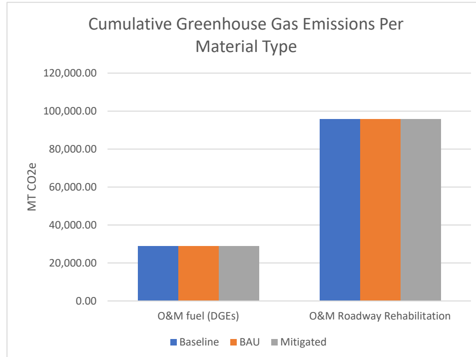
O&M Roadway Rehabilitation

30 year Annualized Results	Annualized Energy Use – Baseline: Energy use (mmBTU)	Annualized Energy Use – BAU: Energy use (mmBTU)	Annualized Energy Use – Mitigated: Energy use (mmBTU)	Annualized Greenhouse Gas Emissions – Baseline: GHG emissions (MT CO2e)	Annualized Greenhouse Gas Emissions – BAU: GHG emissions (MT CO2e)	Annualized Greenhouse Gas Emissions – Mitigated: GHG emissions (MT CO2e)
Aggregate	4,599	4,599	4,599	260	260	260
Bitumen (Asphalt Binder)	9,606	9,606	9,606	743	743	743
Cement	2,811	2,811	2,811	524	524	524
Steel	2,748	2,748	2,748	222	222	222
Water	1	1	1	0	0	0
Transportation Fuel	2,850	2,850	2,850	229	229	229
Construction Fuel	15,100	15,100	15,100	1,216	1,216	1,216
O&M fuel (DGEs)	-	-	-	-	-	-
O&M Roadway Rehabilitation	37,715	37,715	37,715	3,194	3,194	3,194

Results Charts

Show	Cumulative Greenhouse Gas Emissions	Units	MT CO2e





	Cumulative Greenhouse Gas Emissions		
	MT CO2e	MT CO2e	MT CO2e
	Baseline	BAU	Mitigated
Materials	-	-	-
Transportation	-	-	-
Construction	-	-	-
O&M	124,616	124,616	124,616
Total	**124,616**	**124,616**	**124,616**

	Cumulative Greenhouse Gas Emissions Per Material Type		
	MT CO2e	MT CO2e	MT CO2e
	Baseline	BAU	Mitigated
O&M fuel (DGEs)	28,785	28,785	28,785
O&M Roadway Rehabilitation	95,832	95,832	95,832
Total	**124,616**	**124,616**	**124,616**

	Cumulative Greenhouse Gas Emissions Reductions Relative to BAU				
	MT CO2e	MT CO2e	MT CO2e	MT CO2e	MT CO2e
	Materials	Transportation	Construction	O&M	TOTAL
Total	-	-	-	-	-

Lighting

Example of vertical with arm lighting.
Source:
http://www.sanengineeringllc.com/Projects/Structural-Engineering-NMDOT.php

ICE estimates the energy and GHG emissions associated with lighting use projects. Annual energy consumption will be paired with energy emission factors for individual states to determine GHG emissions.

Roadway lighting projects can be a significant contributor to the annual energy use and GHG emissions of many transportation agencies. ICE estimates the energy and GHG emissions associated with lighting projects. ICE evaluates the impacts of two of the most common lighting technologies: High Pressure Sodium (HPS) & Light Emitting Diode (LED). It includes lifecycle impacts associated with common support structures: High Mast, Vertical, and Vertical with arm.

Note that ICE only includes roadway lighting energy and GHG emissions from the use phase and lighting support structures, as manufacturing energy and emissions for HPS and LED luminaries and replacement parts is currently poorly characterized.

Specification

Select Mitigation Strategies

Lighting Structures		Avg number of HPS lights per roadway mile	Avg number of LED lights per roadway mile
Support Structure Type	Lumen Range		
Vertical	4000-5000	-	-
Vertical	7000-8800	-	-
Vertical	8500-11500	-	-
Vertical	11500-14000	-	-
Vertical	21000-28000	-	-
Vertical and Vertical with 8 Arm	4000-5000	-	-
Vertical and Vertical with 8 Arm	7000-8800	-	-
Vertical and Vertical with 8 Arm	8500-11500	-	-
Vertical and Vertical with 8 Arm	11500-14000	-	0.6
Vertical and Vertical with 8 Arm	21000-28000	-	-
High Mast	28800 - 42000	-	-
High Mast	46500-52800	-	-
High Mast	52500-58300	-	-

Number of roadway miles	182.14

Baseline Energy Use and GHG Emissions

Material Energy Use and Emissions		Energy use (mmBTU)	GHG emissions (MT CO2e)
Aggregate		5	0
Aluminum			
Cement		80	15
Steel		676	58

Materials Transportation		Energy use (mmBTU)	GHG emissions (MT CO2e)
Transportation fuel (DGEs)		7	1
Total		7	1

Construction Process		Energy use (mmBTU)	GHG emissions (MT CO2e)
Electricity (kWh)		-	-
Construction fuel (DGEs)		-	-
Total		-	-

Operations and Maintenance		Energy use (mmBTU)	GHG emissions (MT CO2e)
Electricity (kWh)		13,556	1,165
Maintenance fuel (DGEs)		-	-
Water		-	-
Total		13,556	1,165

Mitigated Results

	Annualized Energy Use			Annualized Greenhouse Gas Emissions		
	Baseline	BAU	Mitigated	Baseline	BAU	Mitigated
30 year Annualized Results	Energy use (mmBTU)	Energy use (mmBTU)	Energy use (mmBTU)	GHG emissions (MT CO2e)	GHG emissions (MT CO2e)	GHG emissions (MT CO2e)
Aggregate	0	0	0	0	0	0
Aluminum	-	-	-	-	-	-
Cement	3	3	3	0	0	0
Steel	23	23	23	2	2	2
Water	0	0	0	0	0	0
Transportation Fuel	0	0	0	0	0	0
Construction Fuel	-	-	-	-	-	-
O&M Electricity (kWh)	452	452	452	39	39	39
Materials subtotal	25	25	25	2	2	2
Transportation subtotal	0	0	0	0	0	0
Construction subtotal	-	-	-	-	-	-
Operations & Maintenance subtotal	452	452	452	39	39	39
Total	477	477	477	41	41	41

Results Charts

Show	Cumulative Greenhouse Gas Emissions	Units	MT CO2e

	Cumulative Greenhouse Gas Emissions		
	MT CO2e	MT CO2e	MT CO2e
	Baseline	BAU	Mitigated
Materials	73	73	73
Transportation	1	1	1
Construction	-	-	-
O&M	1,165	1,165	1,165
Total	**1,238**	**1,238**	**1,238**

	Cumulative Greenhouse Gas Emissions Per Material Type		
	MT CO2e	MT CO2e	MT CO2e
	Baseline	BAU	Mitigated
Aggregate	0	0	0
Cement	15	15	15
Steel	58	58	58
Water	0	0	0
Transportation Fuel	1	1	1
O&M Electricity (kWh)	1,165	1,165	1,165
Total	**1,238**	**1,238**	**1,238**

	Cumulative Greenhouse Gas Emissions Reductions Relative to BAU				
	MT CO2e	MT CO2e	MT CO2e	MT CO2e	MT CO2e
	Materials	Transportation	Construction	O&M	TOTAL
Total	-	-	-	-	-

Example of Vehicle Operations
Source: https://www.greencarreports.com/news/1093560_1-2-billion-vehicles-on-worlds-roads-now-2-billion-by-2035-report

ICE estimates vehicle operations impacts of infrastructure projects from two distinct effects:

- Vehicle operating emissions – Operating emissions associated with vehicles using the roadway.
- Construction delay emissions – Additional emissions due to congested traffic speeds due to construction delays.

In both cases, these emissions are limited to roadway projects. Users should be aware that ICE2.2 relies on energy consumption rates and projections based on EPA's MOVES3 model, which is the current version as of publication date of this model. Significant changes are expected in the subsequent MOVES4 model when it is released.

ICE2.2 allows two approaches to calculating these emissions. In the first, the user will enter emissions associated with the two operating modes calculated from a seperate approach. For example, this could be detailed traffic and emissions modeling or sketch modeling with parameters specific to your location and project setting. This is the preferred approach, particularly when considering congestion delay across a large network or other, complex cases. In this case, the user simply enters the amount of emissions per year and number of years into ICE2.2. ICE2.2 then carries the values forward to reporting along with the other infrastructure types included. ICE also offers the ability to convert "tailpipe" (a.k.a. "downstream") emissions entered by a user into full lifecycle values, consistent with other ICE formulations.

In the second formulation, ICE2.2 computes these values from user inputs of VMT and speed. This approach is simplistic and designed to estimate impacts of congestion on speed and thus emissions, but cannot consider speed impacts across a complex network. In this case, two entries are required:

- Vehicle operating emissions – The user enters the years, average daily traffic (AADVMT), and average speed for the opening and horizon years on the project. ICE computes the cumulative operating emissions over on the project's lifetime.
- Construction delay emissions – The user enters the years, average daily traffic (AADVMT), and average speed for the year construction starts, project opening year, and the baseline year for comparison (typically the year before construction starts). ICE computes the additional energy and GHG emissions due to vehicle delay during construction. Estimates of emissions and additional energy use from construction delay and vehicle operating emissions using ICE2.2 calculations are meant to provide a rough sense of the scale of emissions relative to the construction processes themselves, and are not meant to replace estimates derived from traffic modeling software. Planned construction projects that will result in significant lane closures on high volume roads should be evaluated using traffic modeling software and the first input option for those emissions.

Note that mitigations are not applicable for vehicle operating emissions. Also, the calcualtions reflect a standard automobile fleet. They should not be used to estimate bus emissions on BRT or train emissions from Light- or Heavy-Rail. Also, results are integrated over the project lifetime. (I.e., "baseline" doesn't just mean baseline year.) ICE2.2 allows a default fleet mix or seperate inputs for light and heavy duty vehicles.

Specification

Enter results from external model?	

Vehicle Operating Emissions

Emissions from	Tailpipe - upscale to full lifecycle	
	Year	**kg CO2e/year from roadway network**
Start year	2030	843961780
End year	2060	777257958

Construction Delay, Additional Emissions

Emissions from	Tailpipe - upscale to full lifecycle	
	Year	**Increased emissions (kg CO2e/year)**
Start year		
End year		

Construction start year	2030
Avg Daily VMT impacted by project	0
Speed without congestion (mph or NA)	NA

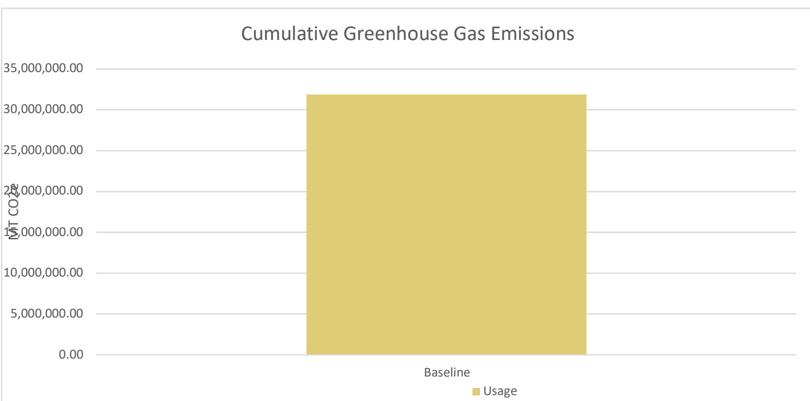
Baseline Energy Use and GHG Emissions

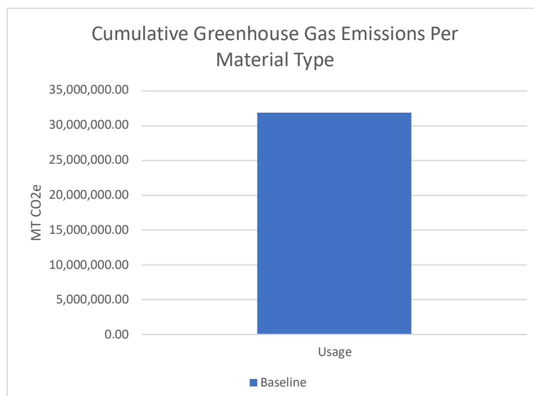
Usage Process		Energy use (mmBTU)	GHG emissions (MT CO2e)
Vehicle Operating Emissions		2,094,057	31,878,667
Construction Delay		0	0
Total		2,094,057	31,878,667

	Annualized Energy Use	Annualized Greenhouse Gas Emissions
	Baseline	Baseline
30 year Annualized Results	Energy use (mmBTU)	GHG emissions (MT CO2e)
Usage Emissions	69,802	1,062,622
Materials subtotal	-	-
Transportation subtotal	-	-
Construction subtotal	-	-
Usage subtotal	69,802	1,062,622
Total	69,802	1,062,622

Results Charts

Show	Cumulative Greenhouse Gas Emissions	Units	MT CO2e





No mitigations are available for Ve

	Cumulative Greenhouse Gas Emissions
	MT CO2e
	Baseline
Usage	31,878,667
Total	**31,878,667**

	Cumulative Greenhouse Gas Emissions Per Material Type
	MT CO2e
	Baseline
Usage	31,878,667
Total	**31,878,667**

Project Inputs

Planning Summary of Inputs - See Individual Tabs for Details

Display result in 508 compliant format:	
Hide Instructions	No

INSTRUCTIONS

1. Populate location (state) and lifetime (years) for your analysis.
2. Select operating mode (*Project* or *Planning*) for your analysis. (The tool can analyze individual projects (*Project* mode) or a suite of projects in a comprehensive plan (*Planning* mode). Most analyses using *Planning* mode.
3. Select the infrastructure type(s) to analyze. Input all requested data using information from the project or plan you want to analyze. Then navigate to the relevant *analysis page(*s) for your project or the individual project(s) in your plan and complete the analysis for each infrastructure type by entering information in all cells that are shaded yellow. Blue and gray cells display fixed values and results; do not change the information in these cells.
4. Apply any selected mitigation measures on the *Mitigation Strategies* tab.
5. Review outputs on the *Summary Results* tab.
6. For further instructions, refer to the accompanying User Guide for detailed descriptions of factors and assumptions used in this tool.

Infrastructure location (state)	WI
Analysis period of your plan or project (years)	30
Year construction starts	2030
Use custom electric emission profile (RPS)?	No

Tool Use	Planning

Infrastructure Types

Roadways	BRT	Heavy Rail	Light Rail	Parking	Signage	
Bridges & Overpasses	Culverts	Interchanges	Lighting	Pathways	Vehicle Operations	Custom Pavement

	Title:	I39/90/94 GHG Analysis	Title:	Build Alternatives - GP Lane	Title:	
Enter comments and comment titles. These will be displayed on the Summary Results worksheet.	I30/90/94 GHG Analysis		This anlaysis included emissions from project construction between 2030-2040, maintenance, and vehicle operation emissions due to delay caused by the construction. Operation emissions covered 2030-2060			

Roadways

Roadways

The Roadways module in ICE accounts for the full roadway lifespan, including construction, rehabilitation, routine maintenance, and preventive maintenance for new and existing roadways. Separate inputs are required for construction, rehabilitation, and effects of preventative maintenance. Module inputs include those for both the existing and new construction. As noted, some inputs are lane miles; some are centerline miles. See the Roadways sheet and User's Guide for more information.

Source: https://commons.wikimedia.org/wiki/File:Veterans_Memorial_Parkway,_London,_Ontario.jpg

Roadway System

Total existing centerline miles	182.14
Total newly constructed centerline miles	187.26

Roadway Projects

Facility type	Roadway System	Roadway Construction				
	Existing Roadway (lane miles)	New Roadway (lane miles)	Construct Additional Lane (lane miles)	Realignment (lane miles)	Lane Widening (lane miles)	Shoulder Improvement (centerline miles)
Rural Interstates	268.3	349.05				
Rural Principal Arterials	0	0				
Rural Minor Arterials	17.19	14.21				
Rural Collectors	11.97	13.14				
Urban Interstates / Expressways	116.88	156.87				
Urban Principal Arterials	8.93	6.96				
Urban Minor Arterials / Collectors	15.51	28.47				

	Yes
% roadway construction on rocky / mountainous terrain	0%

Bridges & Overpasses

Bridges & Overpasses

The Bridge and Overpasses module addesses new construction, reconstruction, and lane addition for single span, two span, and multi-span bridges (over land or water). Note this module applies to the construction of the bridge structure rather than the pavement surface. Bridge paving activities should be entered as part of the Roadway construction activities. See the Bridges_Overpasses sheet and User's Guide for more information.

Source: https://en.wikipedia.org/wiki/Low-water_crossing#/media/File:Roanoke_River_low_water_crossing.jpg

Bridge/Overpass Structure	Construct New Bridge/Overpass				Reconstruct Bridge/Overpass				Add Lane to Bridge/Overpass		
	Number of bridges & overpasses	Average number of spans per structure	Average number of lanes per structure	Total number of lane-spans	Number of bridges & overpasses	Average number of spans per structure	Average number of lanes recon structed per structure	Total number of lane-spans	Number of bridges & overpasses	Average number of spans per structure	Average number of lanes per structure added
Single-Span	24	1	2.38	**57.12**	0	1	0	**0**		1	
Two Span	19	2	3	**114**	9	2	3.78	**68.04**		2	
Multi Span (over land)	32	3.965	2.095	**265.8136**	35	3.62	3.035	**384.5345**			
Multi Span (over water)	2	2	2	**8**	4	3	2.5	**30**			

Specification
Baseline Energy Use and GHG Emissions
Mitigated Results
Results - Charts

Lighting

Lighting

The Lighting module estimates the energy and GHG emissions associated with roadway lighting projects. ICE considers LED and HPS type lights and state-specific energy factors. See the Lighting sheet and User's Guide for more information. Module inputs include average number of lights per roadway mile by type and luminosity.

Source: http://www.sanengineeringllc.com/Projects/Structural-Engineering-NMDOT.php

Number of roadway miles	187.26

Lighting Structures Support Structure Type	Lumen Range	Ave. number of HPS lights per roadway mile	Ave. number of LED lights per roadway mile
Vertical	4000 5000		
Vertical	7000 8800		
Vertical	8500 11500		
Vertical	11500-14000		
Vertical	21000-28000		
Vertical and Vertical with 8 Arm	4000 5000		
Vertical and Vertical with 8 Arm	7000 8800		
Vertical and Vertical with 8 Arm	8500 11500		

Vertical and Vertical with 8 Arm	11500-14000	
Vertical and Vertical with 8 Arm	21000-28000	
High Mast	28800 - 42000	
High Mast	46500-52800	
High Mast	52500-58300	

Signage

Signage

The Signage module charaterizes small, medium, and large signs for aluminum sheet metal and directly embedded or concrete encased steel. See the Signage sheet and User's Guide for more information. Module inputs include average number of each type of sign per roadway mile and the total project roadway miles.

Source: dot.state.mn.us/trafficeng/publ/tem/2009/Chapter-06.pdf; https://www.defensivedriving.org/dmv-handbook/29-unusual-road-signs/; https://www.waaytv.com/content/news/School-bus-warning-signs-installed-on-Highway-43-463727923.html

Number of roadway miles	187.26

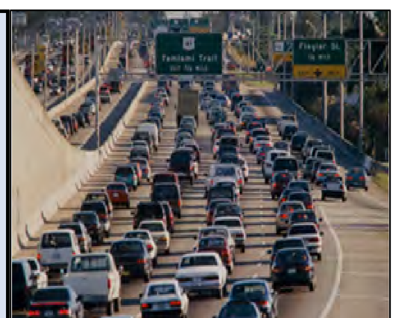
Signage Structures	Avg. number of signs per roadway mile
Small (3'x3') 14 Gauge Steel Post (MDOT SIGN 150-D)	15
Medium (6'x6) 14 Gauge Steel Posts (MDOT SIGN 150-D)	6
Large (10 x14') 8 Gauge Cantilever Arm (MDOT SIGN 300-A)	5

Specification
Baseline Energy Use and GHG Emissions
Mitigated Results
Results - Charts

Vehicle Ops

Vehicle_Ops

The Vehicle Operations module estimates on roadway infrastructure from vehicle operations. It addresses both ongoing vehicle operations and additional emissions from construction delay.
ICE2.2 includes two approaches: 1) The preferred approach is for the user to enter custom emission amounts directly from a seperate calculation. ICE then combines this with any other infrastructure included. 2) The alternative approach estimates these values from user inputs of VMT, speed, and optional vehicle type. Note ICE2.2 uses MOVES3 projections of vehicle energy consumption and fleet mix.
See the Vehicle_Ops sheet and User's Guide for more information.



Source: https://www.greencarreports.com/news/1093560_1-2-billion-vehicles-on-worlds-roads-now-2-billion-by-2035-report

Enter results from external model?	Yes

Vehicle Operating Emissions

Custom emissions represent:	Tailpipe - upscale to full lifecycle	
	Year	kg CO2e/year from roadway network
Start year	2030	852813882
End Year	2060	819523343

Construction Delay, Additional Emissions

Custom emissions represent:		
	Year	Increased emissions (kg CO2e/year)
Start year	2030	896976
End Year	2040	896976

Specification
Baseline Energy Use and GHG Emissions
Mitigated Results
Results - Charts

Summary Results

Roadways | BRT | Heavy Rail | Light Rail | Parking | Signage

Bridges & Overpasses | Culverts | Interchanges | Lighting | Pathways | Vehicle Operations | Custom Pavement

Show		Units	

I39/90/94 GHG Analysis

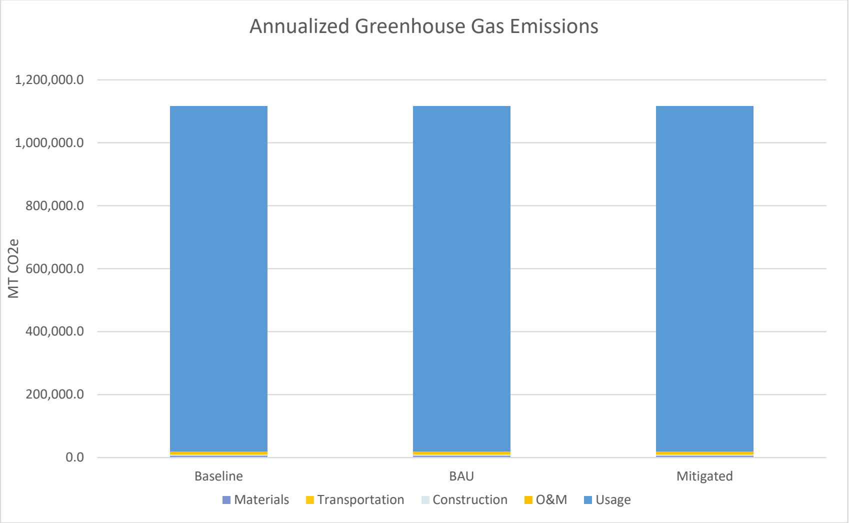
I30/90/94 GHG Analysis

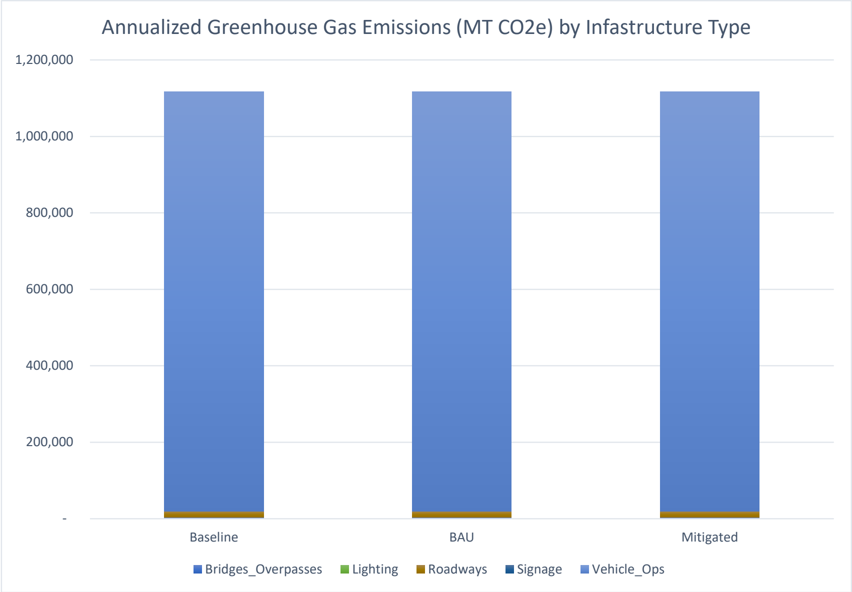
Build Alternatives - GP Lane

This anlaysis included emissions from project construction between 2030-2040, maintenance, and vehicle operation emissions due to delay caused by the construction. Operation emissions covered 2030-2060

	Annualized Greenhouse Gas Emissions (MT CO2e) by Infastructure Type		
	MT CO2e	MT CO2e	MT CO2e
	Baseline	BAU	Mitigated
Bridges_Overpasses	2,330	2,330	2,330
Lighting	96	96	96
Roadways	17,316	17,316	17,316
Signage	210	210	210
Vehicle_Ops	1,096,532	1,096,532	1,096,532
Total	**1,116,484**	**1,116,484**	**1,116,484**

Summary Results Charts





Summary Results Tables

	Annualized Greenhouse Gas Emissions		
	MT CO2e	MT CO2e	MT CO2e
	Baseline	BAU	Mitigated
Materials	6,043	6,043	6,043
Transportation	564	564	564
Construction	3,704	3,704	3,704
O&M	9,642	9,642	9,642
Usage	1,096,532	1,096,532	1,096,532
Total	**1,116,484**	**1,116,484**	**1,116,484**

	Annualized Greenhouse Gas Emissions Per Material Type		
	MT CO2e	MT CO2e	MT CO2e
	Baseline	BAU	Mitigated
Aggregate	558	558	558
Aluminum	24	24	24
Bitumen (Asphalt Binder)	1,018	1,018	1,018
Cement	3,012	3,012	3,012
Steel	1,429	1,429	1,429
Water	2	2	2
Transportation Fuel	564	564	564
Construction Fuel	3,704	3,704	3,704
O&M Electricity (kWh)	91	91	91

O&M fuel (DGEs)	2,184	2,184	2,184
O&M Roadway Rehabilitation	7,368	7,368	7,368
Usage	1,096,532	1,096,532	1,096,532
Total	**1,116,484**	**1,116,484**	**1,116,484**

	Annualized Greenhouse Gas Emissions Reductions Relative to BAU				
	MT CO2e	MT CO2e	MT CO2e	MT CO2e	MT CO2e
	Materials	Transportation	Construction	O&M	TOTAL
Total	-	-	-	-	-

	ıualized Greenhouse Gas Emissions (MT CO2e) by Infastructure T		
	MT CO2e	MT CO2e	MT CO2e
	Baseline	BAU	Mitigated
Bridges_Overpasses	2,330	2,330	2,330
Lighting	96	96	96
Roadways	17,316	17,316	17,316
Signage	210	210	210
Vehicle_Ops	1,096,532	1,096,532	1,096,532
Total	**1,116,484**	**1,116,484**	**1,116,484**

Mitigation Strategies

Return To

Instructions: Follow the steps below to calculate the impact of energy and GHG mitigation strategies:

The user will enter both the business as usual (BAU) deployment (i.e., the extent to which the strategy is deployed through standard agency practices) in Column F and the planned deployment (i.e., the extent to which the strategy will be deployed in the project that you are examining) in Column G. (Baseline refers to values without any mitigations.) For Pavement Preservation strategies, enter both the schedule change and application frequency.

Column H displays the increase in deployment from implementation of the strategy. Some reduction strategies (e.g., Switch from diesel to Soybean-based Biodiesel and biodiesel/hybrid maintenance vehicles and equipment) may be incompatible. The user should take care that inputs do not describe a total deployment greater than 100% for overlapping strategies. The tool will warn if "excess" energy savings from mitigation are predicted or incompatible strategies are selected.

For a more refined mitigation analysis, please refer to FHWA's upcoming Pavement LCA Tool.

						BAU Reductions		Planned Reductions	
Strategy	BAU deployment	Planned deployment	Deployment increase	Energy reduction factor	GHG reduction factor	Energy reductions	GHG reductions	Energy reductions	GHG reductions
Alternative fuels and vehicle hybridization									
Sw tch from diesel to Soybean based B odiesel			0.0%	26%	14%	0.0%	0.0%	0.0%	0.0%
Sw tch from diesel to Soybean based RDII 100			0.0%	28%	65%	0.0%	0.0%	0.0%	0.0%
Sw tch from diesel to Forest Residue based RDII 100			0.0%	67%	73%	0.0%	0.0%	0.0%	0.0%
Sw tch from diesel to E Diese , Corn			0.0%	5%	14%	0.0%	0.0%	0.0%	0.0%
Sw tch from diesel to PHEV: Diesel and E ectr city (State M x)			0.0%	18%	24%	0.0%	0.0%	0.0%	0.0%
Sw tch from diesel to Hybrid D esel			0.0%	11%	11%	0.0%	0.0%	0.0%	0.0%
Sw tch from diesel to Electricity			0.0%	56%	63%	0.0%	0.0%	0.0%	0.0%
Sw tch from diesel to CNG, from NG			0.0%	9%	11%	0.0%	0.0%	0.0%	0.0%
Sw tch from diesel to LNG, from NG			0.0%	13%	8%	0.0%	0.0%	0.0%	0.0%
Sw tch from diesel to Convent onal Diesel (BD20)			0.0%	5%	14%	0.0%	0.0%	0.0%	0.0%
Sw tch from diesel to Hydrogen (from NG)			0.0%	40%	52%	0.0%	0.0%	0.0%	0.0%
Sw tch from diesel to Biodiesel (from corn)			0.0%	88%	90%	0.0%	0.0%	0.0%	0.0%
Sw tch from diesel to RDII (from corn)			0.0%	81%	87%	0.0%	0.0%	0.0%	0.0%
Sw tch from diesel to CNG (from Landfill, Off site Refuel ng)			0.0%	2%	17%	0.0%	0.0%	0.0%	0.0%
Sw tch from diesel to Renewab e CNG (from Wastewater Treatment, Off site refuel ng)			0.0%	62%	136%	0.0%	0.0%	0.0%	0.0%
Hybrid maintenance vehic es and equipment			0.0%	11%	11%	0.0%	0.0%	0.0%	0.0%
Combined hybridization/B20 in maintenance vehic es and equipment			0.0%	1%	27%	0.0%	0.0%	0.0%	0.0%
Hybrid construction vehicles and equipment			0.0%	11%	11%	0.0%	0.0%	0.0%	0.0%
Combined hybridization/B20 in construction veh cles and equipment			0.0%	1%	27%	0.0%	0.0%	0.0%	0.0%
Vegetation management									
A ternative vegetation management strategies (hardscaping, alternative mowing, integrated roadway/vegetation management)			N/A	25%	25%	0.0%	0.0%	0.0%	0.0%
Snow fencing and removal strategies									
A ternative snow removal strategies (snow fencing, wing plows)			N/A	50%	50%	0.0%	0.0%	0.0%	0.0%
In place roadway recycling									
Cold In place recycling			0.0%	33%	37%	0.0%	0.0%	0.0%	0.0%
Fu depth reclamation			0.0%	68%	68%	0.0%	0.0%	0.0%	0.0%
Warm-mix asphalt									
Warm mix asphalt			0.0%	37%	37%	0.0%	0.0%	0.0%	0.0%
Recycled and reclaimed materials									
Use recycled asphalt pavement as a substitute for virg n asphalt aggregate			0.0%	12%	12%	0.0%	0.0%	0.0%	0.0%
Use recycled asphalt pavement as a substitute for virg n asphalt bitumen			0.0%	84%	84%	0.0%	0.0%	0.0%	0.0%
Use industria byproducts as substitutes for Portland cement			0.0%	59%	59%	0.0%	0.0%	0.0%	0.0%
Use recycled concrete aggregate as a substitute for base stone			0.0%	58%	58%	0.0%	0.0%	0.0%	0.0%
Pavement preservation									
Pavement preservation extends roadway maintenance activities by (%)			0.0%	N/A	N/A	N/A	N/A	N/A	N/A
Pavement preservation frequency (every N years, for entire roadway system)			N/A	N/A	N/A	N/A	N/A	N/A	N/A

Roadways

Roadway example.
Source: https://commons.wikimedia.org/wiki/File:Veterans_Memorial_Parkway,_London,_Ontario.jpg

ICE accounts for the full roadway lifespan, including construction, rehabilitation, routine maintenance, and preventive maintenance. ICE handles these activities in different ways. Separate inputs are required for construction, rehabilitation, and effects of preventative maintenance. Specifically:

- New construction – The user enters lane miles of construction (or centerline miles of shoulder improvement) projects. Separately, the user indicates what fraction of roadway construction is in difficult terrain.
- Roadway rehabilitation – The user enters expected lane miles for reconstruction and resurfacing projects the length of the analysis period. Separately, the user enters a rehabilitation schedule. (Defaults are provided and used if no values are entered.) As a general rule of thumb, new roadways require resurfacing after 15 years and reconstruction after 30 years. Note that roadway rehabilitation applies to both existing and new roadways.
- Preventive maintenance – Preventive maintenance is pavement preservation techniques, such as crack sealing, patching, chip seals, and micro-surfacing, that prolong the life of the pavement. In ICE2.0, the user has the option to specify an extension of the roadway rehabilitiation schedule due to implementation of a (generic) preventive maintenance program. Application of preventative maintenance is accessible on the *Mitigation Strategies* tab. Note that the energy and emissions "cost" of a preventative maintenance program is based on an average of several potential strategies from different studies. More specific values may be obtainable from FHWA's Pavement LCA tool (when it becomes available).

Emissions and energy associated with routine maintenance (sweeping, striping, bridge deck repair, litter pickup, and maintenance of appurtenances) and roadway rehabilitation is automatically estimated per lane mile of both new and existing roadways associated with your project. To estimate associated use-phase emissions, visit the Vehicle Operations tab.

Note that roadway projects do not include sidewalks. If your project or plan includes constructing sidewalks, they should be entered separately in the Rail, Bus, Bicycle, and Pedestrian Facilities section of the tool.

Note that ICE2.0 does not calculate energy or GHG emissions savings from pavement smoothness effects related to any resurfacing and reconstruction projects.

ICE also does not intrinsically allow customized pavement configurations. Most analyses should use this Roadway tab and ICE's internal pavement configuration. The Custom Pavement analysis relies on external data rather than ICE's calculations to estimate lifecycle values for different configurations. Please see the Custom Pavement tab for more information. Users should not enter both Roadway and Custom Pavement values for the same project.

Example: The user enters new construction of 10 lane miles of new freeway, with an analysis period of 40 years. Assuming that all construction takes place in year 1, the user enters 10 lane miles of freeway resurfacing (assumed to take place in year 15) and 10 lane miles of freeway reconstruction (assumed to take place in year 30). The tool automatically includes routine maintenance of the 10 newly constructed lane miles. The user has the option of specifying a generic preventive maintenance program, which will increase the longevity of the pavement surface and therefore reduce the amount of energy and emissions associated with resurfacing and rehabilitation.

Specification

Select Mitigation Strategies

Roadway System	Existing	New	Total
Total centerline miles	182	187	369
Total lane miles	434	563	998

		Facility type						
		Rural Interstates	Rural Principal Arterials	Rural Minor Arterials	Rural Collectors	Urban Interstates / Expressways	Urban Principal Arterials	Urban Minor Arterials / Collectors
Roadway Lane Width (feet) (before construction)	Default	12	11	11	11	12	11	11
Roadway Construction	New Roadway (ICE equivalent lane miles)	349.1	0.0	13.0	12.0	156.9	6.4	26.1

Include roadway rehabilitation activities (reconstruct and resurface)	
% roadway construction on rocky / mountainous terrain	0%

Baseline Energy Use and GHG Emissions

Construction	O&M Roadway Rehabilitation

Material Energy Use and Emissions	Energy use (mmBTU)	GHG emissions (MT CO2e)	Energy use (mmBTU)	GHG emissions (MT CO2e)
Aggregate	282,492	15,387	317,737	17,967
Bitumen (Asphalt Binder)	394,820	30,547	662,927	51,290
Cement	265,846	49,548	195,758	36,485
Steel	292,068	23,789	189,966	15,341
Water	101	13	74	10
Total	1,235,327	119,285	1,366,462	121,093

Materials Transportation	Construction		O&M Roadway Rehabilitation	
	Energy use (mmBTU)	GHG emissions (MT CO2e)	Energy use (mmBTU)	GHG emissions (MT CO2e)
Transportation fuel (DGEs)	193,283	15,574	197,019	15,860
Total	193,283	15,574	197,019	15,860

Construction Process	Construction		O&M Roadway Rehabilitation	
	Energy use (mmBTU)	GHG emissions (MT CO2e)	Energy use (mmBTU)	GHG emissions (MT CO2e)
Electricity (kWh)	0	0	0	0
Construction fuel (DGEs)	1,217,329	98,088	1,044,429	84,077
Total	1,217,329	98,088	1,044,429	84,077

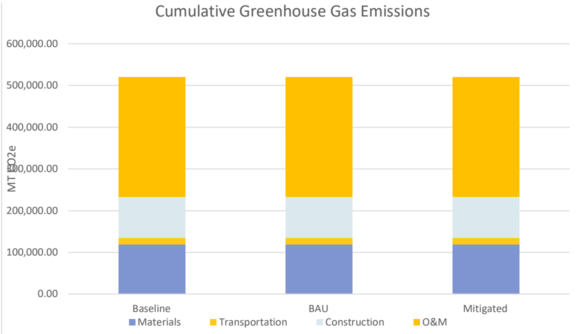
Operations and Maintenance	Energy use (mmBTU)	GHG emissions (MT CO2e)
Electricity (kWh)	-	-
Maintenance fuel (DGEs)	813,829.9	65,513.6
Roadway Rehabilitation (O&M)	2,607,910.2	221,030.2
Water	-	-
Total	3,421,740.1	286,543.9

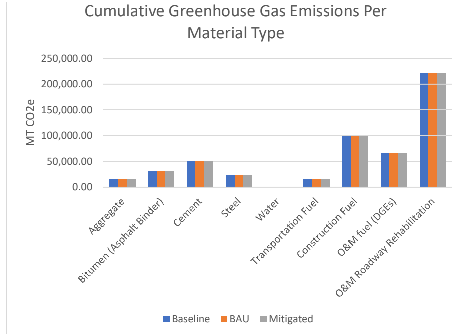
Mitigated Results

30 year Annualized Results	Construction						O&M Roadway Rehabilitation					
	Annualized Energy Use			Annualized Greenhouse Gas Emissions			Annualized Energy Use			Annualized Greenhouse Gas Emissions		
	Baseline	BAU	Mitigated	Baseline	BAU	Mitigated	Baseline	BAU	Mitigated	Baseline	BAU	Mitigated
	Energy use (mmBTU)	Energy use (mmBTU)	Energy use (mmBTU)	GHG emissions (MT CO2e)	GHG emissions (MT CO2e)	GHG emissions (MT CO2e)	Energy use (mmBTU)	Energy use (mmBTU)	Energy use (mmBTU)	GHG emissions (MT CO2e)	GHG emissions (MT CO2e)	GHG emissions (MT CO2e)
Aggregate	9,416	9,416	9,416	513	513	513	10,591	10,591	10,591	599	599	599
Bitumen (Asphalt Binder)	13,161	13,161	13,161	1,018	1,018	1,018	22,098	22,098	22,098	1,710	1,710	1,710
Cement	8,862	8,862	8,862	1,652	1,652	1,652	6,525	6,525	6,525	1,216	1,216	1,216
Steel	9,736	9,736	9,736	793	793	793	6,332	6,332	6,332	511	511	511
Water	3	3	3	0	0	0	2	2	2	0	0	0
Transportation Fuel	6,443	6,443	6,443	519	519	519	6,567	6,567	6,567	529	529	529
Construction Fuel	40,578	40,578	40,578	3,270	3,270	3,270	34,814	34,814	34,814	2,803	2,803	2,803
O&M fuel (DGEs)	27,128	27,128	27,128	2,184	2,184	2,184	-	-	-	-	-	-
O&M Roadway Rehabilitation	86,930	86,930	86,930	7,368	7,368	7,368	86,930	86,930	86,930	7,368	7,368	7,368
Materials subtotal	41,178	41,178	41,178	3,976	3,976	3,976						
Transportation subtotal	6,443	6,443	6,443	519	519	519						
Construction subtotal	40,578	40,578	40,578	3,270	3,270	3,270						
Operations & Maintenance subtotal	114,058	114,058	114,058	9,551	9,551	9,551						
Total	202,256	202,256	202,256	17,316	17,316	17,316						

Results Charts

Show	Cumulative Greenhouse Gas Emissions	Units	MT CO2e





	Cumulative Greenhouse Gas Emissions		
	MT CO2e	MT CO2e	MT CO2e
	Baseline	BAU	Mitigated
Materials	119,285	119,285	119,285
Transportation	15,574	15,574	15,574
Construction	98,088	98,088	98,088
O&M	286,544	286,544	286,544
Total	**519,491**	**519,491**	**519,491**

	Cumulative Greenhouse Gas Emissions Per Material Type		
	MT CO2e	MT CO2e	MT CO2e
	Baseline	BAU	Mitigated
Aggregate	15,387.3	15,387.3	15,387.3
Bitumen (Asphalt Binder)	30,547	30,547	30,547
Cement	49,548	49,548	49,548
Steel	23,789	23,789	23,789
Water	13	13	13
Transportation Fuel	15,574	15,574	15,574
Construction Fuel	98,088	98,088	98,088
O&M fuel (DGEs)	65,514	65,514	65,514
O&M Roadway Rehabilitation	221,030	221,030	221,030
Total	**519,491**	**519,491**	**519,491**

	Cumulative Greenhouse Gas Emissions Reductions Relative to BAU				
	MT CO2e	MT CO2e	MT CO2e	MT CO2e	MT CO2e
	Materials	Transportation	Construction	O&M	TOTAL
Total	-	-	-	-	-

Bridges & Overpasses

Example of a concrete bridge
(not representative of all possible project types).

Source: https://en.wikipedia.org/wiki/Low-water_crossing#/media/File:Roanoke_River_low_water_crossing.jpg

ICE estimates the energy and GHG emissions associated with the construction, reconstruction, or lane addition for single span, two-span, and multi-span bridges and overpasses. Bridges and overpasses are treated as being functionally equivalent in ICE.

The *Bridges and Overpasses* module in ICE applies to the construction of the bridge structure rather than the pavement surface. Bridge paving activities should be entered as part of the Roadway construction activities.

Approximately half of short bridges in the U.S. (less than 1000 feet long) are single-span or double-span. If information about number of spans is not available, it is reasonable to assume a mix of single-span and two-span bridges. Note that the number of spans is an important factor in energy use and GHG emissions.

Please note that very large bridges that carry traffic very high or span very deep spaces are unique and likely require additional materials and construction processes that cannot be approximated by ICE.

Specification

Select Mitigation Strategies

	Construct New Bridge				Reconstruct Bridge				Add Lane to Bridge			
Bridge and Overpass Structures	Number of bridges	Avg number of spans per bridge	Avg number of lanes per bridge	Total number of lane spans	Number of bridges	Avg number of spans per bridge	Avg number of lanes per bridge	Total number of lane spans	Number of bridges	Avg number of spans per bridge	Avg number of new lanes per bridge	Total number of lane spans
Single Span	24	1	2	**57**	-	1	-	**-**	-	1	-	**-**
Two Span	19	2	3	**114**	9	2	4	**68**	-	2	-	**-**
Multi-Span (over land)	32	4	2	**266**	35	4	3	**385**	-	-	-	**-**
Multi-Span (over water)	2	2	2	**8**	4	3	3	**30**	-	-	-	**-**

Materials Transportation		Energy use (mmBTU)	GHG emissions (MT CO2e)

Transportation fuel (DGEs)		16,244	1,309
Total		16,244	1,309

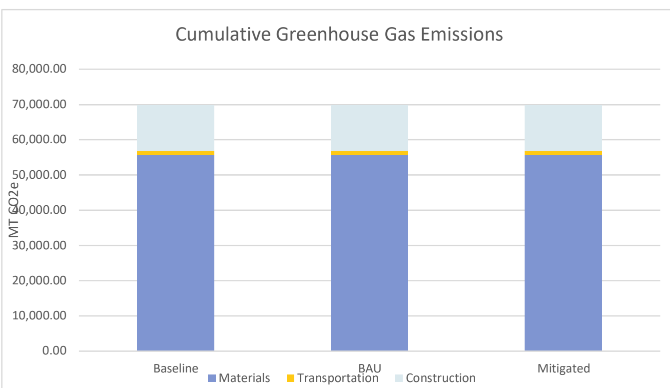
Construction Process		Energy use (mmBTU)	GHG emissions (MT CO2e)
Electricity (kWh)		-	-
Construction fuel (DGEs)		161,705	13,030
Total		161,705	13,030

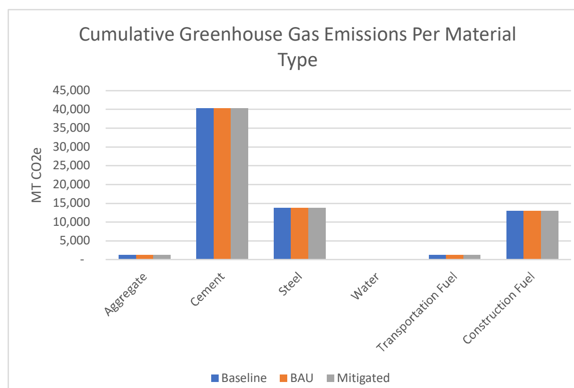
Mitigated Results

	Annualized Energy Use			Annualized Greenhouse Gas Emissions		
	Baseline	BAU	Mitigated	Baseline	BAU	Mitigated
30 year Annualized Results	Energy use (mmBTU)	Energy use (mmBTU)	Energy use (mmBTU)	GHG emissions (MT CO2e)	GHG emissions (MT CO2e)	GHG emissions (MT CO2e)
Aggregate	818	818	818	45	45	45
Cement	7,223	7,223	7,223	1,346	1,346	1,346
Steel	6,038	6,038	6,038	460	460	460
Water	11	11	11	1	1	1
Transportation Fuel	541	541	541	44	44	44
Construction Fuel	5,390	5,390	5,390	434	434	434
Materials subtotal	14,090	14,090	14,090	1,852	1,852	1,852
Transportation subtotal	541	541	541	44	44	44
Construction subtotal	5,390	5,390	5,390	434	434	434
Total	20,022	20,022	20,022	2,330	2,330	2,330

Results Charts

Show	Cumulative Greenhouse Gas Emissions	Units	MT CO2e





	Cumulative Greenhouse Gas Emissions		
	MT CO2e	MT CO2e	MT CO2e
	Baseline	BAU	Mitigated
Materials	55,558	55,558	55,558
Transportation	1,309	1,309	1,309
Construction	13,030	13,030	13,030
Total	**69,897**	**69,897**	**69,897**

	Cumulative Greenhouse Gas Emissions Per Material Type		
	MT CO2e	MT CO2e	MT CO2e
	Baseline	BAU	Mitigated
Aggregate	1,338	1,338	1,338
Cement	40,389	40,389	40,389
Steel	13,787	13,787	13,787
Water	44	44	44
Transportation Fuel	1,309	1,309	1,309
Construction Fuel	13,030	13,030	13,030
Total	**69,897**	**69,897**	**69,897**

	Cumulative Greenhouse Gas Emissions Reductions Relative to BAU				
	MT CO2e	MT CO2e	MT CO2e	MT CO2e	MT CO2e
	Materials	Transportation	Construction	O&M	TOTAL
Total	-	-	-	-	-

Lighting

Example of vertical with arm lighting.
Source: http://www.sanengineeringllc.com/Projects/Structural-Engineering-NMDOT.php

ICE estimates the energy and GHG emissions associated with lighting use projects. Annual energy consumption will be paired with energy emission factors for individual states to determine GHG emissions.

Roadway lighting projects can be a significant contributor to the annual energy use and GHG emissions of many transportation agencies. ICE estimates the energy and GHG emissions associated with lighting projects. ICE evaluates the impacts of two of the most common lighting technologies: High Pressure Sodium (HPS) & Light Emitting Diode (LED). It includes lifecycle impacts associated with common support structures: High Mast, Vertical, and Vertical with arm.

Note that ICE only includes roadway lighting energy and GHG emissions from the use phase and lighting support structures, as manufacturing energy and emissions for HPS and LED luminaries and replacement parts is currently poorly characterized.

Specification

Select Mitigation Strategies

Lighting Structures		Avg number of HPS lights per roadway mile	Avg number of LED lights per roadway mile
Support Structure Type	Lumen Range		
Vertical			
Vertical			
Vertical			
Vertical			
Vertical			
Vertical and Vertical with 8' Arm			
Vertical and Vertical with 8' Arm			
Vertical and Vertical with 8' Arm			
Vertical and Vertical with 8' Arm			
Vertical and Vertical with 8' Arm			
High Mast			
High Mast			
High Mast			

Number of roadway miles	187.26

Baseline Energy Use and GHG Emissions

Material Energy Use and Emissions		Energy use (mmBTU)	GHG emissions (MT CO2e)
Aggregate		12	1
Aluminum			
Cement		186	35
Steel		1,576	136
Water		0	0
Total		1,774	171

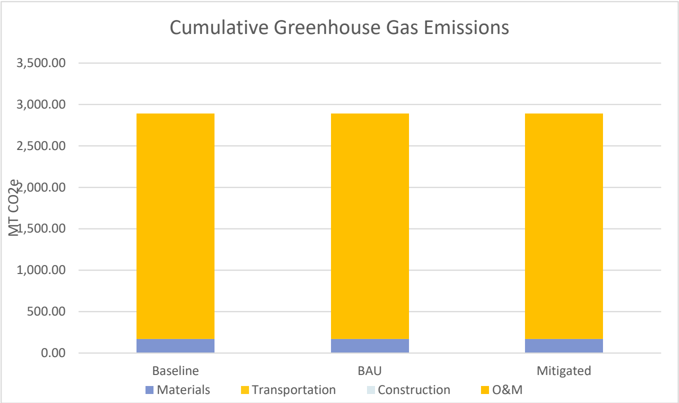
Materials Transportation		Energy use (mmBTU)	GHG emissions (MT CO2e)
Transportation fuel (DGEs)		17	1
Total		17	1

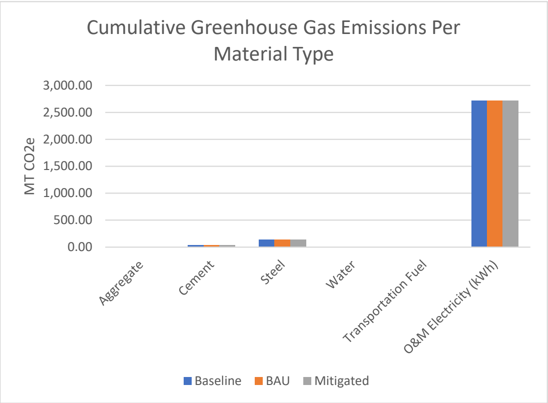
Mitigated Results

30 year Annualized Results	Annualized Energy Use			Annualized Greenhouse Gas Emissions		
	Baseline	BAU	Mitigated	Baseline	BAU	Mitigated
	Energy use (mmBTU)	Energy use (mmBTU)	Energy use (mmBTU)	GHG emissions (MT CO2e)	GHG emissions (MT CO2e)	GHG emissions (MT CO2e)
Aggregate	0	0	0	0	0	0
Aluminum	-	-	-	-	-	-
Cement	6	6	6	1	1	1
Steel	53	53	53	5	5	5
Water	0	0	0	0	0	0
Transportation Fuel	1	1	1	0	0	0
Construction Fuel	-	-	-	-	-	-
O&M Electricity (kWh)	1,054	1,054	1,054	91	91	91
Materials subtotal	59	59	59	6	6	6
Transportation subtotal	1	1	1	0	0	0
Construction subtotal	-	-	-	-	-	-
Operations & Maintenance subtotal	1,054	1,054	1,054	91	91	91
Total	1,114	1,114	1,114	96	96	96

Results - Charts

Show	Cumulative Greenhouse Gas Emissions	Units	MT CO2e





	Cumulative Greenhouse Gas Emissions		
	MT CO2e	MT CO2e	MT CO2e
	Baseline	BAU	Mitigated
Materials	171	171	171
Transportation	1	1	1
Construction	-	-	-
O&M	2,717	2,717	2,717
Total	**2,889**	**2,889**	**2,889**

	Cumulative Greenhouse Gas Emissions Per Material Type		
	MT CO2e	MT CO2e	MT CO2e
	Baseline	BAU	Mitigated
Aggregate	1	1	1
Cement	35	35	35
Steel	136	136	136
Water	0	0	0
Transportation Fuel	1	1	1
O&M Electricity (kWh)	2,717	2,717	2,717
Total	**2,889**	**2,889**	**2,889**

	Cumulative Greenhouse Gas Emissions Reductions Relative to BAU				
	MT CO2e	MT CO2e	MT CO2e	MT CO2e	MT CO2e
	Materials	Transportation	Construction	O&M	TOTAL
Total	-	-	-	-	-

Signage

ICE divides the signage category is divided into small, medium, and large structures representing the three most common types of roadway signs. Small and medium sized signs are typically regulatory and warning signs supported by a single post. Large signs include overhead guidance highway signs, typically supported by two posts or hung overhead on large steel cantilever arms. Signage infrastructure is a combination of aluminum sheet metal, and directly embedded or concrete encased supports.

The user enters the average number of each type of sign per roadway mile and the total project roadway miles.

Example large, medium, and small signs.

Source: dot.state.mn.us/trafficeng/publ/tem/2009/Chapter-06.pdf; https://www.defensivedriving.org/dmv-handbook/29-unusual-road-signs/; https://www.waaytv.com/content/news/School-bus-warning-signs-installed-on-Highway-43-463727923.html

Specification

Select Mitigation Strategies

Small (3'x3') 14 Gauge Steel Post (MDOT SIGN 150-D)	
Medium (6'x6') 14 Gauge Steel Posts (MDOT SIGN 150-D)	
Large (10'x14') 8 Gauge Cantilever Arm (MDOT SIGN 300-A)	

Number of roadway miles	187

Baseline Energy Use and GHG Emissions

Material Energy Use and Emissions		Energy use (mmBTU)	GHG emissions (MT CO2e)

Materials Transportation		Energy use (mmBTU)	GHG emissions (MT CO2e)
Transportation fuel (DGEs)		294	24
Total		294	24

Construction Process		Energy use (mmBTU)	GHG emissions (MT CO2e)
Electricity (kWh)		0	0
Construction fuel (DGEs)		0	0
Total		0	0

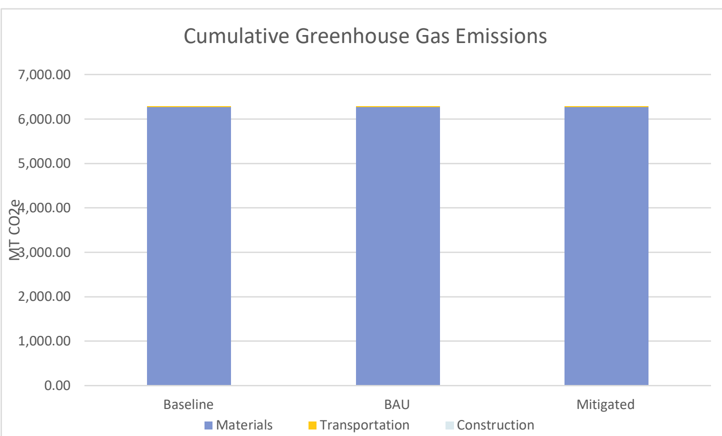
Operations and Maintenance		Energy use (mmBTU)	GHG emissions (MT CO2e)

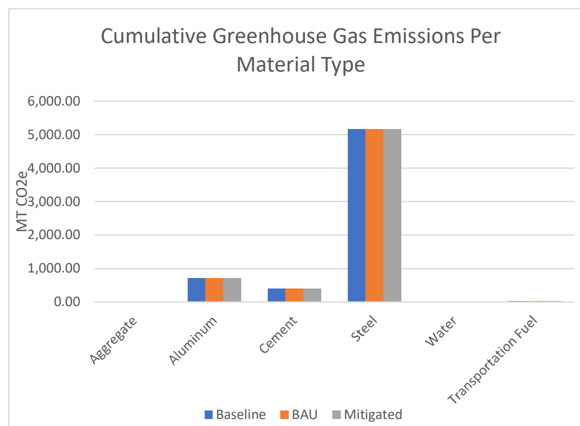
Mitigated Results

30 year Annualized Results	Annualized Energy Use			Annualized Greenhouse Gas Emissions		
	Baseline	BAU	Mitigated	Baseline	BAU	Mitigated
	Energy use (mmBTU)	Energy use (mmBTU)	Energy use (mmBTU)	GHG emissions (MT CO2e)	GHG emissions (MT CO2e)	GHG emissions (MT CO2e)
Aggregate	4	4	4	0	0	0
Aluminum	361	361	361	24	24	24
Cement	69	69	69	13	13	13
Steel	1,989	1,989	1,989	172	172	172
Water	0	0	0	0	0	0
Transportation Fuel	10	10	10	1	1	1
Construction Fuel	-	-	-	-	-	-
Materials subtotal	2,423	2,423	2,423	209	209	209
Transportation subtotal	10	10	10	1	1	1
Construction subtotal	-	-	-	-	-	-
Total	2,433	2,433	2,433	210	210	210

Results Charts

Show	Cumulative Greenhouse Gas Emissions	Units	MT CO2e





	Cumulative Greenhouse Gas Emissions		
	MT CO2e	MT CO2e	MT CO2e
	Baseline	BAU	Mitigated
Materials	6,273	6,273	6,273
Transportation	24	24	24
Construction	-	-	-
Total	**6,297**	**6,297**	**6,297**

	Cumulative Greenhouse Gas Emissions Per Material Type		
	MT CO2e	MT CO2e	MT CO2e
	Baseline	BAU	Mitigated
Aggregate	7	7	7
Aluminum	719	719	719
Cement	385	385	385
Steel	5,163	5,163	5,163
Water	0	0	0
Transportation Fuel	24	24	24
Total	**6,297**	**6,297**	**6,297**

	Cumulative Greenhouse Gas Emissions Reductions Relative to BAU				
	MT CO2e	MT CO2e	MT CO2e	MT CO2e	MT CO2e
	Materials	Transportation	Construction	O&M	TOTAL
Total	-	-	-	-	-

Vehicle Operations and Construction Delay Emissions

Example of Vehicle Operations

Source: https://www.greencarreports.com/news/1093560_1-2-billion-vehicles-on-worlds-roads-now-2-billion-by-2035-report

ICE estimates vehicle operations impacts of infrastructure projects from two distinct effects:

- Vehicle operating emissions – Operating emissions associated with vehicles using the roadway.
- Construction delay emissions – Additional emissions due to congested traffic speeds due to construction delays.

In both cases, these emissions are limited to roadway projects. Users should be aware that ICE2.2 relies on energy consumption rates and projections based on EPA's MOVES3 model, which is the current version as of publication date of this model. Significant changes are expected in the subsequent MOVES4 model when it is released.

ICE2.2 allows two approaches to calculating these emissions. In the first, the user will enter emissions associated with the two operating modes calculated from a seperate approach. For example, this could be detailed traffic and emissions modeling or sketch modeling with parameters specific to your location and project setting. This is the preferred approach, particularly when considering congestion delay across a large network or other, complex cases. In this case, the user simply enters the amount of emissions per year and number of years into ICE2.2. ICE2.2 then carries the values forward to reporting along with the other infrastructure types included. ICE also offers the ability to convert "tailpipe" (a.k.a. "downstream") emissions entered by a user into full lifecycle values, consistent with other ICE formulations.

In the second formulation, ICE2.2 computes these values from user inputs of VMT and speed. This approach is simplistic and designed to estimate impacts of congestion on speed and thus emissions, but cannot consider speed impacts across a complex network. In this case, two entries are required:

- Vehicle operating emissions – The user enters the years, average daily traffic (AADVMT), and average speed for the opening and horizon years on the project. ICE computes the cumulative operating emissions over on the project's lifetime.
- Construction delay emissions – The user enters the years, average daily traffic (AADVMT), and average speed for the year construction starts, project opening year, and the baseline year for comparison (typically the year before construction starts). ICE computes the additional energy and GHG emissions due to vehicle delay during construction. Estimates of emissions and additional energy use from construction delay and vehicle operating emissions using ICE2.2 calculations are meant to provide a rough sense of the scale of emissions relative to the construction processes themselves, and are not meant to replace estimates derived from traffic modeling software. Planned construction projects that will result in significant lane closures on high volume roads should be evaluated using traffic modeling software and the first input option for those emissions.

Note that mitigations are not applicable for vehicle operating emissions. Also, the calcualtions reflect a standard automobile fleet. They should not be used to estimate bus emissions on BRT or train emissions from Light- or Heavy-Rail. Also, results are integrated over the project lifetime. (I.e., "baseline" doesn't just mean baseline year.) ICE2.2 allows a default fleet mix or seperate inputs for light and heavy duty vehicles.

Specification

Enter results from external model?	

Vehicle Operating Emissions

Emissions from	Tailpipe - upscale to full lifecycle	
	Year	kg CO2e/year from roadway network
Start year	2030	852813882
End year	2060	819523343

Construction Delay, Additional Emissions

Emissions from	Tailpipe - upscale to full lifecycle	
	Year	Increased emissions (kg CO2e/year)
Start year	2030	896976
End year	2040	896976

Construction start year	
Avg Daily VMT impacted by project	
Speed without congestion (mph or NA)	

Baseline Energy Use and GHG Emissions

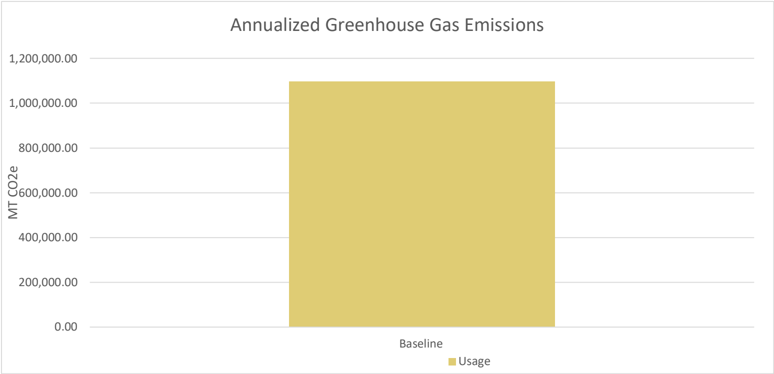
Usage Process		Energy use (mmBTU)	GHG emissions (MT CO2e)
Vehicle Operating Emissions		2,160,083	32,883,810
Construction Delay		798	12,144
Total		2,160,881	32,895,954

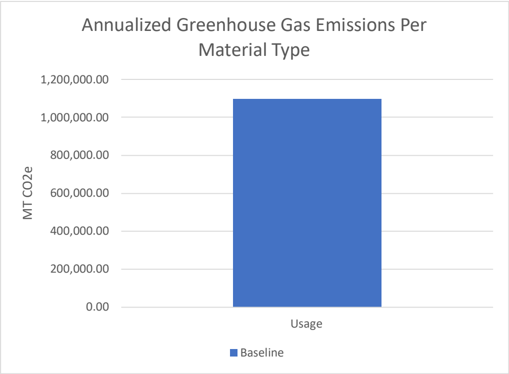
Mitigated Results

30 year Annualized Results	Annualized Energy Use Energy use (mmBTU)	Annualized Greenhouse Gas Emissions GHG emissions (MT CO2e)
Usage Emissions	72,029	1,096,532
Materials subtotal	-	-
Transportation subtotal	-	-
Construction subtotal	-	-
Usage subtotal	72,029	1,096,532
Total	72,029	1,096,532

Results Charts

Show	Annualized Greenhouse Gas Emissions	Units	MT CO2e





No mitigations are available for Ve

Annualized Greenhouse Gas Emissions
MT CO2e
Baseline

Usage	1,096,532
Total	**1,096,532**

	Annualized Greenhouse Gas Emissions Per Material Type
	MT CO2e
	Baseline
Usage	
Total	

Project Inputs

Planning Summary of Inputs - See Individual Tabs for Details

Display result in 508 compliant format:	No
Hide Instructions	No

Clear All User Data

INSTRUCTIONS

1. Populate location (state) and lifetime (years) for your analysis.
2. Select operating mode (*Project* or *Planning*) for your analysis. (The tool can analyze individual projects (*Project* mode) or a suite of projects in a comprehensive plan (*Planning* mode). Most analyses using *Planning* mode.
3. Select the infrastructure type(s) to analyze. Input all requested data using information from the project or plan you want to analyze. Then navigate to the relevant *analysis page(s)* for your project or the individual project(s) in your plan and complete the analysis for each infrastructure type by entering information in all cells that are shaded yellow. Blue and gray cells display fixed values and results; do not change the information in these cells.
4. Apply any selected mitigation measures on the *Mitigation Strategies* tab.
5. Review outputs on the *Summary Results* tab.
6. For further instructions, refer to the accompanying User Guide for detailed descriptions of factors and assumptions used in this tool.

Infrastructure location (state)	WI
Analysis period of your plan or project (years)	30
Year construction starts	2030
Use custom electric emission profile (RPS)?	No

Tool Use	Planning

Infrastructure Types

Roadways | BRT | Heavy Rail | Light Rail | Parking | Signage

Bridges & Overpasses | Culverts | Interchanges | Lighting | Pathways | Vehicle Operations | Custom Pavement

Stand-Alone Infrastructure Type

Roadway Rehabilitation

Note: This project type cannot be combined with other infrastructure types and is designed solely for short-term projects, such as one-time resurfacing events.

	Title:	I39/90/94 GHG Analysis	Title:	Build Alternatives - Hybrid	Title:	
Enter comments and comment titles. These will be displayed on the Summary Results worksheet	I30/90/94 GHG Analysis		This anlaysis included emissions from project construction between 2030-2040, maintenance, and vehicle operation emissions due to delay caused by the construction. Operation emissions covered 2030-2060			

Roadways

Roadways

The Roadways module in ICE accounts for the full roadway lifespan, including construction, rehabilitation, routine maintenance, and preventive maintenance for new and existing roadways. Separate inputs are required for construction, rehabilitation, and effects of preventative maintenance. Module inputs include those for both the existing and new construction. As noted, some inputs are lane miles; some are centerline miles. See the Roadways sheet and User's Guide for more information.

Source: https://commons.wikimedia.org/wiki/File:Veterans_Memorial_Parkway,_London,_Ontario.jpg

Roadway System

Total existing centerline miles	182.14
Total newly constructed centerline miles	187.26

Roadway Projects

Facility type	Roadway System	Roadway Construction				
	Existing Roadway (lane miles)	New Roadway (lane miles)	Construct Additional Lane (lane miles)	Realignment (lane miles)	Lane Widening (lane miles)	Shoulder Improvement (centerline miles)
Rural Interstates	268.3	349.05				
Rural Principal Arterials	0	0				
Rural Minor Arterials	17.19	14.21				
Rural Collectors	11.97	13.14				
Urban Interstates / Expressways	116.88	156.87				
Urban Principal Arterials	8.93	6.96				
Urban Minor Arterials / Collectors	15.51	28.47				

Include roadway rehabilitation activities (reconstruct and resurface)	

% roadway construction on rocky / mountainous terrain	0%

Specification
Baseline Energy Use and GHG Emissions
Mitigated Results
Results - Charts

Bridges & Overpasses

Bridges & Overpasses

The Bridge and Overpasses module addesses new construction, reconstruction, and lane addition for single span, two span, and multi-span bridges (over land or water). Note this module applies to the construction of the bridge structure rather than the pavement surface. Bridge paving activities should be entered as part of the Roadway construction activities. See the Bridges_Overpasses sheet and User's Guide for more information.

Source: https://en.wikipedia.org/wiki/Low-water_crossing#/media/File:Roanoke_River_low_water_crossing.jpg

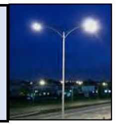
	Reconstruct Bridge/Overpass											
Bridge/Overpass Structure	Number of bridges & overpasses	Average number of spans per structure	Average number of lanes per structure	Total number of lane-spans	Number of bridges & overpasses	Average number of spans per structure	Average number of lanes recon structed per structure	Total number of lane-spans	Number of bridges & overpasses	Average number of spans per structure	Average number of lanes per structure added	Total number of lane-spans
Single-Span	24	1	2.38	57.12	0	1	0	0		1		0
Two Span	19	2	3	114	9	2	3.78	68.04		2		0
Multi-Span (over land)	32	3.965	2.095	265.8136				384.5345				0
Multi-Span (over water)	2	2	2	8				30				0

Specification
Baseline Energy Use and GHG Emissions
Mitigated Results
Results - Charts

Lighting

Lighting

The Lighting module estimates the energy and GHG emissions associated with roadway lighting projects. ICE considers LED and HPS type lights and state-specific energy factors. See the Lighting sheet and User's Guide for more information. Module inputs include average number of lights per roadway mile by type and luminosity.



Source: http://www.sanengineeringllc.com/Projects/Structural-Engineering-NMDOT.php

Number of roadway miles	187.26

Lighting Structures			
Support Structure Type	Lumen Range	Ave. number of HPS lights per roadway mile	Ave. number of LED lights per roadway mile
Vertical	4000-5000		
Vertical	7000-8800		
Vertical	8500-11500		
Vertical	11500-14000		
Vertical	21000-28000		
Vertical and Vertical with 8' Arm	4000-5000		
Vertical and Vertical with 8' Arm	7000-8800		
Vertical and Vertical with 8' Arm	8500-11500		
Vertical and Vertical with 8' Arm	11500-14000		1.308
Vertical and Vertical with 8' Arm	21000-28000		
High Mast	28800 - 42000		
High Mast	46500-52800		
High Mast	52500-58300		

Specification
Baseline Energy Use and GHG Emissions
Mitigated Results
Results - Charts

Signage

Signage

The Signage module charaterizes small, medium, and large signs for aluminum sheet metal and directly embedded or concrete encased steel. See the Signage sheet and User's Guide for more information. Module inputs include average number of each type of sign per roadway mile and the total project roadway miles.

Source: dot.state.mn.us/trafficeng/publ/tem/2009/Chapter-06.pdf; https://www.defensivedriving.org/dmv-handbook/29-unusual-road-signs/;

Number of roadway miles	187.26

Signage Structures	Avg. number of signs per roadway mile
Small (3'x3') 14 Gauge Steel Post (MDOT SIGN 150 D)	15
Medium (6'x6') 14 Gauge Steel Posts (MDOT SIGN 150 D)	6
Large (10'x14') 8 Gauge Cantilever Arm (MDOT SIGN 300 A)	5

Specification
Baseline Energy Use and GHG Emissions
Mitigated Results
Results - Charts

Vehicle Ops

Vehicle_Ops

The Vehicle Operations module estimates on roadway infrastructure from vehicle operations. It addresses both ongoing vehicle operations and additional emissions from construction delay.
ICE2.2 includes two approaches: 1) The preferred approach is for the user to enter custom emission amounts directly from a seperate calculation. ICE then combines this with any other infrastructure included. 2) The alternative approach estimates these values from user inputs of VMT, speed, and optional vehicle type. Note ICE2.2 uses MOVES3 projections of vehicle energy consumption and fleet mix.
See the Vehicle_Ops sheet and User's Guide for more information.

Source: https://www.greencarreports.com/news/1093560_1-2-billion-vehicles-on-worlds-roads-now-2-billion-by-2035-report

Enter results from external model?	Yes

Vehicle Operating Emissions

Custom emissions represent:	Tailpipe - upscale to full lifecycle	
	Year	kg CO2e/year from roadway network
Start year	2030	852673874
End Year	2060	818587350

Construction Delay, Additional Emissions

Custom emissions represent:	Tailpipe - upscale to full lifecycle	
	Year	Increased emissions (kg CO2e/year)
Start year	2030	896976
End Year	2040	896976

Specification
Baseline Energy Use and GHG Emissions
Mitigated Results
Results - Charts

Summary Results

Roadways	BRT	Heavy Rail	Light Rail	Parking	Signage	
Bridges & Overpasses	Culverts	Interchanges	Lighting	Pathways	Vehicle Operations	Custom Pavement

Show	Annualized Greenhouse Gas Emissions	Un ts	MT CO2e

39/90/94 GHG Analysis

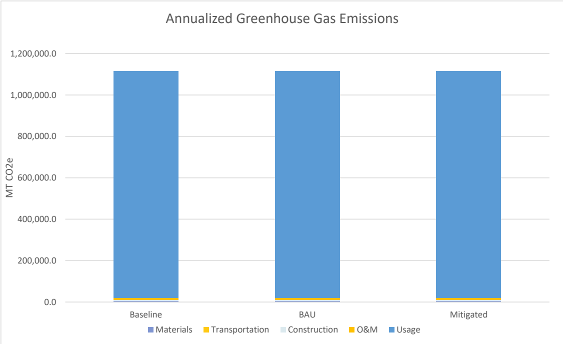
I30/90/94 GHG Analysis

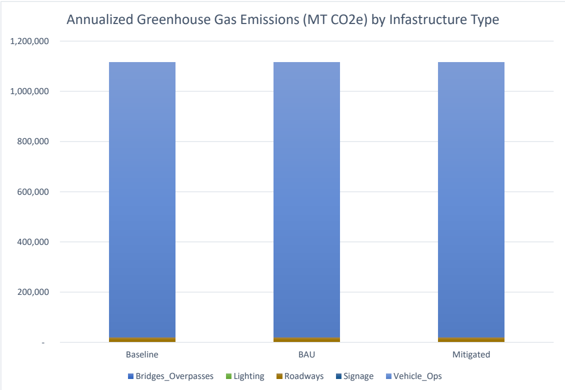
Build Alternatives_ Hybrid

This anlaysis included emissions from project construction between 2030-2040, maintenance, and vehicle operation emissions due to delay caused by the construction. Operation emissions covered 2030-2060

	Annual zed Greenhouse Gas Em ssions (MT CO2e) by nfastructure Type		
	MT CO2e	MT CO2e	MT CO2e
	Base ne	BAU	M tigated
Br dges_Overpasses			
L ghting			
Roadways			
Signage			
Veh cle_Ops			
Total			

Summary Results Charts





Summary Results   Tables

	Annual zed Greenhouse Gas Em ssions		
	MT CO2e	MT CO2e	MT CO2e
	Base ne	BAU	M tigated
Mater als	6,043	6,043	6,043
Transportation	564	564	564
Construction	3,704	3,704	3,704
O&M	9,642	9,642	9,642
Usage	1,095,827	1,095,827	1,095,827
Total	**1,115,779**	**1,115,779**	**1,115,779**

	Annual zed Greenhouse Gas Em ssions Per Mater al Type		
	MT CO2e	MT CO2e	MT CO2e
	Base ne	BAU	M tigated
Aggregate	558	558	558
A uminum	24	24	24
B tumen (Asphalt B nder)	1,018	1,018	1,018
Cement	3,012	3,012	3,012
Steel	1,429	1,429	1,429
Water	2	2	2
Transportation Fuel	564	564	564
Construction Fuel	3,704	3,704	3,704
O&M Electr city (kWh)	91	91	91
O&M fuel (DGEs)	2,184	2,184	2,184
O&M Roadway Rehab tation	7,368	7,368	7,368
Usage	1,095,827	1,095,827	1,095,827
Total	**1,115,779**	**1,115,779**	**1,115,779**

	Annual zed Greenhouse Gas Em ssions Reductions Relative to BAU				
	MT CO2e	MT CO2e	MT CO2e	MT CO2e	MT CO2e
	Mater als	Transportation	Construction	O&M	TOTAL
Total	-	-	-	-	-

	ual zed Greenhouse Gas Em ssions (MT CO2e) by nfastructure T		
	MT CO2e	MT CO2e	MT CO2e
	Base ne	BAU	M tigated
Br dges_Overpasses	2,330	2,330	2,330
L ghting	96	96	96
Roadways	17,316	17,316	17,316
Signage	210	210	210
Veh cle_Ops	1,095,827	1,095,827	1,095,827
Total	**1,115,779**	**1,115,779**	**1,115,779**

Instructions: Follow the steps below to calculate the impact of energy and GHG mitigation strategies:

The user will enter both the business as usual (BAU) deployment (i.e., the extent to which the strategy is deployed through standard agency practices) in Column F and the planned deployment (i.e., the extent to which the strategy will be deployed in the project that you are examining) in Column G. (Baseline refers to values without any mitigations.) For Pavement Preservation strategies, enter both the schedule change and application frequency.

Column H displays the increase in deployment from implementation of the strategy. Some reduction strategies (e.g., Switch from diesel to Soybean-based Biodiesel and biodiesel/hybrid maintenance vehicles and equipment) may be incompatible. The user should take care that inputs do not describe a total deployment greater than 100% for overlapping strategies. The tool will warn if "excess" energy savings from mitigation are predicted or incompatible strategies are selected.

For a more refined mitigation analysis, please refer to FHWA's upcoming Pavement LCA Tool.

Strategy	BAU deployment	Planned deployment	Deployment increase	Energy reduction factor	GHG reduction factor	Energy reductions	GHG reductions	Energy reductions	GHG reductions
Alternative fuels and vehicle hybridization									
Sw tch from d ese to Soybean based Biodiese			0.0%	26%	14%	0.0%	0.0%	0.0%	0.0%
Sw tch from d ese to Soybean based RDII 100			0.0%	28%	65%	0.0%	0.0%	0.0%	0.0%
Sw tch from d ese to Forest Residue based RDII 100			0.0%	67%	73%	0.0%	0.0%	0.0%	0.0%
Sw tch from d ese to E D ese , Corn			0.0%	5%	14%	0.0%	0.0%	0.0%	0.0%
Sw tch from d ese to PHEV: Diesel and Electr city (State M x)			0.0%	18%	24%	0.0%	0.0%	0.0%	0.0%
Sw tch from d ese to Hybr d D esel			0.0%	11%	11%	0.0%	0.0%	0.0%	0.0%
Sw tch from d ese to E ectr c ty			0.0%	56%	63%	0.0%	0.0%	0.0%	0.0%
Sw tch from d ese to CNG, from NG			0.0%	9%	11%	0.0%	0.0%	0.0%	0.0%
Sw tch from d ese to LNG, from NG			0.0%	13%	8%	0.0%	0.0%	0.0%	0.0%
Sw tch from d ese to Convent onal Diesel (BD20)			0.0%	5%	14%	0.0%	0.0%	0.0%	0.0%
Sw tch from d ese to Hydrogen (from NG)			0.0%	40%	52%	0.0%	0.0%	0.0%	0.0%
Sw tch from d ese to B od ese (from corn)			0.0%	88%	90%	0.0%	0.0%	0.0%	0.0%
Sw tch from d ese to RDII (from corn)			0.0%	81%	87%	0.0%	0.0%	0.0%	0.0%
Sw tch from d ese to CNG (from Landfill, Off s te Refue ng)			0.0%	2%	17%	0.0%	0.0%	0.0%	0.0%
Sw tch from d ese to Renewable CNG (from Wastewater Treatment, Off s te refue ng)			0.0%	62%	136%	0.0%	0.0%	0.0%	0.0%
Hybr d ma ntenance veh c es and equipment			0.0%	11%	11%	0.0%	0.0%	0.0%	0.0%
Comb ned hybr d zat on/B20 n maintenance veh c es and equ pment			0.0%	1%	27%	0.0%	0.0%	0.0%	0.0%
Hybr d construct on veh c es and equipment			0.0%	11%	11%	0.0%	0.0%	0.0%	0.0%
Comb ned hybr d zat on/B20 n construction veh c es and equ pment			0.0%	1%	27%	0.0%	0.0%	0.0%	0.0%
Vegetation management									
A ternat ve vegetat on management strateg es (hardscap ng, a ternat ve mow ng, ntegrated roadway/vegetat on management)			N/A	25%	25%	0.0%	0.0%	0.0%	0.0%
Snow fencing and removal strategies									
A ternat ve snow remova strateg es (snow fencing, w ng p ows)			N/A	50%	50%	0.0%	0.0%	0.0%	0.0%
In place roadway recycling									
Co d In p ace recyc ng			0.0%	33%	37%	0.0%	0.0%	0.0%	0.0%
Fu depth rec amat on			0.0%	68%	68%	0.0%	0.0%	0.0%	0.0%
Warm mix asphalt									
Warm m x aspha t			0.0%	37%	37%	0.0%	0.0%	0.0%	0.0%
Recycled and reclaimed materials									
Use recyc ed aspha t pavement as a substitute for v rg n aspha t aggregate			0.0%	12%	12%	0.0%	0.0%	0.0%	0.0%
Use recyc ed aspha t pavement as a substitute for v rg n aspha t b tumen			0.0%	84%	84%	0.0%	0.0%	0.0%	0.0%
Use ndustr a byproducts as subst tutes for Portland cement			0.0%	59%	59%	0.0%	0.0%	0.0%	0.0%
Use recyc ed concrete aggregate as a substitute for base stone			0.0%	58%	58%	0.0%	0.0%	0.0%	0.0%
Pavement preservation									
Pavement preservat on extends roadway ma ntenance act v t es by (%)			0.0%	N/A	N/A	N/A	N/A	N/A	N/A
Pavement preservat on frequency (every N years, for ent re roadway system)			N/A	N/A	N/A	N/A	N/A	N/A	N/A

Roadways

Roadway example.
Source: https://commons.wikimedia.org/wiki/File:Veterans_Memorial_Parkway,_London,_Ontario.jpg

ICE accounts for the full roadway lifespan, including construction, rehabilitation, routine maintenance, and preventive maintenance. ICE handles these activities in different ways. Separate inputs are required for construction, rehabilitation, and effects of preventative maintenance. Specifically:

- New construction – The user enters lane miles of construction (or centerline miles of shoulder improvement) projects. Separately, the user indicates what fraction of roadway construction is in difficult terrain.
- Roadway rehabilitation – The user enters expected lane miles for reconstruction and resurfacing projects the length of the analysis period. Separately, the user enters a rehabilitation schedule. (Defaults are provided and used if no values are entered.) As a general rule of thumb, new roadways require resurfacing after 15 years and reconstruction after 30 years. Note that roadway rehabilitation applies to both existing and new roadways.
- Preventive maintenance – Preventive maintenance is pavement preservation techniques, such as crack sealing, patching, chip seals, and micro-surfacing, that prolong the life of the pavement. In ICE2.0, the user has the option to specify an extension of the roadway rehabilitiation schedule due to implementation of a (generic) preventive maintenance program. Application of preventative maintenance is accessible on the *Mitigation Strategies* tab. Note that the energy and emissions "cost" of a preventative maintenance program is based on an average of several potential strategies from different studies. More specific values may be obtainable from FHWA's Pavement LCA tool (when it becomes available).

Emissions and energy associated with routine maintenance (sweeping, striping, bridge deck repair, litter pickup, and maintenance of appurtenances) and roadway rehabilitation is automatically estimated per lane mile of both new and existing roadways associated with your project. To estimate associated use-phase emissions, visit the Vehicle Operations tab.

Note that roadway projects do not include sidewalks. If your project or plan includes constructing sidewalks, they should be entered separately in the Rail, Bus, Bicycle, and Pedestrian Facilities section of the tool.

Note that ICE2.0 does not calculate energy or GHG emissions savings from pavement smoothness effects related to any resurfacing and reconstruction projects.

ICE also does not intrinsically allow customized pavement configurations. Most analyses should use this Roadway tab and ICE's internal pavement configuration. The Custom Pavement analysis relies on external data rather than ICE's calculations to estimate lifecycle values for different configurations. Please see the Custom Pavement tab for more information. Users should not enter both Roadway and Custom Pavement values for the same project.

Example: The user enters new construction of 10 lane miles of new freeway, with an analysis period of 40 years. Assuming that all construction takes place in year 1, the user enters 10 lane miles of freeway resurfacing (assumed to take place in year 15) and 10 lane miles of freeway reconstruction (assumed to take place in year 30). The tool automatically includes routine maintenance of the 10 newly constructed lane miles. The user has the option of specifying a generic preventive maintenance program, which will increase the longevity of the pavement surface and therefore reduce the amount of energy and emissions associated with resurfacing and rehabilitation.

Specification

Select Mitigation Strategies

Roadway System	Existing	New	Total
Total centerline miles	182	187	369
Total lane miles	434	563	998

			Facility type						
			Rural Interstates	Rural Principal Arterials	Rural Minor Arterials	Rural Collectors	Urban Interstates / Expressways	Urban Principal Arterials	Urban Minor Arterials / Collectors
Roadway Lane Width (feet) (before construction)		Default	12	11	11	11	12	11	11
Roadway Construction	New Roadway (ICE equivalent lane miles)		349.1	0.0	13.0	12.0	156.9	6.4	26.1

Include roadway rehabilitation activities (reconstruct and resurface)	Yes
% roadway construction on rocky / mountainous terrain	0%

Baseline Energy Use and GHG Emissions

Material Energy Use and Emissions	Construction Energy use (mmBTU)	Construction GHG emissions (MT CO2e)	O&M Roadway Rehabilitation Energy use (mmBTU)	O&M Roadway Rehabilitation GHG emissions (MT CO2e)
Aggregate	282,492	15,387	317,737	17,967
Bitumen (Asphalt Binder)	394,820	30,547	662,927	51,290
Cement	265,846	49,548	195,758	36,485
Steel	292,068	23,789	189,966	15,341
Water	101	13	74	10
Total	1,235,327	119,285	1,366,462	121,093

Materials Transportation	Construction Energy use (mmBTU)	Construction GHG emissions (MT CO2e)	O&M Roadway Rehabilitation Energy use (mmBTU)	O&M Roadway Rehabilitation GHG emissions (MT CO2e)
Transportation fuel (DGEs)	193,283	15,574	197,019	15,860
Total	193,283	15,574	197,019	15,860

Construction Process	Construction Energy use (mmBTU)	Construction GHG emissions (MT CO2e)	O&M Roadway Rehabilitation Energy use (mmBTU)	O&M Roadway Rehabilitation GHG emissions (MT CO2e)
Electricity (kWh)	0	0	0	0
Construction fuel (DGEs)	1,217,329	98,088	1,044,429	84,077
Total	1,217,329	98,088	1,044,429	84,077

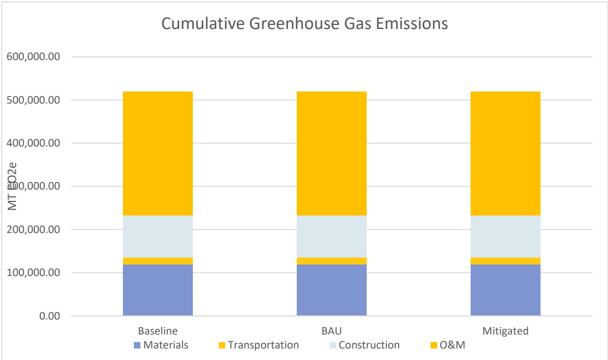
Operations and Maintenance	Energy use (mmBTU)	GHG emissions (MT CO2e)
Electricity (kWh)	-	-
Maintenance fuel (DGEs)	813,829.9	65,513.6
Roadway Rehabilitation (O&M)	2,607,910.2	221,030.2
Water	-	-
Total	3,421,740.1	286,543.9

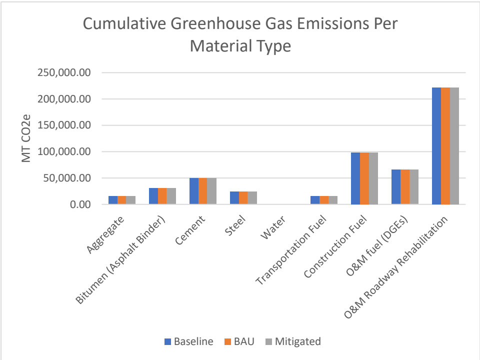
Mitigated Results

30 year Annualized Results	Construction						O&M Roadway Rehabilitation					
	Annualized Energy Use			Annualized Greenhouse Gas Emissions			Annualized Energy Use			Annualized Greenhouse Gas Emissions		
	Baseline	BAU	Mitigated	Baseline	BAU	Mitigated	Baseline	BAU	Mitigated	Baseline	BAU	Mitigated
	Energy use (mmBTU)	Energy use (mmBTU)	Energy use (mmBTU)	GHG emissions (MT CO2e)	GHG emissions (MT CO2e)	GHG emissions (MT CO2e)	Energy use (mmBTU)	Energy use (mmBTU)	Energy use (mmBTU)	GHG emissions (MT CO2e)	GHG emissions (MT CO2e)	GHG emissions (MT CO2e)
Aggregate	9,416	9,416	9,416	513	513	513	10,591	10,591	10,591	599	599	599
Bitumen (Asphalt Binder)	13,161	13,161	13,161	1,018	1,018	1,018	22,098	22,098	22,098	1,710	1,710	1,710
Cement	8,862	8,862	8,862	1,652	1,652	1,652	6,525	6,525	6,525	1,216	1,216	1,216
Steel	9,736	9,736	9,736	793	793	793	6,332	6,332	6,332	511	511	511
Water	3	3	3	0	0	0	2	2	2	0	0	0
Transportation Fuel	6,443	6,443	6,443	519	519	519	6,567	6,567	6,567	529	529	529
Construction Fuel	40,578	40,578	40,578	3,270	3,270	3,270	34,814	34,814	34,814	2,803	2,803	2,803
O&M fuel (DGEs)	27,128	27,128	27,128	2,184	2,184	2,184	-	-	-	-	-	-
O&M Roadway Rehabilitation	86,930	86,930	86,930	7,368	7,368	7,368	86,930	86,930	86,930	7,368	7,368	7,368
Materials subtotal	41,178	41,178	41,178	3,976	3,976	3,976						
Transportation subtotal	6,443	6,443	6,443	519	519	519						
Construction subtotal	40,578	40,578	40,578	3,270	3,270	3,270						
Operations & Maintenance subtotal	114,058	114,058	114,058	9,551	9,551	9,551						
Total	202,256	202,256	202,256	17,316	17,316	17,316						

Results Charts

Show	Cumulative Greenhouse Gas Emissions	Units	MT CO2e





	Cumulative Greenhouse Gas Emissions		
	MT CO2e	MT CO2e	MT CO2e
	Baseline	BAU	Mitigated
Materials	119,285	119,285	119,285
Transportation	15,574	15,574	15,574
Construction	98,088	98,088	98,088
O&M	286,544	286,544	286,544
Total	**519,491**	**519,491**	**519,491**

	Cumulative Greenhouse Gas Emissions Per Material Type		
	MT CO2e	MT CO2e	MT CO2e
	Baseline	BAU	Mitigated
Aggregate	15,387.3	15,387.3	15,387.3
Bitumen (Asphalt Binder)	30,547	30,547	30,547
Cement	49,548	49,548	49,548
Steel	23,789	23,789	23,789
Water	13	13	13
Transportation Fuel	15,574	15,574	15,574
Construction Fuel	98,088	98,088	98,088
O&M fuel (DGEs)	65,514	65,514	65,514
O&M Roadway Rehabilitation	221,030	221,030	221,030
Total	**519,491**	**519,491**	**519,491**

	Cumulative Greenhouse Gas Emissions Reductions Relative to BAU				
	MT CO2e	MT CO2e	MT CO2e	MT CO2e	MT CO2e
	Materials	Transportation	Construction	O&M	TOTAL
Total	-	-	-	-	-

Bridges & Overpasses

Return to Pro ect nputs

Example of a concrete bridge
(not representative of all possible project types).

Source: https://en.wikipedia.org/wiki/Low-water_crossing#/media/File:Roanoke_River_low_water_crossing.jpg

ICE estimates the energy and GHG emissions associated with the construction, reconstruction, or lane addition for single span, two-span, and multi-span bridges and overpasses. Bridges and overpasses are treated as being functionally equivalent in ICE.

The *Bridges and Overpasses* module in ICE applies to the construction of the bridge structure rather than the pavement surface. Bridge paving activities should be entered as part of the Roadway construction activities.

Approximately half of short bridges in the U.S. (less than 1000 feet long) are single-span or double-span. If information about number of spans is not available, it is reasonable to assume a mix of single-span and two-span bridges. Note that the number of spans is an important factor in energy use and GHG emissions.

Please note that very large bridges that carry traffic very high or span very deep spaces are unique and likely require additional materials and construction processes that cannot be approximated by ICE.

Specification

Se ect M t gat on Strateg es

	Cons ruc New Bridge				Recons ruc Bridge				Add Lane o Bridge			
Br dge and Overpass Structures	Number of bridges	Avg number of spans per bridge	Avg number of anes per bridge	Tota number of ane spans	Number of bridges	Avg number of spans per bridge	Avg number of anes per bridge	Tota number of ane spans	Number of bridges	Avg number of spans per bridge	Avg number of new anes per bridge	Tota number of ane spans
S ngle Span	24	1	2	57	-	1	-	-	-	1	-	-
Two-Span	19	2	3	114	9	2	4	68	-	2	-	-
Mul Span over and)	32	4	2	266	35	4	3	385	-	-	-	-
Mul Span over wa er)	2	2	2	8	4	3	3	30	-	-	-	-

Baseline Energy Use and GHG Emissions

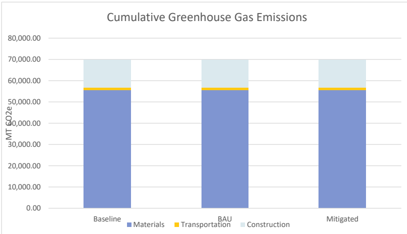
Ma eria s Transporta on		Energy use mmBTU	GHG em ss ons MT CO2e
Transporta on ue DGEs		16,244	1,309
Tota		16,244	1,309

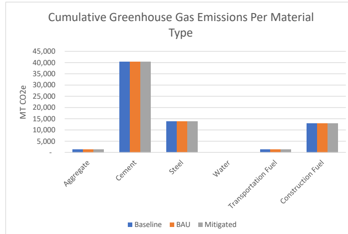
Mitigated Results

	Annua zed Energy Use			Annua zed Greenhouse Gas Em ss ons		
	Base ne	BAU	M ga ed	Base ne	BAU	M ga ed
30 year Annua zed Resul s	Energy use mmBTU	Energy use mmBTU	Energy use mmBTU	GHG em ss ons MT CO2e	GHG em ss ons MT CO2e	GHG em ss ons MT CO2e
Aggrega e	818	818	818	45	45	45
Cement	7,223	7,223	7,223	1,346	1,346	1,346
S ee	6,038	6,038	6,038	460	460	460
Wa er	11	11	11	1	1	1
Transporta on Fue	541	541	541	44	44	44
Cons ruc on Fue	5,390	5,390	5,390	434	434	434
Ma eria s subtota	14,090	14,090	14,090	1,852	1,852	1,852
Transporta on subtota	541	541	541	44	44	44
Cons ruc on subtota	5,390	5,390	5,390	434	434	434
Tota	20,022	20,022	20,022	2,330	2,330	2,330

Results Charts

Show	Cumulative Greenhouse Gas Emissions	Uni s	MT CO2e





	Cumula ve Greenhouse Gas Em ss ons		
	MT CO2e	MT CO2e	MT CO2e
	Base ne	BAU	M ga ed
Ma eria s	55,558	55,558	55,558
Transporta on	1,309	1,309	1,309
Cons ruc on	13,030	13,030	13,030
Tota	**69,897**	**69,897**	**69,897**

	Cumula ve Greenhouse Gas Em ss ons Pe Ma eria Type		
	MT CO2e	MT CO2e	MT CO2e
	Base ne	BAU	M ga ed
Aggrega e	1,338	1,338	1,338
Cement	40,389	40,389	40,389
S ee	13,787	13,787	13,787
Wa er	44	44	44
Transporta on Fue	1,309	1,309	1,309
Cons ruc on Fue	13,030	13,030	13,030
Tota	**69,897**	**69,897**	**69,897**

	Cumula ve Greenhouse Gas Em ss ons Reduc ons Re a ve o BAU				
	MT CO2e	MT CO2e	MT CO2e	MT CO2e	MT CO2e
	Ma eria s	Transporta on	Cons ruc on	O&M	TOTAL
Tota	-	-	-	-	-

Lighting

Example of vertical with arm lighting.

Source:
http://www.sanengineeringllc.com/Projects/Structural-Engineering-NMDOT.php

ICE estimates the energy and GHG emissions associated with lighting use projects. Annual energy consumption will be paired with energy emission factors for individual states to determine GHG emissions.

Roadway lighting projects can be a significant contributor to the annual energy use and GHG emissions of many transportation agencies. ICE estimates the energy and GHG emissions associated with lighting projects. ICE evaluates the impacts of two of the most common lighting technologies: High Pressure Sodium (HPS) & Light Emitting Diode (LED). It includes lifecycle impacts associated with common support structures: High Mast, Vertical, and Vertical with arm.

Note that ICE only includes roadway lighting energy and GHG emissions from the use phase and lighting support structures, as manufacturing energy and emissions for HPS and LED luminaries and replacement parts is currently poorly characterized.

Specification

Se ect Mit gat on Strateg es

L ghting Structures		Avg number o HPS ghts per roadway m e	Avg number o LED ghts per roadway m e
Suppor Structure Type	Lumen Range		
Vertica	4000-5000	-	-
Vertica	7000-8800	-	-
Vertica	8500-11500	-	-
Vertica	11500-14000	-	-
Vertica	21000-28000	-	-
Vertica and Vertica w th 8 Arm	4000-5000	-	-
Vertica and Vertica w th 8 Arm	7000-8800	-	-
Vertica and Vertica w th 8 Arm	8500-11500	-	-
Vertica and Vertica w th 8 Arm	11500-14000	-	1.3
Vertica and Vertica w th 8 Arm	21000-28000	-	-
H gh Mas	28800 - 42000	-	-
H gh Mas	46500-52800	-	-
H gh Mas	52500-58300	-	-

Number o roadway m es	187.26

Baseline Energy Use and GHG Emissions

Mater a Energy Use and Em ss ons		Energy use (mmBTU	GHG em ss ons (MT CO2e
Aggregate		12	1
A um num			
Cemen		186	35
Stee		1,576	136
Water		0	0
Tota		1,774	171

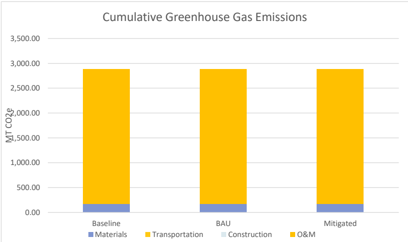
Mater a s Transportation		Energy use (mmBTU	GHG em ss ons (MT CO2e
Transportation fue (DGEs		17	1
Tota		17	1

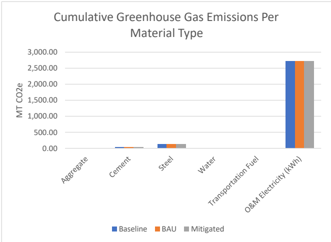
Mitigated Results

	Annua zed Energy Use			Annua zed Greenhouse Gas Em ss ons		
	Base ne	BAU	M tigated	Base ne	BAU	M tigated
30 year Annua zed Resu ts	Energy use (mmBTU	Energy use (mmBTU	Energy use (mmBTU	GHG em ss ons (MT CO2e	GHG em ss ons (MT CO2e	GHG em ss ons (MT CO2e
Aggregate	0	0	0	0	0	0
A um num	-	-	-	-	-	-
Cemen	6	6	6	1	1	1
Stee	53	53	53	5	5	5
Water	0	0	0	0	0	0
Transportation Fue	1	1	1	0	0	0
Construction Fue	-	-	-	-	-	-
O&M E ectr c ty (kWh	1,054	1,054	1,054	91	91	91
Mater a s subtota	59	59	59	6	6	6
Transportation subtota	1	1	1	0	0	0
Construction subtota	-	-	-	-	-	-
Operations & Ma ntenance subtota	1,054	1,054	1,054	91	91	91
Tota	1,114	1,114	1,114	96	96	96

Results Charts

Show	Cumulative Greenhouse Gas Emissions	Un ts	MT CO2e





	Cumu ative Greenhouse Gas Em ss ons		
	MT CO2e	MT CO2e	MT CO2e
	Base ne	BAU	M tigated
Mater a s	171	171	171
Transportation	1	1	1
Construction	-	-	-
O&M	2,717	2,717	2,717
Tota	**2,889**	**2,889**	**2,889**

	Cumu ative Greenhouse Gas Em ss ons Per Mater a Type		
	MT CO2e	MT CO2e	MT CO2e
	Base ne	BAU	M tigated
Aggregate	1	1	1
Cemen	35	35	35
Stee	136	136	136
Water	0	0	0
Transportation Fue	1	1	1
O&M E ectr c ty (kWh	2,717	2,717	2,717
Tota	**2,889**	**2,889**	**2,889**

	Cumu ative Greenhouse Gas Em ss ons Reductions Re ative to BAU				
	MT CO2e	MT CO2e	MT CO2e	MT CO2e	MT CO2e
	Mater a s	Transportation	Construction	O&M	TOTAL
Tota	-	-	-	-	-

ICE divides the signage category is divided into small, medium, and large structures representing the three most common types of roadway signs. Small and medium sized signs are typically regulatory and warning signs supported by a single post. Large signs include overhead guidance highway signs, typically supported by two posts or hung overhead on large steel cantilever arms. Signage infrastructure is a combination of aluminum sheet metal, and directly embedded or concrete encased supports.

The user enters the average number of each type of sign per roadway mile and the total project roadway miles.

Example large, medium, and small signs.

Source: dot.state.mn.us/trafficeng/publ/tem/2009/Chapter-06.pdf; https://www.defensivedriving.org/dmv-handbook/29-unusual-road-signs/; https://www.waaytv.com/content/news/School-bus-warning-signs-installed-on-Highway-43-463727923.html

Specification

Select Mitigation Strategies

Signage Structures	Avg. number of signs per roadway mile
Small (3'x3') 14 Gauge Steel Post (MDOT SIGN 150-D)	15.0
Medium (6'x6') 14 Gauge Steel Posts (MDOT SIGN 150-D)	6.0
Large (10'x14') 8 Gauge Cantilever Arm (MDOT SIGN 300-A)	5.0

Number of roadway miles	187

Baseline Energy Use and GHG Emissions

Material Energy Use and Emissions		Energy use (mmBTU)	GHG emissions (MT CO2e)
Aggregate		130	7
Aluminum		10,826	719
Cement		2,065	385
Steel		59,681	5,163
Water		1	0
Total		72,702	6,273

Materials Transportation		Energy use (mmBTU)	GHG emissions (MT CO2e)
Transportation fuel (DGEs)		294	24
Total		294	24

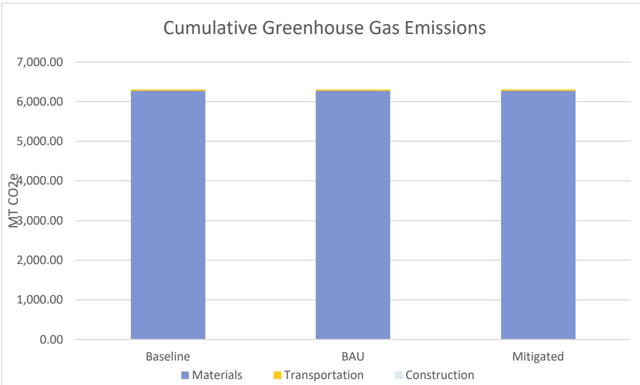
Construction Process		Energy use (mmBTU)	GHG emissions (MT CO2e)
Electricity (kWh)		0	0
Construction fuel (DGEs)		0	0
Total		0	0

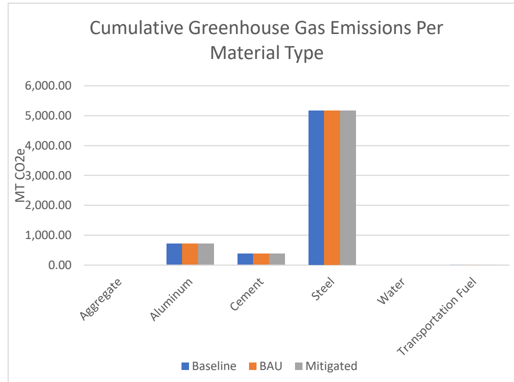
Operations and Maintenance		Energy use (mmBTU)	GHG emissions (MT CO2e)
Electricity (kWh)		0	0
Maintenance fuel (DGEs)		0	0
Water		0	0
Total		0	0

Mitigated Results

	Annualized Energy Use			Annualized Greenhouse Gas Emissions		
	Baseline	BAU	Mitigated	Baseline	BAU	Mitigated
30 year Annualized Results	Energy use (mmBTU)	Energy use (mmBTU)	Energy use (mmBTU)	GHG emissions (MT CO2e)	GHG emissions (MT CO2e)	GHG emissions (MT CO2e)
Aggregate	4	4	4	0	0	0
Aluminum	361	361	361	24	24	24
Cement	69	69	69	13	13	13
Steel	1,989	1,989	1,989	172	172	172
Water	0	0	0	0	0	0
Transportation Fuel	10	10	10	1	1	1
Construction Fuel	-	-	-	-	-	-
Materials subtotal	2,423	2,423	2,423	209	209	209
Transportation subtotal	10	10	10	1	1	1
Construction subtotal	-	-	-	-	-	-
Total	2,433	2,433	2,433	210	210	210

Results Charts





	Cumulative Greenhouse Gas Emissions		
	MT CO2e	MT CO2e	MT CO2e
	Baseline	BAU	Mitigated
Materials	6,273	6,273	6,273
Transportation	24	24	24
Construction	-	-	-
Total	**6,297**	**6,297**	**6,297**

	Cumulative Greenhouse Gas Emissions Per Material Type		
	MT CO2e	MT CO2e	MT CO2e
	Baseline	BAU	Mitigated
Aggregate	7	7	7
Aluminum	719	719	719
Cement	385	385	385
Steel	5,163	5,163	5,163
Water	0	0	0
Transportation Fuel	24	24	24
Total	**6,297**	**6,297**	**6,297**

	Cumulative Greenhouse Gas Emissions Reductions Relative to BAU				
	MT CO2e	MT CO2e	MT CO2e	MT CO2e	MT CO2e
	Materials	Transportation	Construction	O&M	TOTAL
Total	-	-	-	-	-

Vehicle Operations and Construction Delay Emissions

Example of Vehicle Operations

Source: https://www.greencarreports.com/news/1093560_1-2-billion-vehicles-on-worlds-roads-now-2-billion-by-2035-report

ICE estimates vehicle operations impacts of infrastructure projects from two distinct effects:

- Vehicle operating emissions – Operating emissions associated with vehicles using the roadway.
- Construction delay emissions – Additional emissions due to congested traffic speeds due to construction delays.

In both cases, these emissions are limited to roadway projects. Users should be aware that ICE2.2 relies on energy consumption rates and projections based on EPA's MOVES3 model, which is the current version as of publication date of this model. Significant changes are expected in the subsequent MOVES4 model when it is released.

ICE2.2 allows two approaches to calculating these emissions. In the first, the user will enter emissions associated with the two operating modes calculated from a seperate approach. For example, this could be detailed traffic and emissions modeling or sketch modeling with parameters specific to your location and project setting. This is the preferred approach, particularly when considering congestion delay across a large network or other, complex cases. In this case, the user simply enters the amount of emissions per year and number of years into ICE2.2. ICE2.2 then carries the values forward to reporting along with the other infrastructure types included. ICE also offers the ability to convert "tailpipe" (a.k.a. "downstream") emissions entered by a user into full lifecycle values, consistent with other ICE formulations.

In the second formulation, ICE2.2 computes these values from user inputs of VMT and speed. This approach is simplistic and designed to estimate impacts of congestion on speed and thus emissions, but cannot consider speed impacts across a complex network. In this case, two entries are required:

- Vehicle operating emissions – The user enters the years, average daily traffic (AADVMT), and average speed for the opening and horizon years on the project. ICE computes the cumulative operating emissions over on the project's lifetime.
- Construction delay emissions – The user enters the years, average daily traffic (AADVMT), and average speed for the year construction starts, project opening year, and the baseline year for comparison (typically the year before construction starts). ICE computes the additional energy and GHG emissions due to vehicle delay during construction. Estimates of emissions and additional energy use from construction delay and vehicle operating emissions using ICE2.2 calculations are meant to provide a rough sense of the scale of emissions relative to the construction processes themselves, and are not meant to replace estimates derived from traffic modeling software. Planned construction projects that will result in significant lane closures on high volume roads should be evaluated using traffic modeling software and the first input option for those emissions.

Note that mitigations are not applicable for vehicle operating emissions. Also, the calcualtions reflect a standard automobile fleet. They should not be used to estimate bus emissions on BRT or train emissions from Light- or Heavy-Rail. Also, results are integrated over the project lifetime. (I.e., "baseline" doesn't just mean baseline year.) ICE2.2 allows a default fleet mix or seperate inputs for light and heavy duty vehicles.

Specification

Enter results from external model?	Yes

Vehicle Operating Emissions

Emissions from	Tailpipe - upscale to full lifecycle	
	Year	kg CO2e/year from roadway network
Start year	2030	852673874
End year	2060	818587350

Construction Delay, Additional Emissions

Emissions from	Tailpipe - upscale to full lifecycle	
	Year	Increased emissions (kg CO2e/year)
Start year	2030	896976
End year	2040	896976

Construction start year	2030
Avg Daily VMT impacted by project	0
Speed without congestion (mph or NA)	NA

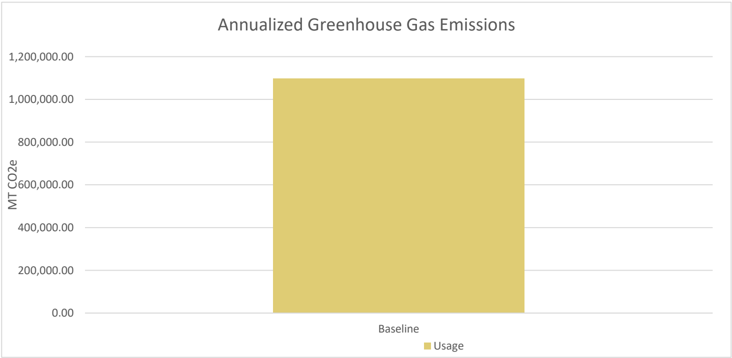
Baseline Energy Use and GHG Emissions

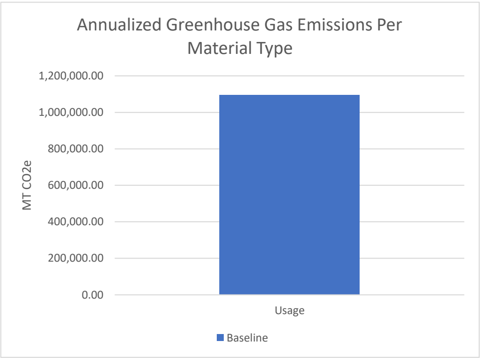
Mitigated Results

30 year Annualized Results	Annualized Energy Use Baseline Energy use (mmBTU)	Annualized Greenhouse Gas Emissions Baseline GHG emissions (MT CO2e)
Usage Emissions	71,983	1,095,827
Materials subtotal	-	-
Transportation subtotal	-	-
Construction subtotal	-	-
Usage subtotal	71,983	1,095,827
Total	71,983	1,095,827

Results - Charts

Show	Annualized Greenhouse Gas Emissions	Units	MT CO2e





No mitigations are available for Vehicle Ops.

	Annualized Greenhouse Gas Emissions
	MT CO2e
	Baseline
Usage	
Total	

	Annualized Greenhouse Gas Emissions Per Material Type
	MT CO2e
	Baseline
Usage	1,095,827
Total	**1,095,827**

APPENDIX C:

Study Corridor-Specific VMT and Speed Bin Information Used in MOVES4 Modeling

Project Specific Data Used in MOVES4 Modeling

County	Year	Scenario	Speed Range (mph)	Average Speed (mph)	Road Type	Auto Daily VMT	Truck Daily VMT
Dane	2023	EC	0-5	-	Urban Restricted	-	-
Dane	2023	EC	5-10	9.4	Urban Restricted	1	-
Dane	2023	EC	10-15	13.8	Urban Restricted	80	6
Dane	2023	EC	15-20	18.4	Urban Restricted	268	25
Dane	2023	EC	20-25	23.7	Urban Restricted	3831	623
Dane	2023	EC	25-30	29.3	Urban Restricted	35792	2798
Dane	2023	EC	30-35	33.8	Urban Restricted	2413	148
Dane	2023	EC	35-40	37.3	Urban Restricted	39307	3274
Dane	2023	EC	40-45	41.6	Urban Restricted	11470	627
Dane	2023	EC	45-50	-	Urban Restricted	-	-
Dane	2023	EC	50-55	52.3	Urban Restricted	192	25
Dane	2023	EC	55-60	-	Urban Restricted	-	-
Dane	2023	EC	60-65	65.0	Urban Restricted	321049	35469
Dane	2023	EC	65-70	69.9	Urban Restricted	1192458	142567
Dane	2023	EC	70-75	-	Urban Restricted	-	-
Dane	2023	EC	75-80	-	Urban Restricted	-	-
Dane	2023	EC	0-5	4.5	Urban Unrestricted	6	-
Dane	2023	EC	5-10	8.4	Urban Unrestricted	55	7
Dane	2023	EC	10-15	11.5	Urban Unrestricted	296	35
Dane	2023	EC	15-20	17.6	Urban Unrestricted	1123	105
Dane	2023	EC	20-25	23.3	Urban Unrestricted	4628	464
Dane	2023	EC	25-30	27.2	Urban Unrestricted	9964	1051
Dane	2023	EC	30-35	33.2	Urban Unrestricted	136674	12074
Dane	2023	EC	35-40	37.8	Urban Unrestricted	299483	23844
Dane	2023	EC	40-45	41.1	Urban Unrestricted	88339	6780
Dane	2023	EC	45-50	47.1	Urban Unrestricted	123745	13205
Dane	2023	EC	50-55	53.4	Urban Unrestricted	38939	4311
Dane	2023	EC	55-60	57.0	Urban Unrestricted	18963	2637
Dane	2023	EC	60-65	-	Urban Unrestricted	-	-
Dane	2023	EC	65-70	-	Urban Unrestricted	-	-
Dane	2023	EC	70-75	-	Urban Unrestricted	-	-
Dane	2023	EC	75-80	-	Urban Unrestricted	-	-
Dane	2023	EC	0-5	-	Rural Restricted	-	-
Dane	2023	EC	5-10	-	Rural Restricted	-	-
Dane	2023	EC	10-15	-	Rural Restricted	-	-
Dane	2023	EC	15-20	-	Rural Restricted	-	-
Dane	2023	EC	20-25	-	Rural Restricted	-	-
Dane	2023	EC	25-30	-	Rural Restricted	-	-
Dane	2023	EC	30-35	-	Rural Restricted	-	-
Dane	2023	EC	35-40	-	Rural Restricted	-	-
Dane	2023	EC	40-45	-	Rural Restricted	-	-
Dane	2023	EC	45-50	46.9	Rural Restricted	6092	959
Dane	2023	EC	50-55	53.7	Rural Restricted	70194	8529
Dane	2023	EC	55-60	-	Rural Restricted	-	-
Dane	2023	EC	60-65	-	Rural Restricted	-	-
Dane	2023	EC	65-70	70.0	Rural Restricted	175357	14672
Dane	2023	EC	70-75	-	Rural Restricted	-	-
Dane	2023	EC	75-80	-	Rural Restricted	-	-
Dane	2023	EC	0-5	-	Rural Unrestricted	-	-
Dane	2023	EC	5-10	-	Rural Unrestricted	-	-
Dane	2023	EC	10-15	-	Rural Unrestricted	-	-
Dane	2023	EC	15-20	-	Rural Unrestricted	-	-
Dane	2023	EC	20-25	20.7	Rural Unrestricted	39	2
Dane	2023	EC	25-30	-	Rural Unrestricted	-	-
Dane	2023	EC	30-35	-	Rural Unrestricted	-	-
Dane	2023	EC	35-40	39.8	Rural Unrestricted	11026	354
Dane	2023	EC	40-45	43.5	Rural Unrestricted	11477	622
Dane	2023	EC	45-50	49.0	Rural Unrestricted	94838	3547
Dane	2023	EC	50-55	52.1	Rural Unrestricted	58566	3473
Dane	2023	EC	55-60	-	Rural Unrestricted	-	-
Dane	2023	EC	60-65	-	Rural Unrestricted	-	-
Dane	2023	EC	65-70	-	Rural Unrestricted	-	-
Dane	2023	EC	70-75	-	Rural Unrestricted	-	-
Dane	2023	EC	75-80	-	Rural Unrestricted	-	-
Dane	2030	NB	0-5	-	Urban Restricted	-	-
Dane	2030	NB	5-10	9.4	Urban Restricted	1	-
Dane	2030	NB	10-15	13.8	Urban Restricted	87	7
Dane	2030	NB	15-20	17.9	Urban Restricted	298	30

County	Year	Scenario	Speed Range (mph)	Average Speed (mph)	Road Type	Auto Daily VMT	Truck Daily VMT
Dane	2030	NB	20-25	22.7	Urban Restricted	4302	705
Dane	2030	NB	25-30	29.1	Urban Restricted	38490	3193
Dane	2030	NB	30-35	33.9	Urban Restricted	4530	356
Dane	2030	NB	35-40	37.2	Urban Restricted	40638	3536
Dane	2030	NB	40-45	41.4	Urban Restricted	12354	739
Dane	2030	NB	45-50	-	Urban Restricted	-	-
Dane	2030	NB	50-55	52.3	Urban Restricted	204	27
Dane	2030	NB	55-60	-	Urban Restricted	-	-
Dane	2030	NB	60-65	64.9	Urban Restricted	342733	39110
Dane	2030	NB	65-70	69.7	Urban Restricted	1266001	155467
Dane	2030	NB	70-75	-	Urban Restricted	-	-
Dane	2030	NB	75-80	-	Urban Restricted	-	-
Dane	2030	NB	0-5	4.5	Urban Unrestricted	7	-
Dane	2030	NB	5-10	8.3	Urban Unrestricted	61	8
Dane	2030	NB	10-15	11.4	Urban Unrestricted	314	37
Dane	2030	NB	15-20	17.7	Urban Unrestricted	1441	134
Dane	2030	NB	20-25	23.4	Urban Unrestricted	5014	524
Dane	2030	NB	25-30	27.3	Urban Unrestricted	11729	1298
Dane	2030	NB	30-35	33.1	Urban Unrestricted	157826	14051
Dane	2030	NB	35-40	37.7	Urban Unrestricted	328452	27571
Dane	2030	NB	40-45	41.1	Urban Unrestricted	92281	7604
Dane	2030	NB	45-50	47.0	Urban Unrestricted	132897	14374
Dane	2030	NB	50-55	53.2	Urban Unrestricted	41108	4651
Dane	2030	NB	55-60	56.9	Urban Unrestricted	21129	3108
Dane	2030	NB	60-65	-	Urban Unrestricted	-	-
Dane	2030	NB	65-70	-	Urban Unrestricted	-	-
Dane	2030	NB	70-75	-	Urban Unrestricted	-	-
Dane	2030	NB	75-80	-	Urban Unrestricted	-	-
Dane	2030	NB	0-5	-	Rural Restricted	-	-
Dane	2030	NB	5-10	-	Rural Restricted	-	-
Dane	2030	NB	10-15	-	Rural Restricted	-	-
Dane	2030	NB	15-20	-	Rural Restricted	-	-
Dane	2030	NB	20-25	-	Rural Restricted	-	-
Dane	2030	NB	25-30	-	Rural Restricted	-	-
Dane	2030	NB	30-35	-	Rural Restricted	-	-
Dane	2030	NB	35-40	-	Rural Restricted	-	-
Dane	2030	NB	40-45	-	Rural Restricted	-	-
Dane	2030	NB	45-50	45.9	Rural Restricted	9112	1535
Dane	2030	NB	50-55	53.4	Rural Restricted	72832	9086
Dane	2030	NB	55-60	-	Rural Restricted	-	-
Dane	2030	NB	60-65	-	Rural Restricted	-	-
Dane	2030	NB	65-70	70.0	Rural Restricted	180159	15402
Dane	2030	NB	70-75	-	Rural Restricted	-	-
Dane	2030	NB	75-80	-	Rural Restricted	-	-
Dane	2030	NB	0-5	-	Rural Unrestricted	-	-
Dane	2030	NB	5-10	-	Rural Unrestricted	-	-
Dane	2030	NB	10-15	-	Rural Unrestricted	-	-
Dane	2030	NB	15-20	-	Rural Unrestricted	-	-
Dane	2030	NB	20-25	20.7	Rural Unrestricted	44	2
Dane	2030	NB	25-30	-	Rural Unrestricted	-	-
Dane	2030	NB	30-35	-	Rural Unrestricted	-	-
Dane	2030	NB	35-40	39.8	Rural Unrestricted	12300	435
Dane	2030	NB	40-45	43.3	Rural Unrestricted	13038	720
Dane	2030	NB	45-50	48.8	Rural Unrestricted	106773	4470
Dane	2030	NB	50-55	51.8	Rural Unrestricted	64659	4168
Dane	2030	NB	55-60	-	Rural Unrestricted	-	-
Dane	2030	NB	60-65	-	Rural Unrestricted	-	-
Dane	2030	NB	65-70	-	Rural Unrestricted	-	-
Dane	2030	NB	70-75	-	Rural Unrestricted	-	-
Dane	2030	NB	75-80	-	Rural Unrestricted	-	-
Dane	2030	B	0-5	-	Urban Restricted	-	-
Dane	2030	B	5-10	9.4	Urban Restricted	2	-
Dane	2030	B	10-15	13.8	Urban Restricted	75	5
Dane	2030	B	15-20	16.6	Urban Restricted	31	3
Dane	2030	B	20-25	20.3	Urban Restricted	377	24
Dane	2030	B	25-30	28.9	Urban Restricted	34372	2760
Dane	2030	B	30-35	32.8	Urban Restricted	9896	905
Dane	2030	B	35-40	37.4	Urban Restricted	49095	4091
Dane	2030	B	40-45	41.7	Urban Restricted	13021	726
Dane	2030	B	45-50	49.3	Urban Restricted	4894	306

County	Year	Scenario	Speed Range (mph)	Average Speed (mph)	Road Type	Auto Daily VMT	Truck Daily VMT
Dane	2030	B	50-55	54.8	Urban Restricted	24646	2725
Dane	2030	B	55-60	60.0	Urban Restricted	106877	15190
Dane	2030	B	60-65	64.9	Urban Restricted	298286	34421
Dane	2030	B	65-70	70.0	Urban Restricted	1298410	154727
Dane	2030	B	70-75	-	Urban Restricted	-	-
Dane	2030	B	75-80	-	Urban Restricted	-	-
Dane	2030	B	0-5	4.5	Urban Unrestricted	7	-
Dane	2030	B	5-10	8.4	Urban Unrestricted	55	7
Dane	2030	B	10-15	11.7	Urban Unrestricted	308	36
Dane	2030	B	15-20	17.6	Urban Unrestricted	994	88
Dane	2030	B	20-25	23.6	Urban Unrestricted	5984	744
Dane	2030	B	25-30	27.7	Urban Unrestricted	14341	1581
Dane	2030	B	30-35	33.3	Urban Unrestricted	143025	13061
Dane	2030	B	35-40	37.9	Urban Unrestricted	322237	27521
Dane	2030	B	40-45	41.2	Urban Unrestricted	73511	5742
Dane	2030	B	45-50	47.1	Urban Unrestricted	97636	10570
Dane	2030	B	50-55	53.3	Urban Unrestricted	40759	4550
Dane	2030	B	55-60	56.9	Urban Unrestricted	20599	2857
Dane	2030	B	60-65	-	Urban Unrestricted	-	-
Dane	2030	B	65-70	55.1	Urban Unrestricted	113	7
Dane	2030	B	70-75	-	Urban Unrestricted	-	-
Dane	2030	B	75-80	-	Urban Unrestricted	-	-
Dane	2030	B	0-5	-	Rural Restricted	-	-
Dane	2030	B	5-10	-	Rural Restricted	-	-
Dane	2030	B	10-15	-	Rural Restricted	-	-
Dane	2030	B	15-20	-	Rural Restricted	-	-
Dane	2030	B	20-25	-	Rural Restricted	-	-
Dane	2030	B	25-30	-	Rural Restricted	-	-
Dane	2030	B	30-35	-	Rural Restricted	-	-
Dane	2030	B	35-40	-	Rural Restricted	-	-
Dane	2030	B	40-45	-	Rural Restricted	-	-
Dane	2030	B	45-50	-	Rural Restricted	-	-
Dane	2030	B	50-55	52.8	Rural Restricted	66913	8011
Dane	2030	B	55-60	60.0	Rural Restricted	10788	789
Dane	2030	B	60-65	65.0	Rural Restricted	6779	522
Dane	2030	B	65-70	70.0	Rural Restricted	185085	15830
Dane	2030	B	70-75	-	Rural Restricted	-	-
Dane	2030	B	75-80	-	Rural Restricted	-	-
Dane	2030	B	0-5	-	Rural Unrestricted	-	-
Dane	2030	B	5-10	-	Rural Unrestricted	-	-
Dane	2030	B	10-15	-	Rural Unrestricted	-	-
Dane	2030	B	15-20	-	Rural Unrestricted	-	-
Dane	2030	B	20-25	20.7	Rural Unrestricted	43	2
Dane	2030	B	25-30	-	Rural Unrestricted	-	-
Dane	2030	B	30-35	-	Rural Unrestricted	-	-
Dane	2030	B	35-40	39.9	Rural Unrestricted	10009	338
Dane	2030	B	40-45	43.5	Rural Unrestricted	11083	573
Dane	2030	B	45-50	48.9	Rural Unrestricted	104365	4375
Dane	2030	B	50-55	52.4	Rural Unrestricted	57812	3737
Dane	2030	B	55-60	-	Rural Unrestricted	-	-
Dane	2030	B	60-65	-	Rural Unrestricted	-	-
Dane	2030	B	65-70	-	Rural Unrestricted	-	-
Dane	2030	B	70-75	-	Rural Unrestricted	-	-
Dane	2030	B	75-80	-	Rural Unrestricted	-	-
Dane	2060	NB	0-5	-	Urban Restricted	-	-
Dane	2060	NB	5-10	9.4	Urban Restricted	5	-
Dane	2060	NB	10-15	13.8	Urban Restricted	114	10
Dane	2060	NB	15-20	15.5	Urban Restricted	426	49
Dane	2060	NB	20-25	21.2	Urban Restricted	8458	1315
Dane	2060	NB	25-30	28.8	Urban Restricted	47066	4463
Dane	2060	NB	30-35	32.2	Urban Restricted	18057	1967
Dane	2060	NB	35-40	36.8	Urban Restricted	45958	4430
Dane	2060	NB	40-45	41.6	Urban Restricted	11296	713
Dane	2060	NB	45-50	-	Urban Restricted	-	-
Dane	2060	NB	50-55	52.2	Urban Restricted	257	37
Dane	2060	NB	55-60	56.9	Urban Restricted	8150	1419
Dane	2060	NB	60-65	64.1	Urban Restricted	562690	75281
Dane	2060	NB	65-70	68.9	Urban Restricted	1435724	188442
Dane	2060	NB	70-75	-	Urban Restricted	-	-
Dane	2060	NB	75-80	-	Urban Restricted	-	-

County	Year	Scenario	Speed Range (mph)	Average Speed (mph)	Road Type	Auto Daily VMT	Truck Daily VMT
Dane	2060	NB	0-5	4.5	Urban Unrestricted	9	1
Dane	2060	NB	5-10	8.1	Urban Unrestricted	158	18
Dane	2060	NB	10-15	12.1	Urban Unrestricted	430	54
Dane	2060	NB	15-20	16.7	Urban Unrestricted	1859	191
Dane	2060	NB	20-25	23.1	Urban Unrestricted	11658	1436
Dane	2060	NB	25-30	27.6	Urban Unrestricted	31959	3293
Dane	2060	NB	30-35	32.8	Urban Unrestricted	298171	30606
Dane	2060	NB	35-40	37.4	Urban Unrestricted	431809	39603
Dane	2060	NB	40-45	42.3	Urban Unrestricted	125010	13580
Dane	2060	NB	45-50	47.2	Urban Unrestricted	133320	15034
Dane	2060	NB	50-55	52.6	Urban Unrestricted	37634	4735
Dane	2060	NB	55-60	56.7	Urban Unrestricted	30484	5069
Dane	2060	NB	60-65	-	Urban Unrestricted	-	-
Dane	2060	NB	65-70	-	Urban Unrestricted	-	-
Dane	2060	NB	70-75	-	Urban Unrestricted	-	-
Dane	2060	NB	75-80	-	Urban Unrestricted	-	-
Dane	2060	NB	0-5	-	Rural Restricted	-	-
Dane	2060	NB	5-10	-	Rural Restricted	-	-
Dane	2060	NB	10-15	-	Rural Restricted	-	-
Dane	2060	NB	15-20	-	Rural Restricted	-	-
Dane	2060	NB	20-25	-	Rural Restricted	-	-
Dane	2060	NB	25-30	-	Rural Restricted	-	-
Dane	2060	NB	30-35	-	Rural Restricted	-	-
Dane	2060	NB	35-40	38.2	Rural Restricted	7147	1299
Dane	2060	NB	40-45	40.5	Rural Restricted	881	146
Dane	2060	NB	45-50	47.9	Rural Restricted	40809	7486
Dane	2060	NB	50-55	53.8	Rural Restricted	54602	5962
Dane	2060	NB	55-60	-	Rural Restricted	-	-
Dane	2060	NB	60-65	-	Rural Restricted	-	-
Dane	2060	NB	65-70	70.0	Rural Restricted	200907	18549
Dane	2060	NB	70-75	-	Rural Restricted	-	-
Dane	2060	NB	75-80	-	Rural Restricted	-	-
Dane	2060	NB	0-5	-	Rural Unrestricted	-	-
Dane	2060	NB	5-10	-	Rural Unrestricted	-	-
Dane	2060	NB	10-15	-	Rural Unrestricted	-	-
Dane	2060	NB	15-20	-	Rural Unrestricted	-	-
Dane	2060	NB	20-25	20.3	Rural Unrestricted	73	3
Dane	2060	NB	25-30	-	Rural Unrestricted	-	-
Dane	2060	NB	30-35	-	Rural Unrestricted	-	-
Dane	2060	NB	35-40	39.7	Rural Unrestricted	19655	925
Dane	2060	NB	40-45	42.2	Rural Unrestricted	21471	1232
Dane	2060	NB	45-50	48.4	Rural Unrestricted	210066	13399
Dane	2060	NB	50-55	51.2	Rural Unrestricted	35294	2135
Dane	2060	NB	55-60	-	Rural Unrestricted	-	-
Dane	2060	NB	60-65	-	Rural Unrestricted	-	-
Dane	2060	NB	65-70	-	Rural Unrestricted	-	-
Dane	2060	NB	70-75	-	Rural Unrestricted	-	-
Dane	2060	NB	75-80	-	Rural Unrestricted	-	-
Dane	2060	B	0-5	-	Urban Restricted	-	-
Dane	2060	B	5-10	9.6	Urban Restricted	8	1
Dane	2060	B	10-15	13.9	Urban Restricted	103	8
Dane	2060	B	15-20	14.9	Urban Restricted	369	30
Dane	2060	B	20-25	21.2	Urban Restricted	4769	567
Dane	2060	B	25-30	28.4	Urban Restricted	53134	4877
Dane	2060	B	30-35	33.5	Urban Restricted	15026	1551
Dane	2060	B	35-40	37.1	Urban Restricted	53327	5053
Dane	2060	B	40-45	41.3	Urban Restricted	17007	1151
Dane	2060	B	45-50	49.7	Urban Restricted	7167	576
Dane	2060	B	50-55	53.7	Urban Restricted	38281	4903
Dane	2060	B	55-60	59.8	Urban Restricted	147664	22759
Dane	2060	B	60-65	64.2	Urban Restricted	379860	48555
Dane	2060	B	65-70	69.7	Urban Restricted	1678718	217191
Dane	2060	B	70-75	-	Urban Restricted	-	-
Dane	2060	B	75-80	-	Urban Restricted	-	-
Dane	2060	B	0-5	4.5	Urban Unrestricted	8	1
Dane	2060	B	5-10	8.3	Urban Unrestricted	147	16
Dane	2060	B	10-15	12.2	Urban Unrestricted	415	53
Dane	2060	B	15-20	17.8	Urban Unrestricted	1952	215
Dane	2060	B	20-25	23.5	Urban Unrestricted	11621	1570
Dane	2060	B	25-30	27.5	Urban Unrestricted	31565	3199

County	Year	Scenario	Speed Range (mph)	Average Speed (mph)	Road Type	Auto Daily VMT	Truck Daily VMT
Dane	2060	B	30-35	32.9	Urban Unrestricted	262330	25453
Dane	2060	B	35-40	37.7	Urban Unrestricted	422565	39125
Dane	2060	B	40-45	41.8	Urban Unrestricted	79766	8107
Dane	2060	B	45-50	46.8	Urban Unrestricted	113619	12526
Dane	2060	B	50-55	52.3	Urban Unrestricted	47775	5491
Dane	2060	B	55-60	56.8	Urban Unrestricted	28739	4435
Dane	2060	B	60-65	-	Urban Unrestricted	-	-
Dane	2060	B	65-70	53.8	Urban Unrestricted	146	11
Dane	2060	B	70-75	-	Urban Unrestricted	-	-
Dane	2060	B	75-80	-	Urban Unrestricted	-	-
Dane	2060	B	0-5	-	Rural Restricted	-	-
Dane	2060	B	5-10	-	Rural Restricted	-	-
Dane	2060	B	10-15	-	Rural Restricted	-	-
Dane	2060	B	15-20	-	Rural Restricted	-	-
Dane	2060	B	20-25	-	Rural Restricted	-	-
Dane	2060	B	25-30	-	Rural Restricted	-	-
Dane	2060	B	30-35	-	Rural Restricted	-	-
Dane	2060	B	35-40	-	Rural Restricted	-	-
Dane	2060	B	40-45	42.4	Rural Restricted	24068	4569
Dane	2060	B	45-50	48.0	Rural Restricted	19034	3237
Dane	2060	B	50-55	54.1	Rural Restricted	45980	4288
Dane	2060	B	55-60	60.0	Rural Restricted	14927	1275
Dane	2060	B	60-65	65.0	Rural Restricted	8949	777
Dane	2060	B	65-70	70.0	Rural Restricted	216371	19891
Dane	2060	B	70-75	-	Rural Restricted	-	-
Dane	2060	B	75-80	-	Rural Restricted	-	-
Dane	2060	B	0-5	-	Rural Unrestricted	-	-
Dane	2060	B	5-10	-	Rural Unrestricted	-	-
Dane	2060	B	10-15	-	Rural Unrestricted	-	-
Dane	2060	B	15-20	-	Rural Unrestricted	-	-
Dane	2060	B	20-25	20.5	Rural Unrestricted	63	3
Dane	2060	B	25-30	-	Rural Unrestricted	-	-
Dane	2060	B	30-35	-	Rural Unrestricted	-	-
Dane	2060	B	35-40	39.7	Rural Unrestricted	17117	766
Dane	2060	B	40-45	42.9	Rural Unrestricted	20394	1182
Dane	2060	B	45-50	48.4	Rural Unrestricted	150788	7866
Dane	2060	B	50-55	51.2	Rural Unrestricted	79783	6295
Dane	2060	B	55-60	-	Rural Unrestricted	-	-
Dane	2060	B	60-65	-	Rural Unrestricted	-	-
Dane	2060	B	65-70	-	Rural Unrestricted	-	-
Dane	2060	B	70-75	-	Rural Unrestricted	-	-
Dane	2060	B	75-80	-	Rural Unrestricted	-	-
Other Counties	2023	EC	0-5	-	Rural Unrestricted	-	-
Other Counties	2023	EC	5-10	-	Rural Unrestricted	-	-
Other Counties	2023	EC	10-15	-	Rural Unrestricted	-	-
Other Counties	2023	EC	15-20	-	Rural Unrestricted	-	-
Other Counties	2023	EC	20-25	-	Rural Unrestricted	-	-
Other Counties	2023	EC	25-30	-	Rural Unrestricted	-	-
Other Counties	2023	EC	30-35	-	Rural Unrestricted	-	-
Other Counties	2023	EC	35-40	40.0	Rural Unrestricted	16312	876
Other Counties	2023	EC	40-45	44.8	Rural Unrestricted	144157	14878
Other Counties	2023	EC	45-50	49.6	Rural Unrestricted	105761	10593
Other Counties	2023	EC	50-55	54.2	Rural Unrestricted	73160	21694
Other Counties	2023	EC	55-60	-	Rural Unrestricted	-	-
Other Counties	2023	EC	60-65	-	Rural Unrestricted	-	-
Other Counties	2023	EC	65-70	-	Rural Unrestricted	-	-
Other Counties	2023	EC	70-75	-	Rural Unrestricted	-	-
Other Counties	2023	EC	75-80	-	Rural Unrestricted	-	-
Other Counties	2023	EC	0-5	-	Urban Unrestricted	-	-
Other Counties	2023	EC	5-10	-	Urban Unrestricted	-	-
Other Counties	2023	EC	10-15	-	Urban Unrestricted	-	-
Other Counties	2023	EC	15-20	-	Urban Unrestricted	-	-
Other Counties	2023	EC	20-25	25.0	Urban Unrestricted	112	8
Other Counties	2023	EC	25-30	30.0	Urban Unrestricted	2099	121
Other Counties	2023	EC	30-35	34.1	Urban Unrestricted	47153	2305
Other Counties	2023	EC	35-40	37.6	Urban Unrestricted	33109	2668
Other Counties	2023	EC	40-45	45.0	Urban Unrestricted	446	138
Other Counties	2023	EC	45-50	-	Urban Unrestricted	-	-
Other Counties	2023	EC	50-55	-	Urban Unrestricted	-	-
Other Counties	2023	EC	55-60	-	Urban Unrestricted	-	-

County	Year	Scenario	Speed Range (mph)	Average Speed (mph)	Road Type	Auto Daily VMT	Truck Daily VMT
Other Counties	2023	EC	60-65	-	Urban Unrestricted	-	-
Other Counties	2023	EC	65-70	-	Urban Unrestricted	-	-
Other Counties	2023	EC	70-75	-	Urban Unrestricted	-	-
Other Counties	2023	EC	75-80	-	Urban Unrestricted	-	-
Other Counties	2023	EC	0-5	-	Rural Restricted	-	-
Other Counties	2023	EC	5-10	-	Rural Restricted	-	-
Other Counties	2023	EC	10-15	-	Rural Restricted	-	-
Other Counties	2023	EC	15-20	-	Rural Restricted	-	-
Other Counties	2023	EC	20-25	-	Rural Restricted	-	-
Other Counties	2023	EC	25-30	-	Rural Restricted	-	-
Other Counties	2023	EC	30-35	34.9	Rural Restricted	14339	1888
Other Counties	2023	EC	35-40	-	Rural Restricted	-	-
Other Counties	2023	EC	40-45	-	Rural Restricted	-	-
Other Counties	2023	EC	45-50	-	Rural Restricted	-	-
Other Counties	2023	EC	50-55	-	Rural Restricted	-	-
Other Counties	2023	EC	55-60	-	Rural Restricted	-	-
Other Counties	2023	EC	60-65	-	Rural Restricted	-	-
Other Counties	2023	EC	65-70	68.8	Rural Restricted	483913	334515
Other Counties	2023	EC	70-75	-	Rural Restricted	-	-
Other Counties	2023	EC	75-80	-	Rural Restricted	-	-
Other Counties	2023	EC	0-5	-	Urban Restricted	-	-
Other Counties	2023	EC	5-10	-	Urban Restricted	-	-
Other Counties	2023	EC	10-15	-	Urban Restricted	-	-
Other Counties	2023	EC	15-20	-	Urban Restricted	-	-
Other Counties	2023	EC	20-25	-	Urban Restricted	-	-
Other Counties	2023	EC	25-30	-	Urban Restricted	-	-
Other Counties	2023	EC	30-35	33.1	Urban Restricted	16047	1394
Other Counties	2023	EC	35-40	-	Urban Restricted	-	-
Other Counties	2023	EC	40-45	-	Urban Restricted	-	-
Other Counties	2023	EC	45-50	-	Urban Restricted	-	-
Other Counties	2023	EC	50-55	-	Urban Restricted	-	-
Other Counties	2023	EC	55-60	-	Urban Restricted	-	-
Other Counties	2023	EC	60-65	-	Urban Restricted	-	-
Other Counties	2023	EC	65-70	68.5	Urban Restricted	433476	394177
Other Counties	2023	EC	70-75	-	Urban Restricted	-	-
Other Counties	2023	EC	75-80	-	Urban Restricted	-	-
Other Counties	2030	NB	0-5	-	Rural Unrestricted	-	-
Other Counties	2030	NB	5-10	-	Rural Unrestricted	-	-
Other Counties	2030	NB	10-15	-	Rural Unrestricted	-	-
Other Counties	2030	NB	15-20	-	Rural Unrestricted	-	-
Other Counties	2030	NB	20-25	-	Rural Unrestricted	-	-
Other Counties	2030	NB	25-30	-	Rural Unrestricted	-	-
Other Counties	2030	NB	30-35	-	Rural Unrestricted	-	-
Other Counties	2030	NB	35-40	40.0	Rural Unrestricted	17412	963
Other Counties	2030	NB	40-45	44.7	Rural Unrestricted	157490	16912
Other Counties	2030	NB	45-50	49.5	Rural Unrestricted	116692	12571
Other Counties	2030	NB	50-55	54.0	Rural Unrestricted	75115	25039
Other Counties	2030	NB	55-60	-	Rural Unrestricted	-	-
Other Counties	2030	NB	60-65	-	Rural Unrestricted	-	-
Other Counties	2030	NB	65-70	-	Rural Unrestricted	-	-
Other Counties	2030	NB	70-75	-	Rural Unrestricted	-	-
Other Counties	2030	NB	75-80	-	Rural Unrestricted	-	-
Other Counties	2030	NB	0-5	-	Urban Unrestricted	-	-
Other Counties	2030	NB	5-10	-	Urban Unrestricted	-	-
Other Counties	2030	NB	10-15	-	Urban Unrestricted	-	-
Other Counties	2030	NB	15-20	-	Urban Unrestricted	-	-
Other Counties	2030	NB	20-25	25.0	Urban Unrestricted	119	8
Other Counties	2030	NB	25-30	30.0	Urban Unrestricted	2182	130
Other Counties	2030	NB	30-35	33.9	Urban Unrestricted	60287	3890
Other Counties	2030	NB	35-40	37.8	Urban Unrestricted	27771	1917
Other Counties	2030	NB	40-45	45.0	Urban Unrestricted	474	168
Other Counties	2030	NB	45-50	-	Urban Unrestricted	-	-
Other Counties	2030	NB	50-55	-	Urban Unrestricted	-	-
Other Counties	2030	NB	55-60	-	Urban Unrestricted	-	-
Other Counties	2030	NB	60-65	-	Urban Unrestricted	-	-
Other Counties	2030	NB	65-70	-	Urban Unrestricted	-	-
Other Counties	2030	NB	70-75	-	Urban Unrestricted	-	-
Other Counties	2030	NB	75-80	-	Urban Unrestricted	-	-
Other Counties	2030	NB	0-5	-	Rural Restricted	-	-
Other Counties	2030	NB	5-10	-	Rural Restricted	-	-

County	Year	Scenario	Speed Range (mph)	Average Speed (mph)	Road Type	Auto Daily VMT	Truck Daily VMT
Other Counties	2030	NB	10-15	-	Rural Restricted	-	-
Other Counties	2030	NB	15-20	-	Rural Restricted	-	-
Other Counties	2030	NB	20-25	-	Rural Restricted	-	-
Other Counties	2030	NB	25-30	-	Rural Restricted	-	-
Other Counties	2030	NB	30-35	34.9	Rural Restricted	14954	2087
Other Counties	2030	NB	35-40	-	Rural Restricted	-	-
Other Counties	2030	NB	40-45	-	Rural Restricted	-	-
Other Counties	2030	NB	45-50	-	Rural Restricted	-	-
Other Counties	2030	NB	50-55	-	Rural Restricted	-	-
Other Counties	2030	NB	55-60	-	Rural Restricted	-	-
Other Counties	2030	NB	60-65	62.7	Rural Restricted	24717	30511
Other Counties	2030	NB	65-70	67.6	Rural Restricted	460384	350546
Other Counties	2030	NB	70-75	-	Rural Restricted	-	-
Other Counties	2030	NB	75-80	-	Rural Restricted	-	-
Other Counties	2030	NB	0-5	-	Urban Restricted	-	-
Other Counties	2030	NB	5-10	-	Urban Restricted	-	-
Other Counties	2030	NB	10-15	-	Urban Restricted	-	-
Other Counties	2030	NB	15-20	-	Urban Restricted	-	-
Other Counties	2030	NB	20-25	-	Urban Restricted	-	-
Other Counties	2030	NB	25-30	29.7	Urban Restricted	2245	140
Other Counties	2030	NB	30-35	33.7	Urban Restricted	14297	1325
Other Counties	2030	NB	35-40	-	Urban Restricted	-	-
Other Counties	2030	NB	40-45	-	Urban Restricted	-	-
Other Counties	2030	NB	45-50	-	Urban Restricted	-	-
Other Counties	2030	NB	50-55	-	Urban Restricted	-	-
Other Counties	2030	NB	55-60	-	Urban Restricted	-	-
Other Counties	2030	NB	60-65	-	Urban Restricted	-	-
Other Counties	2030	NB	65-70	66.4	Urban Restricted	434610	453099
Other Counties	2030	NB	70-75	-	Urban Restricted	-	-
Other Counties	2030	NB	75-80	-	Urban Restricted	-	-
Other Counties	2030	B	0-5	-	Rural Unrestricted	-	-
Other Counties	2030	B	5-10	-	Rural Unrestricted	-	-
Other Counties	2030	B	10-15	-	Rural Unrestricted	-	-
Other Counties	2030	B	15-20	-	Rural Unrestricted	-	-
Other Counties	2030	B	20-25	-	Rural Unrestricted	-	-
Other Counties	2030	B	25-30	-	Rural Unrestricted	-	-
Other Counties	2030	B	30-35	-	Rural Unrestricted	-	-
Other Counties	2030	B	35-40	40.0	Rural Unrestricted	16325	900
Other Counties	2030	B	40-45	44.8	Rural Unrestricted	150083	16845
Other Counties	2030	B	45-50	49.6	Rural Unrestricted	105279	11103
Other Counties	2030	B	50-55	54.0	Rural Unrestricted	74786	24868
Other Counties	2030	B	55-60	-	Rural Unrestricted	-	-
Other Counties	2030	B	60-65	-	Rural Unrestricted	-	-
Other Counties	2030	B	65-70	-	Rural Unrestricted	-	-
Other Counties	2030	B	70-75	-	Rural Unrestricted	-	-
Other Counties	2030	B	75-80	-	Rural Unrestricted	-	-
Other Counties	2030	B	0-5	-	Urban Unrestricted	-	-
Other Counties	2030	B	5-10	-	Urban Unrestricted	-	-
Other Counties	2030	B	10-15	-	Urban Unrestricted	-	-
Other Counties	2030	B	15-20	-	Urban Unrestricted	-	-
Other Counties	2030	B	20-25	25.0	Urban Unrestricted	119	8
Other Counties	2030	B	25-30	29.8	Urban Unrestricted	1427	156
Other Counties	2030	B	30-35	34.1	Urban Unrestricted	55756	3550
Other Counties	2030	B	35-40	37.9	Urban Unrestricted	25342	1658
Other Counties	2030	B	40-45	44.2	Urban Unrestricted	3827	422
Other Counties	2030	B	45-50	49.4	Urban Unrestricted	6254	590
Other Counties	2030	B	50-55	-	Urban Unrestricted	-	-
Other Counties	2030	B	55-60	-	Urban Unrestricted	-	-
Other Counties	2030	B	60-65	-	Urban Unrestricted	-	-
Other Counties	2030	B	65-70	-	Urban Unrestricted	-	-
Other Counties	2030	B	70-75	-	Urban Unrestricted	-	-
Other Counties	2030	B	75-80	-	Urban Unrestricted	-	-
Other Counties	2030	B	0-5	-	Rural Restricted	-	-
Other Counties	2030	B	5-10	-	Rural Restricted	-	-
Other Counties	2030	B	10-15	-	Rural Restricted	-	-
Other Counties	2030	B	15-20	-	Rural Restricted	-	-
Other Counties	2030	B	20-25	-	Rural Restricted	-	-
Other Counties	2030	B	25-30	-	Rural Restricted	-	-
Other Counties	2030	B	30-35	34.9	Rural Restricted	15443	2172
Other Counties	2030	B	35-40	-	Rural Restricted	-	-

County	Year	Scenario	Speed Range (mph)	Average Speed (mph)	Road Type	Auto Daily VMT	Truck Daily VMT
Other Counties	2030	B	40-45	-	Rural Restricted	-	-
Other Counties	2030	B	45-50	-	Rural Restricted	-	-
Other Counties	2030	B	50-55	-	Rural Restricted	-	-
Other Counties	2030	B	55-60	-	Rural Restricted	-	-
Other Counties	2030	B	60-65	-	Rural Restricted	-	-
Other Counties	2030	B	65-70	69.7	Rural Restricted	486839	378811
Other Counties	2030	B	70-75	-	Rural Restricted	-	-
Other Counties	2030	B	75-80	-	Rural Restricted	-	-
Other Counties	2030	B	0-5	-	Urban Restricted	-	-
Other Counties	2030	B	5-10	-	Urban Restricted	-	-
Other Counties	2030	B	10-15	-	Urban Restricted	-	-
Other Counties	2030	B	15-20	-	Urban Restricted	-	-
Other Counties	2030	B	20-25	-	Urban Restricted	-	-
Other Counties	2030	B	25-30	-	Urban Restricted	-	-
Other Counties	2030	B	30-35	33.4	Urban Restricted	19271	1796
Other Counties	2030	B	35-40	35.0	Urban Restricted	655	59
Other Counties	2030	B	40-45	-	Urban Restricted	-	-
Other Counties	2030	B	45-50	-	Urban Restricted	-	-
Other Counties	2030	B	50-55	-	Urban Restricted	-	-
Other Counties	2030	B	55-60	-	Urban Restricted	-	-
Other Counties	2030	B	60-65	-	Urban Restricted	-	-
Other Counties	2030	B	65-70	69.9	Urban Restricted	446596	464487
Other Counties	2030	B	70-75	-	Urban Restricted	-	-
Other Counties	2030	B	75-80	-	Urban Restricted	-	-
Other Counties	2060	NB	0-5	-	Rural Unrestricted	-	-
Other Counties	2060	NB	5-10	-	Rural Unrestricted	-	-
Other Counties	2060	NB	10-15	-	Rural Unrestricted	-	-
Other Counties	2060	NB	15-20	-	Rural Unrestricted	-	-
Other Counties	2060	NB	20-25	-	Rural Unrestricted	-	-
Other Counties	2060	NB	25-30	-	Rural Unrestricted	-	-
Other Counties	2060	NB	30-35	-	Rural Unrestricted	-	-
Other Counties	2060	NB	35-40	39.9	Rural Unrestricted	35787	3878
Other Counties	2060	NB	40-45	44.3	Rural Unrestricted	208091	21390
Other Counties	2060	NB	45-50	48.9	Rural Unrestricted	151571	21031
Other Counties	2060	NB	50-55	52.4	Rural Unrestricted	81063	53028
Other Counties	2060	NB	55-60	-	Rural Unrestricted	-	-
Other Counties	2060	NB	60-65	-	Rural Unrestricted	-	-
Other Counties	2060	NB	65-70	-	Rural Unrestricted	-	-
Other Counties	2060	NB	70-75	-	Rural Unrestricted	-	-
Other Counties	2060	NB	75-80	-	Rural Unrestricted	-	-
Other Counties	2060	NB	0-5	-	Urban Unrestricted	-	-
Other Counties	2060	NB	5-10	-	Urban Unrestricted	-	-
Other Counties	2060	NB	10-15	-	Urban Unrestricted	-	-
Other Counties	2060	NB	15-20	-	Urban Unrestricted	-	-
Other Counties	2060	NB	20-25	25.0	Urban Unrestricted	188	15
Other Counties	2060	NB	25-30	28.1	Urban Unrestricted	16034	791
Other Counties	2060	NB	30-35	33.7	Urban Unrestricted	71483	5962
Other Counties	2060	NB	35-40	37.4	Urban Unrestricted	38139	2904
Other Counties	2060	NB	40-45	45.0	Urban Unrestricted	637	868
Other Counties	2060	NB	45-50	-	Urban Unrestricted	-	-
Other Counties	2060	NB	50-55	-	Urban Unrestricted	-	-
Other Counties	2060	NB	55-60	-	Urban Unrestricted	-	-
Other Counties	2060	NB	60-65	-	Urban Unrestricted	-	-
Other Counties	2060	NB	65-70	-	Urban Unrestricted	-	-
Other Counties	2060	NB	70-75	-	Urban Unrestricted	-	-
Other Counties	2060	NB	75-80	-	Urban Unrestricted	-	-
Other Counties	2060	NB	0-5	-	Rural Restricted	-	-
Other Counties	2060	NB	5-10	-	Rural Restricted	-	-
Other Counties	2060	NB	10-15	-	Rural Restricted	-	-
Other Counties	2060	NB	15-20	-	Rural Restricted	-	-
Other Counties	2060	NB	20-25	-	Rural Restricted	-	-
Other Counties	2060	NB	25-30	-	Rural Restricted	-	-
Other Counties	2060	NB	30-35	34.6	Rural Restricted	17332	3081
Other Counties	2060	NB	35-40	-	Rural Restricted	-	-
Other Counties	2060	NB	40-45	-	Rural Restricted	-	-
Other Counties	2060	NB	45-50	49.1	Rural Restricted	17415	25073
Other Counties	2060	NB	50-55	51.4	Rural Restricted	7299	9351
Other Counties	2060	NB	55-60	56.9	Rural Restricted	111980	94113
Other Counties	2060	NB	60-65	-	Rural Restricted	250735	237374
Other Counties	2060	NB	65-70	-	Rural Restricted	114681	88464

County	Year	Scenario	Speed Range (mph)	Average Speed (mph)	Road Type	Auto Daily VMT	Truck Daily VMT
Other Counties	2060	NB	70-75	-	Rural Restricted	-	-
Other Counties	2060	NB	75-80	-	Rural Restricted	-	-
Other Counties	2060	NB	0-5	-	Urban Restricted	-	-
Other Counties	2060	NB	5-10	-	Urban Restricted	-	-
Other Counties	2060	NB	10-15	-	Urban Restricted	-	-
Other Counties	2060	NB	15-20	-	Urban Restricted	-	-
Other Counties	2060	NB	20-25	-	Urban Restricted	-	-
Other Counties	2060	NB	25-30	26.3	Urban Restricted	2627	200
Other Counties	2060	NB	30-35	33.6	Urban Restricted	15915	1664
Other Counties	2060	NB	35-40	-	Urban Restricted	-	-
Other Counties	2060	NB	40-45	-	Urban Restricted	-	-
Other Counties	2060	NB	45-50	-	Urban Restricted	-	-
Other Counties	2060	NB	50-55	-	Urban Restricted	-	-
Other Counties	2060	NB	55-60	59.8	Urban Restricted	49401	50477
Other Counties	2060	NB	60-65	60.7	Urban Restricted	349077	364385
Other Counties	2060	NB	65-70	66.4	Urban Restricted	67477	98364
Other Counties	2060	NB	70-75	-	Urban Restricted	-	-
Other Counties	2060	NB	75-80	-	Urban Restricted	-	-
Other Counties	2060	B	0-5	-	Rural Unrestricted	-	-
Other Counties	2060	B	5-10	-	Rural Unrestricted	-	-
Other Counties	2060	B	10-15	-	Rural Unrestricted	-	-
Other Counties	2060	B	15-20	-	Rural Unrestricted	-	-
Other Counties	2060	B	20-25	-	Rural Unrestricted	-	-
Other Counties	2060	B	25-30	-	Rural Unrestricted	-	-
Other Counties	2060	B	30-35	-	Rural Unrestricted	-	-
Other Counties	2060	B	35-40	39.9	Rural Unrestricted	49809	5545
Other Counties	2060	B	40-45	44.6	Rural Unrestricted	189048	27460
Other Counties	2060	B	45-50	49.3	Rural Unrestricted	125959	16936
Other Counties	2060	B	50-55	53.1	Rural Unrestricted	82683	41101
Other Counties	2060	B	55-60	-	Rural Unrestricted	-	-
Other Counties	2060	B	60-65	-	Rural Unrestricted	-	-
Other Counties	2060	B	65-70	-	Rural Unrestricted	-	-
Other Counties	2060	B	70-75	-	Rural Unrestricted	-	-
Other Counties	2060	B	75-80	-	Rural Unrestricted	-	-
Other Counties	2060	B	0-5	-	Urban Unrestricted	-	-
Other Counties	2060	B	5-10	-	Urban Unrestricted	-	-
Other Counties	2060	B	10-15	-	Urban Unrestricted	-	-
Other Counties	2060	B	15-20	-	Urban Unrestricted	-	-
Other Counties	2060	B	20-25	25.0	Urban Unrestricted	188	15
Other Counties	2060	B	25-30	28.5	Urban Unrestricted	12507	1492
Other Counties	2060	B	30-35	33.9	Urban Unrestricted	64958	4578
Other Counties	2060	B	35-40	37.7	Urban Unrestricted	31605	2386
Other Counties	2060	B	40-45	43.7	Urban Unrestricted	4544	1142
Other Counties	2060	B	45-50	48.8	Urban Unrestricted	7471	1010
Other Counties	2060	B	50-55	-	Urban Unrestricted	-	-
Other Counties	2060	B	55-60	-	Urban Unrestricted	-	-
Other Counties	2060	B	60-65	-	Urban Unrestricted	-	-
Other Counties	2060	B	65-70	-	Urban Unrestricted	-	-
Other Counties	2060	B	70-75	-	Urban Unrestricted	-	-
Other Counties	2060	B	75-80	-	Urban Unrestricted	-	-
Other Counties	2060	B	0-5	-	Rural Restricted	-	-
Other Counties	2060	B	5-10	-	Rural Restricted	-	-
Other Counties	2060	B	10-15	-	Rural Restricted	-	-
Other Counties	2060	B	15-20	-	Rural Restricted	-	-
Other Counties	2060	B	20-25	-	Rural Restricted	-	-
Other Counties	2060	B	25-30	-	Rural Restricted	-	-
Other Counties	2060	B	30-35	34.8	Rural Restricted	18603	3157
Other Counties	2060	B	35-40	-	Rural Restricted	-	-
Other Counties	2060	B	40-45	-	Rural Restricted	-	-
Other Counties	2060	B	45-50	-	Rural Restricted	-	-
Other Counties	2060	B	50-55	53.6	Rural Restricted	4072	8308
Other Counties	2060	B	55-60	-	Rural Restricted	-	-
Other Counties	2060	B	60-65	-	Rural Restricted	-	-
Other Counties	2060	B	65-70	69.5	Rural Restricted	522528	465740
Other Counties	2060	B	70-75	-	Rural Restricted	-	-
Other Counties	2060	B	75-80	-	Rural Restricted	-	-
Other Counties	2060	B	0-5	-	Urban Restricted	-	-
Other Counties	2060	B	5-10	-	Urban Restricted	-	-
Other Counties	2060	B	10-15	-	Urban Restricted	-	-
Other Counties	2060	B	15-20	-	Urban Restricted	-	-

County	Year	Scenario	Speed Range (mph)	Average Speed (mph)	Road Type	Auto Daily VMT	Truck Daily VMT
Other Counties	2060	B	20-25	-	Urban Restricted	-	-
Other Counties	2060	B	25-30	28.6	Urban Restricted	3732	394
Other Counties	2060	B	30-35	34.2	Urban Restricted	19051	2053
Other Counties	2060	B	35-40	35.0	Urban Restricted	219	8
Other Counties	2060	B	40-45	-	Urban Restricted	-	-
Other Counties	2060	B	45-50	-	Urban Restricted	-	-
Other Counties	2060	B	50-55	-	Urban Restricted	-	-
Other Counties	2060	B	55-60	-	Urban Restricted	-	-
Other Counties	2060	B	60-65	-	Urban Restricted	-	-
Other Counties	2060	B	65-70	69.5	Urban Restricted	518734	555350
Other Counties	2060	B	70-75	-	Urban Restricted	-	-
Other Counties	2060	B	75-80	-	Urban Restricted	-	-

Notes:

B = Build

EC = Existing Condition

NB = No-Build