I-94 Connected & Automated Vehicle (CAV) Corridor Project Emission Burdens

AM PEAK DATA

Eastbound - AM Peak

2023 Existing		2035 No Build		2035 Build			2045 No Build		2045 Build		
Average Speed	VMT	Average Speed	VMT	Average Speed	VMT (GP)	VMT (Managed Lane)	Average Speed	VMT	Average Speed	VMT (GP)	VMT (Managed Lane)
62	52,228,619	62	54,788,405	64.7	44,404,511	9,784,531	61.8	56,590,18	64.7	39,362,892	15,670,296

Westbound - AM Peak

2023 Existing		2035 No Build		2035 Build			2045 No Build		2045 Build		
Average Speed	VMT	Average Speed	VMT	Average Speed	VMT (GP)	VMT (Managed Lane)	Average Speed	VMT	Average Speed	VMT (GP)	VMT (Managed Lane)
63.9	45,883,644	64.1	48,141,920	66.6	38,985,651	8,706,999	64	49,704,47	66.2	37,061,227	12,808,394

PM PEAK DATA

Eastbound - PM Peak

2023 Existing		2035 No Build		2035 Build			2045 No Build		2045 Build		
Average Speed	VMT	Average Speed	VMT	Average Speed	VMT (GP)	VMT (Managed Lane)	Average Speed	VMT	Average Speed	VMT (GP)	VMT (Managed Lane)
62.1	52,845,465	62.3	55,498,905	65.8	40,599,804	10,298,255	62.1	57,281,414	65.1	38,830,219	14,896,614

Westbound - PM Peak

2023 Existing		2035 No Build		2035 Build			2045 No Build		2045 Build		
Average Speed	VMT	Average Speed	VMT	Average Speed	VMT (GP)	VMT (Managed Lane)	Average Speed	VMT	Average Speed	VMT (GP)	VMT (Managed Lane)
63.9	45,818,086	63.8	47,712,828	66.5	39,402,500	8,589,350	63.7	49,030,751	65.5	38,532,228	13,286,298

	2023 AM PEAK	2035 AM PEAK		2045 AM PEAK	
	Existing	No Build	Build	No Build	Build
CO_2e	39086.0	34271.4	32842.68453	32816.3	30457.1321
PM_{10}	3.5	1.8	1.559975123	1.6	1.368143867
$PM_{2.5}$	2.2	0.7	0.580782037	0.4	0.375371834
CO	238.8	152.2	159.8221697	116.8	117.6512984
NOx	76.2	22.1	19.10246289	15.1	11.67390478

	2023 PM PEAK	2035 PM PEAK		2045 PM PEAK	
	Existing	No Build	Build	No Build	Build
CO_2e	39303.0	34361.6	31985.13216	32817.9	30688.82519
PM_{10}	3.5	1.8	1.47673926	1.6	1.377151743
$PM_{2.5}$	2.3	0.7	0.558118054	0.4	0.378279406
CO	240.2	152.6	159.3021336	116.7	118.5306736
NOx	76.6	22.2	18.50104963	15.1	11.81095944

Daily Peak Hours Emission Burdens (Metric Tons)

	2023	2035		2045	
	Existing	No Build	Build	No Build	Build
CO_2e	78,389	68,633	64,828	65,634	61,146

0.05544231

MOVES EMISSION RATES (Grams/Mile)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
		2023					2035					2045				
	Speed	CO_2e	PM_{10}	$PM_{2.5}$	CO	Nox	CO_2e	PM_{10}	$PM_{2.5}$	CO	Nox	CO_2e	PM_{10}	$PM_{2.5}$	CO	Nox
GP Lanes	60	390.136	0.036741	0.02254	2.35493	0.744178	326.655	0.019596	0.006596	1.41743	0.204585	303.173	0.017094	0.004272	1.04683	0.133711
	61	392.28	0.036314	0.022663	2.36792	0.753266	328.246	0.019005	0.006545	1.42872	0.207465	304.549	0.016493	0.004213	1.05674	0.136082
	62	394.583	0.035932	0.022783	2.38395	0.763187	330.008	0.01844	0.006501	1.44217	0.210713	306.1	0.015915	0.004157	1.06904	0.138783
	63	396.814	0.035608	0.023108	2.39947	0.772793	331.715	0.017939	0.006465	1.45519	0.213857	307.602	0.015401	0.00411	1.08097	0.141399
	64	402.702	0.03485	0.022953	2.49186	0.792406	336.314	0.016833	0.006383	1.52116	0.220004	311.724	0.01427	0.004005	1.13215	0.146438
	65	402.702	0.03485	0.02316	2.49186	0.792406	336.314	0.016833	0.006383	1.52116	0.220004	311.724	0.01427	0.004005	1.13215	0.146438
	66	407.383	0.034429	0.023274	2.60799	0.803245	340.051	0.016236	0.006344	1.5998	0.22311	315.133	0.013657	0.003953	1.18918	0.148901
	67	411.152	0.034161	0.023402	2.6992	0.813294	343.028	0.015801	0.006324	1.66135	0.226037	317.83	0.013208	0.003921	1.2342	0.151242
	68	414.377	0.033981	0.01423	2.77567	0.822787	345.551	0.015461	0.006316	1.71281	0.228832	320.104	0.012854	0.003901	1.27208	0.153488

		2023					2035					2045				
	Speed	CO_2e	PM_{10}	$PM_{2.5}$	CO	Nox	CO_2e	PM_{10}	$PM_{2.5}$	CO	Nox	CO_2e	PM_{10}	$PM_{2.5}$	CO	Nox
Managed Lanes	60						237.681	0.013744	0.00305	1.33716	0.026816	222.438	0.013478	0.002807	0.934655	0.013325
	61						238.444	0.013186	0.002992	1.34501	0.026996	223.155	0.012917	0.002747	0.940413	0.013388
	62						239.182	0.012646	0.002936	1.35261	0.027171	223.849	0.012374	0.002688	0.945983	0.013448
	63						239.896	0.01216	0.002887	1.35998	0.027341	224.521	0.011886	0.002637	0.951378	0.013506
	64						242.76	0.011094	0.002783	1.41992	0.02783	227.206	0.010811	0.002525	0.993407	0.013673
	65						242.76	0.011094	0.002783	1.41992	0.02783	227.206	0.010811	0.002525	0.993407	0.013673
	66						245.847	0.010507	0.002733	1.50117	0.028255	230.097	0.010218	0.00247	1.04987	0.013817
	67						248.118	0.010099	0.002705	1.56354	0.028573	232.22	0.009804	0.002437	1.09312	0.013903
	68						249.915	0.009794	0.00269	1.61484	0.028829	233.898	0.009494	0.002417	1.12862	0.013956

MOVES Project Level run for GP and Managed Lanes in Wayne County, MI

GP distribution based on RoadType4 VMT mix from National Scale Wayne County regional run

Managed lanes distribution based on RoadType4 VMT mix from National Scale Wayne County regional run, including only source types 11,21,31,32

See file "Wayne_VMT_out.xlsx" for regional output

MOVES EMISSION RATES (Grams/Mile)

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
		2023						2035					2045				
	Speed	CO_2e	PM_{10}	$PM_{2.5}$	CO	Nox		CO_2e	PM_{10}	$PM_{2.5}$	CO	Nox	CO_2e	PM_{10}	$PM_{2.5}$	CO	Nox
GP Lanes	60	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1
	61	2	2	2	2	2		2	2	2	2	2	2	2	2	2	2
	62	3	3	3	3	3		3	3	3	3	3	3	3	3	3	3
	63	4	4	4	4	4		4	4	4	4	4	4	4	4	4	4
	64	5	5	5	5	5		5	5	5	5	5	5	5	5	5	5
	65	6	6	6	6	6		6	6	6	6	6	6	6	6	6	6
	66	7	7	7	7	7		7	7	7	7	7	7	7	7	7	7
	67	8	8	8	8	8		8	8	8	8	8	8	8	8	8	8
	68	9	9	9	9	9		9	9	9	9	9	9	9	9	9	9

		2023					2035					2045				
	Speed	CO_2e	PM_{10}	$PM_{2.5}$	CO	Nox	CO_2e	PM_{10}	$PM_{2.5}$	CO	Nox	CO_2e	PM_{10}	$PM_{2.5}$	CO	Nox
Managed Lanes	60						1	1	1	1	1	1	1	1	1	1
	61						2	2	2	2	2	2	2	2	2	2
	62						3	3	3	3	3	3	3	3	3	3
	63						4	4	4	4	4	4	4	4	4	4
	64						5	5	5	5	5	5	5	5	5	5
	65						6	6	6	6	6	6	6	6	6	6
	66						7	7	7	7	7	7	7	7	7	7
	67						8	8	8	8	8	8	8	8	8	8
	68						9	9	9	9	9	9	9	9	9	9

MOVES County Level run for Wayne County

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	2035	17844576963
End year	2045	17064901533

Construction Delay, Additional Emissions

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

Construction start year	2035
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		15,523,133	236,314,894
Construction Delay		0	0
Total		15,523,133	236,314,894

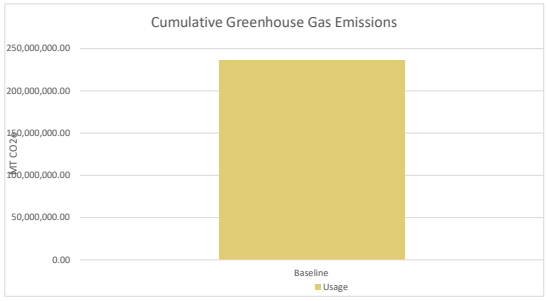
Mitigated Results

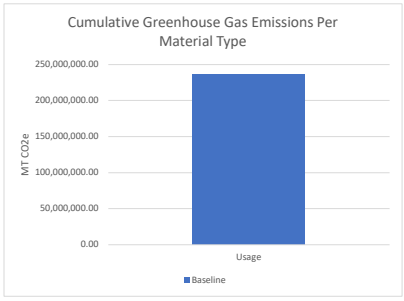
Annualized Energy Use	Annualized Greenhouse Gas Emissions
Baseline	Baseline

10 year Annualized Results	Energy use (mmBTU)	GHG emissions (MT CO2e)
Usage Emissions	1,552,313	23,631,489
Materials subtotal	-	-
Transportation subtotal	-	-
Construction subtotal	-	-
Usage subtotal	1,552,313	23,631,489
Total	1,552,313	23,631,489

Results - Charts

Show	Cumulative Greenhouse Gas Emissions	Units	MT CO2e





No mitigations are available for Vehicle Ops.

	Cumulative Greenhouse Gas Emissions
	MT CO2e
	Baseline
Usage	236,314,894
Total	**236,314,894**

	Cumulative Greenhouse Gas Emissions Per Material Type
	MT CO2e
	Baseline
Usage	236,314,894
Total	**236,314,894**

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	2035	16855232339
End year	2045	15897948894

Construction Delay, Additional Emissions

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

Construction start year	2035
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		14,564,296	221,718,138
Construction Delay		0	0
Total		14,564,296	221,718,138

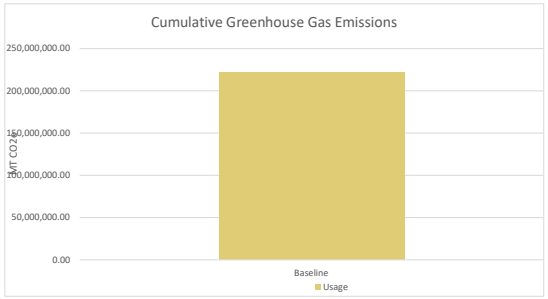
Mitigated Results

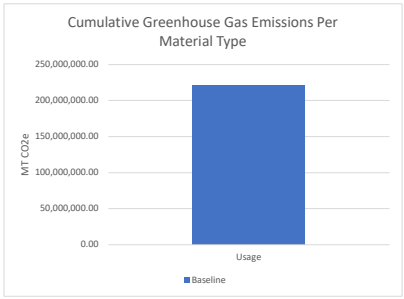
Annualized Energy Use	Annualized Greenhouse Gas Emissions
Baseline	Baseline

10 year Annualized Results	Energy use (mmBTU)	GHG emissions (MT CO2e)
Usage Emissions	1,456,430	22,171,814
Materials subtotal	-	-
Transportation subtotal	-	-
Construction subtotal	-	-
Usage subtotal	1,456,430	22,171,814
Total	1,456,430	22,171,814

Results - Charts

Show	Cumulative Greenhouse Gas Emissions	Units	MT CO2e





No mitigations are available for Vehicle Ops.

	Cumulative Greenhouse Gas Emissions
	MT CO2e
	Baseline
Usage	221,718,138
Total	**221,718,138**

	Cumulative Greenhouse Gas Emissions Per Material Type
	MT CO2e
	Baseline
Usage	221,718,138
Total	**221,718,138**

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	52	52	104
Total lane miles	0	0	0

Roadway Projects

		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	Lane Widening (equivalent lane miles)	0.0	0.0	0.0	0.0	52.0	0.0	0.0

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

Baseline Energy Use and GHG Emissions

	Construction		
Material Energy Use and Emissions		Energy use (mmBTU)	GHG emissions (MT CO2e)
Aggregate		6,325	328
Bitumen (Asphalt Binder)		3,512	272

O&M Roadway Rehabilitation		
	Energy use (mmBTU)	GHG emissions (MT CO2e)
	0	0
	0	0

Cement		4,387	818		0	0
Steel		5,377	441		0	0
Water		2	0		0	0
Total		19,602	1,858		0	0

	Construction			O&M Roadway Rehabilitation		
Materials Transportation		Energy use (mmBTU)	GHG emissions (MT CO2e)		Energy use (mmBTU)	GHG emissions (MT CO2e)
Transportation fuel (DGEs)		4,720	380		0	0
Total		4,720	380		0	0

	Construction			O&M Roadway Rehabilitation		
Construction Process		Energy use (mmBTU)	GHG emissions (MT CO2e)		Energy use (mmBTU)	GHG emissions (MT CO2e)
Electricity (kWh)		0	0		0	0
Construction fuel (DGEs)		24,997	2,014		0	0
Total		24,997	2,014		0	0

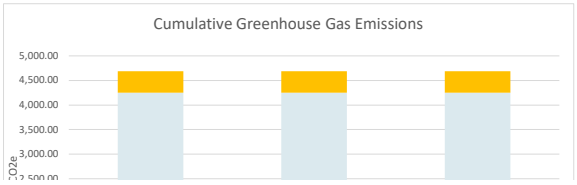
Operations and Maintenance		Energy use (mmBTU)	GHG emissions (MT CO2e)
Electricity (kWh)		-	-
Maintenance fuel (DGEs)		5,411.7	435.7
Water		-	-
Total		5,411.7	435.7

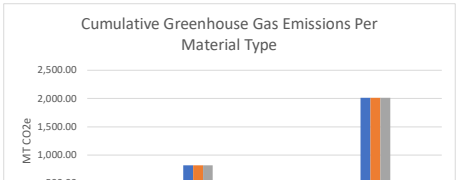
Mitigated Results

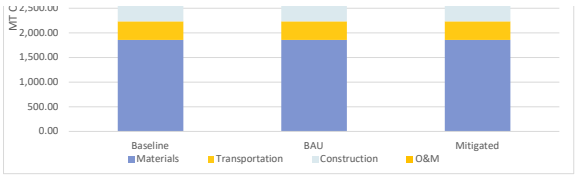
	Construction						O&M Roadway Rehabilitation					
	Annualized Energy Use			Annualized Greenhouse Gas Emissions			Annualized Energy Use			Annualized Greenhouse Gas Emissions		
10 year Annualized Results	Baseline Energy use (mmBTU)	BAU Energy use (mmBTU)	Mitigated Energy use (mmBTU)	Baseline GHG emissions (MT CO2e)	BAU GHG emissions (MT CO2e)	Mitigated GHG emissions (MT CO2e)	Baseline Energy use (mmBTU)	BAU Energy use (mmBTU)	Mitigated Energy use (mmBTU)	Baseline GHG emissions (MT CO2e)	BAU GHG emissions (MT CO2e)	Mitigated GHG emissions (MT CO2e)
Aggregate	632	632	632	33	33	33	-	-	-	-	-	-
Bitumen (Asphalt Binder)	351	351	351	27	27	27	-	-	-	-	-	-
Cement	439	439	439	82	82	82	-	-	-	-	-	-
Steel	538	538	538	44	44	44	-	-	-	-	-	-
Water	0	0	0	0	0	0	-	-	-	-	-	-
Transportation Fuel	472	472	472	38	38	38	-	-	-	-	-	-
Construction Fuel	2,500	2,500	2,500	201	201	201	-	-	-	-	-	-
O&M fuel (DGEs)	541	541	541	44	44	44	-	-	-	-	-	-
Materials subtotal	1,960	1,960	1,960	186	186	186						
Transportation subtotal	472	472	472	38	38	38						
Construction subtotal	2,500	2,500	2,500	201	201	201						
Operations & Maintenance subtotal	541	541	541	44	44	44						
Total	5,473	5,473	5,473	469	469	469						

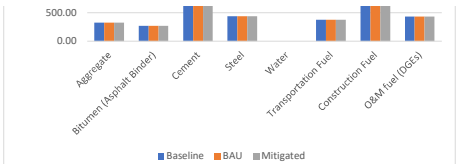
Results - Charts

Show	Cumulative Greenhouse Gas Emissions	Units	MT CO2e









	Cumulative Greenhouse Gas Emissions		
	MT CO2e	MT CO2e	MT CO2e
	Baseline	BAU	Mitigated
Materials	1,858	1,858	1,858
Transportation	380	380	380
Construction	2,014	2,014	2,014
O&M	436	436	436
Total	**4,688**	**4,688**	**4,688**

	Cumulative Greenhouse Gas Emissions Per Material Type		
	MT CO2e	MT CO2e	MT CO2e
	Baseline	BAU	Mitigated
Aggregate	327.6	327.6	327.6
Bitumen (Asphalt Binder)	272	272	272
Cement	818	818	818
Steel	441	441	441
Water	0	0	0
Transportation Fuel	380	380	380
Construction Fuel	2,014	2,014	2,014
O&M fuel (DGEs)	436	436	436
Total	**4,688**	**4,688**	**4,688**

	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	-	-	-	-	-

Emission Changes			
	Emissions Changes (metric tons)		
Year	CO2	CH4	N2O
2020			
2021			
2022			
2023			
2024			
2025			
2026			
2027			
2028			
2029			
2030			
2031			
2032			
2033			
2034			
2035	4,253		
2036	(1,459,207)		
2037	(1,459,207)		
2038	(1,459,207)		
2039	(1,459,207)		
2040	(1,459,207)		
2041	(1,459,207)		
2042	(1,459,207)		
2043	(1,459,207)		
2044	(1,459,207)		
2045	(1,459,207)		
2046			
2047			
2048			
2049			
2050			
2051			
2052			
2053			
2054			
2055			
2056			
2057			
2058			
2059			
2060			
2061			
2062			
2063			
2064			
2065			
2066			
2067			
2068			
2069			
2070			
2071			
2072			
2073			
2074			
2075			
2076			
2077			
2078			
2079			
2080			
Total	(14,587,816)	-	-

Constant discounting			
Number of years (N)	11		
Discount Rate	2.5%	2.0%	1.5%

Present and Annualized Values of CO2 Emission Changes (millions, 2020$)			
GHG	CO2	CO2	CO2
Discount Rate	2.5%	2.0%	1.5%
Present Value in 2024 (2020$)	-$1,693.78	-$2,830.30	-$4,947.49
Annualized Value (11 Years, 2020$)	-$178.03	-$289.19	-$491.26

Present and Annualized Values of CH4 Emission Changes (millions, 2020$)			
GHG	CH4	CH4	CH4
Discount Rate	2.5%	2.0%	1.5%
Present Value in 2024 (2020$)	$0.00	$0.00	$0.00
Annualized Value (11 Years, 2020$)	$0.00	$0.00	$0.00

Present and Annualized Values of N2O Emission Changes (millions, 2020$)			
GHG	N2O	N2O	N2O
Discount Rate	2.5%	2.0%	1.5%
Present Value in 2024 (2020$)	$0.00	$0.00	$0.00
Annualized Value (11 Years, 2020$)	$0.00	$0.00	$0.00

Total Present and Annualized Values of all GHG Emission Changes (CO2, CH4, and N2O) (millions, 2020$)			
GHG	Total	Total	Total
Discount Rate	2.5%	2.0%	1.5%
Present Value in 2024 (2020$)	**-$1,693.78**	**-$2,830.30**	**-$4,947.49**
Annualized Value (11 Years, 2020$)	**-$178.03**	**-$289.19**	**-$491.26**

Discounted, Monetized Value of Emission Changes, discounted to 2024 (millions, 2020$) - Constant Discounting									
	Discounted, Monetized Value of CO2 Emissions Changes (millions, 2020$)			Discounted, Monetized Value of CH4 Emissions Changes (millions, 2020$)			Discounted, Monetized Value of N2O Emissions Changes (millions, 2020$)		
	Discounted Back to 2024			Discounted Back to 2024			Discounted Back to 2024		
	CO2	CO2	CO2	CH4	CH4	CH4	N2O	N2O	N2O
Year	2.5%	2.0%	1.5%	2.5%	2.0%	1.5%	2.5%	2.0%	1.5%
2020									
2021									
2022									
2023									
2024									
2025									
2026									
2027									
2028									
2029									
2030									
2031									
2032									
2033									
2034									
2035	$0.51	$0.85	$1.47						
2036	-$174.69	-$289.94	-$502.83						
2037	-$173.60	-$288.77	-$501.41						
2038	-$172.46	-$286.43	-$499.92						
2039	-$171.28	-$285.15	-$497.21						
2040	-$170.05	-$283.81	-$495.61						
2041	-$168.78	-$282.41	-$493.95						
2042	-$167.47	-$280.96	-$492.23						
2043	-$166.12	-$279.46	-$490.45						
2044	-$165.64	-$277.91	-$488.62						
2045	-$164.20	-$276.31	-$486.74						
2046									
2047									
2048									
2049									
2050									
2051									
2052									
2053									
2054									
2055									
2056									
2057									
2058									
2059									
2060									
2061									
2062									
2063									
2064									
2065									
2066									
2067									
2068									
2069									
2070									
2071									
2072									
2073									
2074									
2075									
2076									
2077									
2078									
2079									
2080									
Totals	**-$1,693.78**	**-$2,830.30**	**-$4,947.49**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**