# Transportation Improvement Program Greenhouse Gas Assessment and Reporting Guidance

GUIDELINES TO ASSIST METROPOLITAN PLANNING ORGANIZATIONS IN COMPLYING WITH 310 CMR 60.05: GLOBAL WARMING SOLUTIONS ACT REQUIREMENTS FOR TRANSPORTATION

## **PREPARED BY:**

Office of Transportation Planning Sustainable Transportation

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### INTRODUCTION

MassDOT and the Commonwealth's Metropolitan Planning Organizations (MPOs) have been assessing and publishing Transportation Improvement Plans'/State Transportation Improvement Programs' (TIP/STIP) greenhouse gas (GHG) impacts since the 2013-2016 STIP process in an effort to better understand how project programming and funding decisions increase or decrease transportation sector GHG emissions.

In August 2017, the Massachusetts Department of Environmental Protection amended 310 CMR 60.05: Global Warming Solutions Act Requirements for Transportation, a legal reinforcement of the GHG assessment and reporting work that MassDOT and the MPOs have been doing since 2012.

The purpose of this guidance document is to assist MPOs in meeting their regulatory requirements under 310 CMR 60.05 around the assessment and reporting of TIP project GHG impacts. Assessment and reporting outputs will help satisfy two Regulation requirements:

- Assist MPOs in using GHG impacts as an evaluation criterion for project prioritization and assist MPOs in annually evaluating the aggregate GHG impacts of their TIPs.
- Allow MassDOT to annually evaluate the aggregate GHG impact of the STIP.

There are two sections to this guidance document: GHG assessment guidance and reporting guidance. The GHG assessment section will assist MPOs in determining whether a project's GHG impacts should be assessed qualitatively or quantitatively as well as data requirements for different categories of TIP projects. The reporting section presents specific guidelines for formatting and relaying impact data annually through the e-STIP application and the GHG Impact Template.

### **APPLICATION**

This update addresses the transition to the e-STIP application for highway project selection implemented during the 2020-2024 STIP development process and will be used going forward until new updates are necessary. **CMAQ spreadsheets, a GHG Impact Template (modified from the former TIP Template), and a spreadsheet of emissions factors will be sent to MPOs each January for use in that year's development process.** For assistance using the CMAQ spreadsheets and with emissions factors, please contact Derek Krevat, MPO Activities, at <u>Derek.Krevat@dot.state.ma.us</u>, and please copy your MPO liaison as well. For questions about reporting, please contact Shannon Greenwell, Sustainable Transportation, at <u>Shannon.greenwell@dot.state.ma.us</u>.



### **GHG ASSESSMENT GUIDANCE**

This section presents the guidelines MPOs should follow when conducting TIP project GHG assessments as part of their TIP development processes.

#### 1.) All TIP projects are subject to GHG assessment

A GHG assessment should be conducted for each TIP project. Depending on the project type, this will either be a quantitative or qualitative assessment.

#### 2.) All TIP projects should assess impact direction and cause

The direction of the GHG impact (increase, decrease or no impact) for all TIP projects should be determined, as well as the project characteristic that caused the impact (i.e. bicycle and pedestrian improvements, bus replacement, Complete Streets project).

#### 3.) All TIP projects should be considered for a quantitative evaluation

The following guidelines should be used to determine whether or not the GHG impacts of a project should be quantified. Note that this process is not necessary for RTP projects that are included in the statewide model. Each of the project types below corresponds with a CMAQ spreadsheet that can be used to estimate the impacts for quantifiable projects.

- Bicycle and pedestrian infrastructure projects should be quantified when any shared use path is constructed or improved as part of a project.
- Bus replacement projects should be quantified any time a bus is replaced with a model that differs in efficiency.
- New/additional transit service projects should always be quantified as they expand transit options for customers.
- Park and Ride lot projects should be quantified any time the number of parking spaces changes or a new lot is built.
- Traffic operational improvement projects should be quantified any time the improvement is expected to reduce intersection delay.
- Complete Streets projects should be quantified any time bicycle or pedestrian facility construction improvements (or both) are included in the project.
- Alternative fuel vehicle procurements should be quantified when alternative fuel/advanced technology vehicles replace traditional gas or diesel vehicles. This spreadsheet can be used for vehicle types that are not appropriate for the bus replacement spreadsheet.
- Anti-idling strategies spreadsheet should be used when GHG emissions reductions are expected from policies such as limiting idling allowed, incorporating anti-idling



technology into fleets and using LED lights on trucks for the purpose of illuminating worksites.

- Bike sharing projects should be quantified anytime a new project is implemented or capacity is changed on an existing system.
- Induced travel projects should be quantified when roadway capacity is changed through the reduction or addition of lanes.
- Speed reduction programs should be quantified when road speeds are reduced to no less than 55 miles per hour.
- Transit signal priority projects should be quantified anytime this technology is applied at a signal intersection or along a corridor that impacts bus service. It cannot be used for rail technologies.
- Truck stop electrification projects should be quantified anytime a new project is implemented or capacity is added to an existing project.

### 4.) Quantitative assessments should use methodologies provided by MassDOT

After determining a project should be quantified, the CMAQ spreadsheets provided by MassDOT should be used to estimate the impact number using inputs from the project's functional design report.<sup>1</sup> These projects fall under the following categories, each with its own spreadsheet:

- Bicycle and pedestrian infrastructure
- Bus replacement
- New/additional transit service
- Park and Ride lot
- Traffic operational improvement
- Complete Streets projects
- Alternative fuel vehicles
- Anti-idling strategies
- Bike sharing projects
- Induced travel
- Speed reduction programs
- Transit signal priority
- Truck stop electrification

Images of these spreadsheets are shown in the Appendix. For the purpose of this reporting, only the  $CO_2$  figure generated by the CMAQ spreadsheets must be included in the e-STIP or GHG Impact Template.

<sup>&</sup>lt;sup>1</sup> If there is difficulty obtaining the functional design report, MPOs should contact the project sponsor and alert him/her that under this regulation the functional design report is required for quantification before a project is programmed into the TIP.



An example of a project that should be quantified with a CMAQ spreadsheet is the construction of a new rail trail using the bicycle and pedestrian infrastructure CMAQ spreadsheet.

There may be cases where it is appropriate to use more than one spreadsheet for a particular project. For example, if a travel lane is taken away and an on-road bicycle lane is put in its place, it is appropriate to use both the induced travel and Complete Streets spreadsheets. The GHG estimates from both sheets should be added together to represent the total estimated impact of the project. This total estimated impact is entered into the e-STIP or GHG Impact Template.

For projects that appear in the out years of the TIP and do not yet have the inputs for the CMAQ spreadsheets, MPOs should make note of this in the e-STIP or GHG Impact Template and quantify the project in a later TIP when more data is available. Until the data is available for the CMAQ spreadsheets and an estimate can be produced, the project should be considered qualitative.

RTP projects that are included in the statewide travel demand model do not need to be quantified separately. However, if an RTP project is not included in the statewide model, its impact should be assessed and reported using these guidelines. Examples of RTP projects include an interstate ramp construction or a major transit project, such as the Green Line Extension in Somerville.

# 5.) Where MPOs may have the option to quantify projects using alternative methodologies when appropriate

If MPOs have alternative methodologies for quantifying projects, including methodologies for quantifying types of projects not addressed by the MassDOT CMAQ spreadsheets, they may use those methodologies provided that they produce the  $CO_2$  impact data required under the Regulation.

# 6.) Qualitative assessments should use the following methodology for determining impact direction

If a project does not fall into the categories above, the direction of the impact should still be estimated as an increase, decrease or no impact. The table below provides examples of the types of projects that might have a qualitative increase, decrease, or no GHG impact.



Increase	Decrease	No/Negligible Impact
Procuring less efficient buses	Pavement improvement	Bridge maintenance that
than those they replace		does not change the roadway
	Transit marketing or	Utility relocation
	customer experience	
	improvement	
	ITS improvement	Median barrier replacement
	Bicycle rack installation	Visitor center improvement
	Safe Routes to School	Retaining wall replacement
	project	
		Culvert repair
		Bridge replacement
		Highway lighting
		improvement

### **REPORTING GUIDANCE**

Greenhouse gas impact estimates will be reported to MassDOT during each TIP/STIP development cycle through the e-STIP or GHG Impact Template and should be included in both the draft and the final versions of the TIP documents. Both reporting methods include a number of fields related to a project's GHG impact, some of which are drop downs with specific response options. This section will provide guidance on where TIP project GHG impact data should be included in the e-STIP or GHG Impact Template. Completed GHG Impact Templates should be sent to your MassDOT MPO Liaison.

GHG impact re	porting method
e-STIP application (general info tab)	GHG impacts (qualitative or quantitative) for all TIP highway projects
GHG Impact Template	GHG impacts for all quantifiable transit projects

Regardless of the reporting method, there are two data fields required for all projects: "GHG Analysis Type" and "GHG Impact Description."

1.) MPOs should specify analysis type for every project

All projects should be designated as qualitative or quantitative in the "GHG Analysis Type" field.



### 2.) MPOs should specify impact direction and cause for every project

The impact direction of all projects (increase, decrease, or no impact) and the project characteristic that causes the impact (i.e. bicycle and pedestrian improvements, bus replacement, Complete Streets project) should be designated in the "GHG Impact Description" field. If a project calls for the use of more than one CMAQ spreadsheet, the analysis should include the impact direction/cause for the greatest impact.

### 3.) Projects with a quantitative impact

The following guidelines apply to all projects determined to have a quantitative impact and should be followed when entering impact information:

- All GHG reduction numbers should be positive and GHG increase numbers should be negative and reported as kg/year (as generated in the CMAQ spreadsheets).<sup>2</sup> Direction of impact will also be captured in the "GHG Impact Description" field. GHG impact numbers should be entered in the "GHG Impact by the Numbers" field.
- Where a project spans more than one STIP year, a note listing all the STIP years in which the project is programmed should be inserted in the "Additional Description" field.
- Where a project falls under one of the CMAQ spreadsheet categories, but there is not yet enough information to generate an estimate, a note should be included in the "Additional Description" field and the project should be listed as qualitative until an estimate can be produced.

#### 4.) Projects with a qualitative impact

These guidelines should be followed when reporting on projects with a qualitative impact:

- A project should be labeled as qualitative any time a GHG number is not provided, even if the project might be quantified in the future.
- The "GHG CO<sub>2</sub> Impact (kg/yr)" field should be left blank for qualitative projects.

<sup>&</sup>lt;sup>2</sup> For example, a project that would increase emissions by 3,000 kg/year would be reported as -3,000, while a project that would decrease emissions by 3,000 kg/year would be reported as 3,000.



# 5.) GHG impacts of transit TIP projects should be reported through the transit tables of the GHG Impact Template

All projects listed in the transit TIP will be assessed for GHG impacts during the CIP scoring process. MassDOT will provide the relevant CMAQ spreadsheets and emissions factors with the Rail and Transit Division CIP scoring guidance. While the assessment will happen during the CIP process, the impacts of the relevant projects should be reported using the transit tables of the GHG Impact Template.

#### 6.) TIPs should contain a GHG impact estimate appendix

All TIPs should contain GHG impact estimates as an appendix.

# 7.) GHG impacts of all projects added to the TIP via amendments should be evaluated and reported

Any new project, highway or transit, added to the TIP via an amendment should be evaluated for GHG impact and reported MassDOT.<sup>3</sup> Projects for which the GHG impacts have already been evaluated and reported in a different year of the TIP do not need to be resubmitted.

<sup>&</sup>lt;sup>3</sup> Projects awarded under the Community Transit Grant Program will be evaluated and reported in aggregate by MassDOT.



# Appendix: CMAQ Spreadsheet Images

# **BUS REPLACEMENT**

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MPO:						
RTA:						
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Emission Rates in gr	ams	lmile at ass	umed operating	speed of :	18 MPH	
Scenario Compa	riso	'n	Summer VOC	Summer NOx	Winter CO	Summer CO2
			(grams/mile)	(grams/mile)	(grams/mile)	(grams/mile)
Evinin - Madal	_	Model Yea	r			
Existing Model" New Bus Purchase"	=	2016	0.195	0.776	0.383	872.900
HDDV 3	_			U. 776 s emission factors		
'Existing Model' being Ethan.Britland@state. Chan an (P Pana)	.ma.u			land at 857-368-884 0.776		072 000
Change (Buy-Base)	J		0.195	0.776	0.383	872.900
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Revenue miles	X	)eadhead	= fleet miles	l operating days	= fleet miles	
per year		factor	per year	per year	per day	
1,623,050		1.15	1,866,508	301	6,201	
Calculate emissi	ons	change	in kilograms p	er summer day		
Change		rate change	/ 1000	X fleet miles	X seasonal	= change/day
		grams/mile	g/kg	per day	adj factor	in kg
						1 000
Change in S	ue	0.405	1.000	0.001	4 0402	
Change in Summer			1,000	6,201	1.0188	1.232
Change in Summer	NO:	0.776	1,000	6,201	1.0188	4.902
	NO: 0	0.776				
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### **NEW/ADDITIONAL TRANSIT SERVICE**

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TIP YEAR:	2013					
MPO:						
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-						
Summary of Vehic	le Emission Rates	;				
Emission Rates by Vehicle Type						
Auto	2016	20	0.280	0.215	11.340	368.1
Bus*	2016	18	0.195	0.776	0.383	872.9
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Euran Briuand at 857	-308-8840 OF at Etha	n.enuand@state.m	ia.uS			
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		-		1.11		
rson trips (reduced)	-					
169	CIMAQ New Bus Service Air Quality Analysis Worksheet         CIMAQ New Bus Service Air Quality Analysis Worksheet           SHADED BOXES ONLY         ShaDED BOXES ONLY         Image: Cimage: Cim					
Calculate emissions	change from auto	VMT savings:	Daily Auto VMT	X Emission	/ 1000g	= change/day
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Summer VOC			-1 117	0 280	1000	-0.313
Summer NOx						
Winter CO						
Summer CO2			-1,117	368.100	1000	-411.211
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	Total Route	X # of round	= fleet miles	X Emission	/ 1000g	= change/day
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Calculate bus rout Pollutant Summer VOC Summer NOx Winter CO Summer CO2 Add impact of bus Pollutant Summer VOC Summer VOC Summer NOx Winter CO Summer CO2 Calculate net emis	Total Route distance (miles) 12 12 12 12 12 emissions to emi	X # of round trips per day 10 10 10 ssion savings fro	= fleet miles per day 120 120 120 120 m private vehicle ar (seasonally ad change/day	X Emission factor (bus) 0.195 0.776 0.383 872.900 es change/day auto (kg) -0.313 -0.240 -12.668 -411.211 justed) X operating	/ 1000g per kg 1000 1000 1000 + change/day bus or van (kg) 0.023 0.093 0.046 104.748 X seasonal	= change/day in kg 0.023 0.093 0.046 104.748 = change/day (NET) in kg -0.289 -0.147 -12.622 -306.463 = change per
Calculate bus rout Pollutant Summer VOC Summer NOx Winter CO Summer CO2 Add impact of bus Pollutant Summer VOC Summer VOC Summer NOx Winter CO Summer CO2 Calculate net emis Pollutant	Total Route distance (miles) 12 12 12 12 12 emissions to emi	X # of round trips per day 10 10 10 ssion savings fro	= fleet miles per day 120 120 120 120 m private vehicle ar (seasonally ad change/day (NET) in kg	X Emission factor (bus) 0.195 0.776 0.383 872.900 es change/day auto (kg) -0.313 -0.240 -12.668 -411.211 justed) X operating days per year	/ 1000g per kg 1000 1000 1000 + change/day bus or van (kg) 0.023 0.093 0.046 104.748 X seasonal adj factor	= change/day in kg 0.023 0.093 0.046 104.748 = change/day (NET) in kg -0.289 -0.147 -12.622 -306.463 = change per year in kg
Calculate bus rout Pollutant Summer VOC Summer NOx Winter CO Summer CO2 Add impact of bus Pollutant Summer VOC Summer VOC Summer CO2 Calculate net emis Pollutant Summer VOC	Total Route distance (miles) 12 12 12 12 12 emissions to emi	X # of round trips per day 10 10 10 ssion savings fro	= fleet miles per day 120 120 120 120 m private vehicle ar (seasonally ad change/day (NET) in kg -0.289	X Emission factor (bus) 0.195 0.776 0.383 872.900 es change/day auto (kg) -0.313 -0.240 -12.668 -411.211 justed) X operating days per year 250	/ 1000g per kg 1000 1000 1000 + change/day bus or van (kg) 0.023 0.093 0.046 104.748 X seasonal adj factor 1.0188	= change/day in kg 0.023 0.093 0.046 104.748 = change/day (NET) in kg -0.289 -0.147 -12.622 -306.463 = change per year in kg -73.708
Calculate bus rout Pollutant Summer VOC Summer NOx Winter CO Summer CO2 Add impact of bus Pollutant Summer VOC Summer VOC Summer NOx Winter CO Summer CO2 Calculate net emis Pollutant	Total Route distance (miles) 12 12 12 12 12 emissions to emi	X # of round trips per day 10 10 10 ssion savings fro	= fleet miles per day 120 120 120 120 m private vehicle ar (seasonally ad change/day (NET) in kg -0.289 -0.147	X Emission factor (bus) 0.195 0.776 0.383 872.900 es change/day auto (kg) -0.313 -0.240 -12.668 -411.211 justed) X operating days per year 250 250	/ 1000g per kg 1000 1000 1000 + change/day bus or van (kg) 0.023 0.093 0.046 104.748 X seasonal adj factor 1.0188 1.0188	= change/day in kg 0.023 0.093 0.046 104.748 = change/day (NET) in kg -0.289 -0.147 -12.622 -306.463 = change per year in kg -73.708 -37.456



### PARK AND RIDE LOT

TIP YEAR:										
MPO:					_	Municipa	litur			
Project:						напсра	incy.			
Jetails of Pro	nicot								-	
Number of Parki	•			Average	Utilization	n of lots in the	area =		(default	: 85%)
Fotal Number	r of Space	es Utilized	0							
Prior Mode S					-					
Drive alone										
Carpool/Vanpo Walk/Bicycle/Tr										
Future Mode			a the lot							
Carpool/Vanpo			ig the lot		Numbe	r of new buse	es added			buses
Transit					Total or	ne-way dista	nce of bu	sroute		miles
Walk/BicycleTra										
Average Veh Arrivals to the lo		pancy 1.1			_					
Carpools from th		2.6								
Fransit Bus from		55								
Distance to F	<sup>2</sup> rimary En	ployment	Center	mi	les					
verage Pea				35 mp						
Calculated E	xisting Co	nditions								
xisting Drive Al	ione Vehicle	Trips	(Spaces Util	ized * % Driv-	e Alone)					0
Existing Car/Var	npool Vehic	le Trips	(Spaces Util	* % Car/Van	pool) • (Avo	g. Arrival Occ. / .	Avg. Carpoo	l Occ.)		0
Total Existing Ve	ehicle Trips									0
Total Existing	3 VMT		(Total Existi	ng Veh. Trip	s • Distance	to Primary Empl	oyment Cent	er) * 2 trips/	day	0
Calculated F	uture Con	ditions								
uture Carpooli	ng Vehicle 1	frips	(Spaces Util	* % Future C	ar/Vanpool	) * (Avg. Arrival	Occ. / Avg. I	Carpool Oco	.)	0
uture Carpo	oling VMT		(Future Carp	ooling Veh.	Trips * Dista	ance to Primary B	Employment	Center) * 2 t	rips/day	0
uture Transit V	lehicle Trica		(Spaces Us)	* 2 Fubura 7	ransia) • (A-	g. Arrival Occ. /	Ava Trees	Bug Occ. )		0
uture Transit	· · · ·							1		0
						vay distance of b	ous routej - 2	e tripsrasy		U
Aobile 6 E <b>n</b> issi	ion Factors	for estimate	d average	travel spe	ei 35	mph:				
	(	2016	_	2016		2016		2016		
Auto (LDGV)"	( Su	mmer VOC Fac grams/hour		ner NOx Fact grams/hour	or \	//inter CO Facto grams/hour		mer CO2 Fa grams/hour	ctor	
	ì	0.232		0.178		11.060				
	(	2016		2016		2016		2016		
Bus"		mmer VOC Fac		ner NOx Fact	or \	/inter CO Facto		mer CO2 Fa	ctor	
	(	grams/hour 0.115	9	rams/hour		grams/hour 0.196		grams/hour		
HDDV3 E	inter vehicle t	ype used for E	Bus emissio	n factors (F	For exampl	e, HDGV 6 or l	HDDV 2b)			
	and an iDensity	otors for an (	operating sp	eed other t	hat 35 MPf		act Ethan F	Britland at (	357-368-8	840. or at
"If you require 'Au Ethan.Britland@s If the park and ride factors.	state.ma.us. e lot is being :	served by an e	wisting bus :					nter 0.0 for	the 'Bus'	emission
Ethan.Britland@s f the park and ride actors.	state.ma.us. e lot is being :	served by an e <b>age in kilog</b> r	xisting bus :	ay:	i no new se		d, please e	nter 0.0 for er CO Emiss		emission CO2 Emission:
Ethan.Britland@s If the park and ride factors. Calculate net en	state.ma.us. e lot is being : nissions cha	served by an e <b>age ia kilog</b> i VMT	xisting bus : rams per d: VC	<b>ay:</b> )C Emissions ograms/day	i no new se	rvice propose NOx Emissions kilograms/day	d, please e Wint	er CO Emiss ilograms/da	ions	CO2 Emission: kilograms/day
Ethan.Britland@s f the park and ride actors. Calculate net en Existing Conditions	state.ma.us. e lot is being : nissions cha	served by an e <b>age ia kilog</b> VMT 0.0	xisting bus : rams per d: VC	<b>ay:</b> )C Emissions ograms/day 0.000	i no new se	rvice propose NOx Emissions kilograms/day 0.000	d, please e Wint	er CO Emiss ilograms/da 0.000	ions	CO2 Emission: kilograms/day 0.000
Ethan,Britland@s ( the park and ride actors. Calculate net en ( xisting Conditions with Improvements	state.ma.us. e lot is being : nissions cha	served by an e <b>age ia kilog</b> i VMT	xisting bus : rams per d: VC	<b>ay:</b> )C Emissions ograms/day	i no new se	rvice propose NOx Emissions kilograms/day	d, please e Wint	er CO Emiss ilograms/da	ions	CO2 Emission: kilograms/day
than.Britland@s the park and ride actors. Calculate net en ixisting Conditions vith Improvements let Change	state.ma.us. e lot is being : nissions cha	served by an e nge in kilog VMT 0.0 0.0 nge in kilog	wisting bus : rams per da VC kil	ay: OC Emissions ograms/day 0.000 0.000 0.000 ear (seaso	no new se	NOx Emissions kilograms/day 0.000 0.000 <b>0.000</b> sted)	d, please e Wint k	er CO Emiss ilograms/da 0.000 0.000	ions	CO2 Emission: kilograms/day 0.000 0.000
than.Britland@s the park and ride actors. calculate net en xisting Conditions /ith Improvements let Change	state.ma.us. e lot is being : nissions cha	served by an e nge in kilogr VMT 0.0 0.0 nge in kilogr Net change	visting bus : rams per d: VC kil rams per ye Avg. weekd:	ay: DC Emissions ograms/day 0.000 0.000 0.000 ear (seaso ays Sc	no new se	NOx Emissions kilograms/day 0.000 0.000 0.000 sted] Adj. net	d, please e Wint k	er CO Emiss ilograms/da 0.000 0.000	ions	CO2 Emission: kilograms/day 0.000 0.000
ithan.Britland@s the park and ridu actors. Calculate act en ixisting Conditions vith Improvements det Change Calculate act en	state.ma.us. e lot is being : nissions cha	served by an e nge in kilog VMT 0.0 0.0 nge in kilog	visting bus : rams per d vo kil rams per ye Avg. weekda per year	ay: DC Emissions ograms/day 0.000 0.000 0.000 ear (seaso ays Sc	no new se	NOx Emissions kilograms/day 0.000 0.000 ested) Adj. net = in kg p	d, please e Wint k	er CO Emiss ilograms/da 0.000 0.000	ions	CO2 Emission: kilograms/day 0.000 0.000
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Than.Britland@s the park and ride actors. Calculate act en xisting Conditions /ith Improvements let Change Calculate act en OC Emissions IOX Emissions /inter CO Emissions	state.ma.us. e lot is being : nissions cha	served by an a sec in kilog VMT 0.0 0.0 sec in kilog Net change per day (kg) > 0.000 > 0.000 > 0.000 >	xisting bus : rams per d: VC kil rams per ye Avg. weekd: per year 250 250 250	ay: C Emissions ograms/day 0.000 0.000 bar (seasol ays Se X X X X X	ally adju saconal adj. factor 1.0188 0.3812	NOx Emissions kilogram:/day 0.000 0.000 sted] Adj. net = in kg p = ( = (	d, please e Wint k change er year 5.000	er CO Emiss ilograms/da 0.000 0.000	ions	CO2 Emission: kilograms/day 0.000 0.000
than.Britland@s the park and ride actors. Falculate act en virtin Improvements for Change Falculate act en OC Emissions (Vinter CO Emission (Vinter CO Emission OZ Emissions	state.ma.us. e lot is being : missions cha missions cha	served by an e nge in kilog VMT 0.0 0.0 nge in kilog Net change per day (kg) > 0.000 > 0.000 > 0.000 >	wisting bus : rams per d kil rams per year 250 250 250 250 250	ay: OC Emissions ograms/day 0.000 0.000 0.000 ear (seaso ays Se X X X X X X X X	ally adja assonal adj. factor 1.0188 1.0188 0.3812 1.0000	NOx Emissions kilograms/day 0.000 0.000 sted] Adj. net = in kg p = c = c = c = c	d, please e Wint k change er year 0.000	er CO Emiss ilograms/da 0.000 0.000	ions	CO2 Emission: kilograms/day 0.000 0.000
than.Britland@s the park and ride actors. Calcelate act en xisting Conditions fith Improvements let Change alcelate act en OC Emissions (inter CO Emission O2 Emissions calcelate cost e	state.ma.us. e lot is being : missions cha ; missions cha s project ,	served by an a sge in kilog VMT 0.0 0.0 sge in kilog Net change per day (kg) > 0.000 > 0.000 > 0.000 > 0.000 > 5 (first year Adj.	wisting bus : rams per d VC kil rams per year 250 250 250 cost per k not change	ay: ograms/day 0.000 0.000 ear (seasol ays Se X X X X X X X X X X X X X X X X X X X	ally adju assonal adj. factor 1.0188 0.3812 1.0000 ioas redu styar cost	NOx Emissions kilograms/day 0.000 0.000 sted] Adj. net = in kg p = c = c = c = c	d, please e Wint k change er year 5.000	er CO Emiss ilograms/da 0.000 0.000	ions	CO2 Emission: kilograms/day 0.000 0.000
Ethan.Britland@s f the park and ride actors. Calculate act en Existing Conditions With Improvements Wet Change Calculate act en VOC Emissions VOC Emissions VOC Emissions Calculate cost e Ensistion	state.ma.us. e lot is being : missions cha s missions cha effectivenes: Project / Cost /	served by an e nge in kilog VMT 0.0 0.0 nge in kilog Net change per day (kg) > 0.000	xisting bus : rams per d: VC kill rams per y Avg. weekd: per year 250 250 250 250 250 250 cost per k net change kill	ay: C Emissions ograms/day 0.000 0.000 0.000 ar (seaso x X X X X X y G cmiss Pir	ally adju asonal adj. factor 1.0188 1.0188 0.3812 1.0000 iots redu ter kilogram	NOx Emissions kilograms/day 0.000 0.000 sted] Adj. net = in kg p = c = c = c = c	d, please e Wint k change er year 5.000	er CO Emiss ilograms/da 0.000 0.000	ions	CO2 Emission: kilograms/day 0.000 0.000
Ethan.Britland@s i the park and ridd actors. Salculate act es interfections with Improvements et Chaage Calculate act es /OC Emissions JO2 Emissions Calculate ocst e imission /OC Emissions	state.ma.us. e lot is being : missions cha missions cha missions cha seffectivenes. Project Cost /	served by an a nge in kilog VMT 0.0 0.0 nge in kilog Net change per day (kg) > 0.000	xisting bus : rams per d VC kil rams per ycar 250 250 250 cost per k net change kg per ycar 0.000 =	ay: CE Emissions ograms/day 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.0000 0.0000 0.000000	aally adju aally adju asonal adj. factor 1.0188 0.9812 1.0000 itoas redu zt yaar cost er kilogram &DIV/0!	NOx Emissions kilograms/day 0.000 0.000 sted] Adj. net = in kg p = c = c = c = c	d, please e Wint k change er year 5.000	er CO Emiss ilograms/da 0.000 0.000	ions	CO2 Emission: kilograms/day 0.000 0.000
Ethan.Britland@s Ethan.Britland@s Ethe park and ride actors. Calculate net en Existing Conditions Vith Improvements Net Change Calculate net en VOC Emissions VOC Emissions CO2 Emissions Calculate cost e	state.ma.us. e lot is being : missions cha s missions cha effectivenes: Project / Cost /	served by an a nge in kilog VMT 0.0 0.0 nge in kilog Net change per day (kg) > 0.000	xisting bus : rams per d: VC kill rams per y Avg. weekd: per year 250 250 250 250 250 250 cost per k net change kill	ay: DC Emissions ograms/day 0.000 0.000 car (seaso x x x x y g of emiss Fir: p	ally adju asonal adj. factor 1.0188 1.0188 0.3812 1.0000 iots redu ter kilogram	NOx Emissions kilograms/day 0.000 0.000 sted] Adj. net = in kg p = c = c = c = c	d, please e Wint k change er year 5.000	er CO Emiss ilograms/da 0.000 0.000	ions	CO2 Emission: kilograms/day 0.000 0.000



### **COMPLETE STREETS PROJECTS**

				orksneet	for Comple	te Streets	5 Project					rev.	12/31/2014	
_	FILL IN SHADE	D BOXES ON	LY											
	TIP YEAR:													
	MPO:						Municipa	lity:						
	Project:													
	Step 1: Calcula	ate New Wa	lk and Bike	Miles Trave	led:						-			
					, if not proceed	with Step 1:								
								(b)	User Input lank for default)	Default				
Α.	Facility Length (	L):					1.0	Miles	ank for default)	Delaul				
	Types of Improv		emented:				Both	(select Pedestrian	. Bicycle, or Bo	th from list)				
	Service Area R						0.5	Miles		0.5				
	Service Area R						0.25	Miles		0.25				
					1 * 200					0.23				
					L * 2RB = SAB		1	Sq. Miles						
					L * 2RW = SAV	V	0.5	Sq. Miles						
F.	Land Area of N	eighborhoods	s Served (AI	I):			1.0	Sq. Miles						
G.	Population of Ne	eighborhoods	Served (PN	):			10,000	Persons						
H.	Population Dens	ity of Neighb	orhoods Ser	ved (PD):			10,000	Persons/Sq. Mile						
I.	Population Serv	ed by Facility	for Bicycling	g (PB): PD *	SAB = PB		10,000	Persons						
J.	Population Serv	ed by Facility	for Walking	(PW): PD * 9	SAW = PW		5,000	Persons			Default I	lode Share	es by Populatio	on Densi
к.	Trips per Perso	n per Day in S	Service Area	a (T):			4.7	Trips		4.7		>7,500	1,000-7,500	<1,00
L.	Baseline Bicycle	e Mode Share	e in Service /	Area (MSB):			1.7%	Percent			Bicycle	1.7%	0.6%	0.6%
	Baseline Walk N						30.2%	Percent			Walk	30.2%	7.2%	4.7%
					from Improveme	ote (BI):	30.0%	Percent		30.0%		00.270	1.2.70	
			-							7.5%				
					om Improvements	( VVI ).	7.5%	Percent		1.0%				
Ρ.	New Bike Trips	(BT): PB * T	* MSB * BI =	BT			240	1-Way Trips/Day						
Q.	New Walk Trips	(WT): PW *	T * MSW * W	/I = WT			532	1-Way Trips/Day						
R.	Average Bike Ti	rip Length (L	B):				2.3	Miles		2.3				
s.	Average Walk T	rip Length (L	.W):				0.7	Miles		0.7				
т.	New Bike and V	Valk Miles of	Travel (BWN	1):			935	Miles per Day						
	Step 2: Calcula	ate the VMT	Reduction	:										
U.	Prior Drive Mode	e Share of Ne	ew Bike and	Walk Trips (N	ISD):		59.0%	Percent	59%					
v.	VMT Reduced p	er Day (VM	rr): BWM '	MSD = VMTF	र		551	Miles per Day						
w.	VMTR * Operati	ng Days Per	Year		551	* 365 =	201,255	VMTR Per Year						
	If the Vehicle Mi	iles Traveled	Reduction is	known enter	in the box to the	right.		VMTR Per Year						
	Note: A manual													
	Step 3: Emissi Note: Use 35 Mi				r Travel Speed	Speed Used:	35 MPH							
	11010. 030 00 MI		an in average		NING WILL	opeca osea.	55 m 1							
	2016 Auto		2016 Auto	atas	2016 Auto		2016 Auto							
50	immer VOC Fact grams/mile	tor Sur	nmer NOx Fa grams/mile	ICIOF 3	Summer CO Fact grams/mile	ur sum	nmer CO2 Fa grams/mile	CIO						
ļ	0.232		0.178		3.540		368.100			_				
	Step 4: Calcula Summer VOC		ns reduction Summer NO2		summer CO		Adjusted): Summer CO2	•						
Ţ	47.6		36.5	ì	725.8		74,081.9							
	Step 5: Calcula		ectiveness		ost per kg of e		-							
	Emission	Project Cost		Emission Re in kg per yea		First year cos per kilogram	ST							
	Summer VOC		1	47.6	; =	\$0								
	Summer NOx	\$0	1	36.5		\$0								



### BICYCLE AND PEDESTRIAN INFRASTRUCTURE

FILL IN SHADED BOX			for Bicycle						-
	ES UNLT								
TIP YEAR:									-
MPO:					Municipa	ality:			
Project:									
Step 1: Calculate Es									
If VMT reduction per	year is known then	go to Step 2B,	if not proceed	with Step 1 :					
A. Facility Length (L):					1.8	Miles			
B. Service Area Radius	(R):				1.0	Miles	(Default = 1	Mile)	
C. Service Area of Com	munity(ies) (SA): L	* 2R = SA			3.6	Sq. Miles			
D. Total Land Area of Co	ommunity(ies) (T):				25	Sq. Miles			
E. Service Area % of Co	ommunity(ies) Land	Area (LA):	SA / T = LA		14.4%				
F. Total Population of Co	mmunity(ies) (TP):				50,000	Persons			
G. Population Served by		P = P			7,200	Persons			-
H. Total Number of Hous					20,000	НН			-
I. Number of Household	-		H = HS		2,880	НН			-
J. Total Number of Work		· ·			25,000	Persons			-
K. Workers Per househo			•1.		1.25	Persons			-
									-
L. Workers in Service A	rea (WSA): HS*W	rnn = WSA			3,600	Persons			
M. Population Density of	the Service area (P	D): P/SA = P	D		2,000	Persons Per Sq. Mi	le		
N. If the bicycle and ped	estrian commuter m	ode share is k	nown, enter the	percentage a	t the right.	(BMS)	2.5%		-
If not, use US Census					-				
http://www.census.c	ov/programs-surve	ys/acs/quidan	ce/estimates.ht	ml					
O. Bike and Ped. Work U	tilitarian Trips (BWT)	: WSA * BMS	s = BWT		90	One-Way Trips			
P. Bike and Ped. Non-W	ork Utilitarian Trips (I	BNWT): BWT	* 1.7 = BNWT		153	One-Way Trips			
(Latest planning assu Step 2: Calculate th			ian trips to be 1	7 times the wo	ork utilitarian	.)			-
A. ((2 * BWT) + (2 * BNV					437.4	VMTR Per Day			
B. VMTR * Operating Da	•			* 200 =	87,480	VMTR Per Year			_
If the Vehicle Miles Tr Note: A manual entry				right.		VMTR Per Year			-
Step 3: MOVES 2014				M:					
Note: Use 35 MPH as	a default if average	speed is not	known.	Speed Used:	35 MPH				
2016 Passenger	2016 Passeng	er	2016 Passenge	r 20	16 Passeng	jer			-
Summer VOC Factor	Summer NOx Fa		ummer CO Fact		mer CO2 Fa				
grams/mile 0.047	grams/mile 0.163		grams/mile 2.460		grams/mile 378.555				-
Step 4: Calculate er	nissions reduction	_	ams per year		Adjusted):	-			
Summer VOC 4.2	Summer NOx		Summer CO	1	Summer CO:	2			-
4.2	14.5		219.3		33,116.0				-
Step 5: Calculate co					•				
	oject ost	Emission Red in kg per yea		First year cos per kilogram	st				-
Summer VOC	/	4.2		\$0					-
Summer NOx	1	14.5		\$0					
	1	219.3	-	\$0					
Summer CO		219.3	-	<b>3</b> 0					



### TRAFFIC OPERATIONAL IMPROVEMENT

ILL IN STR		) BOX		lysis Work				and I						-		
TIP YEAR:																
MPO:		_	_						Municipa	litur						
		_	_			_			municipa	iity:		_				
Project:																
Step 1: Calo	ula			AM Peak H		Interse										
	_		ft-Tur		Total		Thru		Total		ght-Tu		Total	_	Total	
Street Name	Dir	(Vol 7	PHF	X delay per		+ (Vol 7		X delay =		+ (Vol 7		X delay			approach	
Main St.	NB	6	, ###	veh 22.9	delay = 145		J ###	perveh 22.9 =	delay 8,148 -	40	j 1 ###	perveh 22.9	delay	6 =	delay 17,958	
Main St. Main St.	SB	72	###	12.8			###	12.8 =	2,762		6 ###	12.8		50 = 81 =		
Plain St	EB	352	###		= 20,305		###	54.8 =	11,825		7 ###	10.4		71 =		
Keith Ave	WB	002	###		= 0		###	0.1 =	0.010		###	0.1		0 =	· ·	
									_	Tota	Interse	ection Del	ay/Second	ds =	55,073	
Step 2: Cal	cula	te Exi	sting	PM Peak H	lour Total	Interse	ctior	n Delay in 1	Seconds:							
		Le	ft-Tur	ns	Total		Thru		Total	Ri	ght-Tu	rns	Total		Total	
Street Name	Dir	(Vol 7	PHF	X delay per	= move.	+ (Vol 7	PHF	X delay =	move.	+(Vol 7	PHF	X delay	= move.	=	approach	
			)	veh	delay			per veh	delay			per veh	delay		delay	
Main St.	NB		###	11.9			###	11.9 =	4,397		2 ###	11.9		- 70		
Main St.	SB	195 427	### ###	180.0			### ###	180.0 =	75,221		3 ### ) ###	180.0 10.0		63 = 22 -		
Plain St Keith Ave	EB WB	427	### ###	57.4 0.1	= 25,800 = 0		###	57.4 = 0.1 =	6,888 0		###	10.0		32 = 0 =		
Reitri Ave	WD			0.1	- 0	-		0.1	0				= ay/Second			_
Sten 3: The	SDF	eadel	heet	automatical	llu choose	as the n	الأجم	hour with t	he longe						step in the a	nalvsie
otep of the	- 11			automatical		.s are p			e iongei	inte	Jeou	an deidy	.or the f		step in the a	
Peak Hour (Al	4/PN	Pľ	4			Total Inte	ersec	tion Delay	155,817					+		
Step 4: Cal			-	PM	Peak H		1	ersection			ente:			+		
otep 4. Cal	Juia		ft-Tur		Total	an ru(a	Thru		Total		aht-Tu	rns	Total	+	Total	
Street Name	Dir			X delay per		+ (Vol 7		Xdelay =		+(Vol 7		Xdelay			approach	
			· · · · ]	veh	delay			perveh	delay			perveh	delay		delay	
Main St.	NB	5	###	6.0		+ 351	###		2,232	+ 272	2 ###	6.0		29 =		
Main St.	SB	185	###	4.2	= 810	+ 397	###	4.2 =	1,738	+ 13	3 ###	4.2		57 =	2,605	
Plain St	EB	427	###		= 6,090		###	13.6 =	1,626		1 ###	13.6		27 =	8,444	
Keith Ave	WB	8	###	13.8	= 117	+ 38	###	13.8 =	554		3 ###	13.8		72 =		
										Tota	al Interse	ection Del	ay/Second	tel el	16,484	
					-						_		· ·			
Step 5: Cal	cula	te ve	nicle									h	Dala			
-				-	( Delay in :	seconds		Hours per o		/ Secor	nds per 3600			y in h	ours I day	
- Existing peak	hour	interse	ection	delay	(Delay in : (	seconds 155,817	X	10	)	l Secor	3600		= 4	y in h 32.8		
- Existing peak l Peak hour inte	hour ersec	interse ition de	ection elay wi	delay	(Delayin: ( (	seconds 155,817 16,484	X X	10 10	)	/ Secor			= 4	y in h		
- Existing peak l Peak hour inte	hour ersec	interse ition de	ection elay wi	delay	(Delayin: ( (	seconds 155,817 16,484	X X	10 10	)	l Secor	3600		= 4	y in h 32.8		
- Existing peak l Peak hour inte	hour ersec	interse ition de	ection elay wi emis	delay sion factors	( Delay in : ( ( s for Urba	seconds 155,817 16,484 n Unres	X X	10 10 ed idling s	) ) peed:	Secor   	3600 3600		= 4	y in h 32.8		
- Existing peak l Peak hour inte	hour ersec	interse ition de	ection elay wi emis	delay sion factors 2016	(Delayins ( for Urba stor Surr	seconds 155,817 16,484 <b>n Unres</b> 2016	X X stricto	10 10 ed idling s or Wir	) ) peed: 2016	Secor   	3600 3600 Sumn	2016	= 4 =	y in h 32.8		
Existing peak Peak hour inte <b>Step 6: MO</b>	hour ersec VES	interse tion de <b>2014</b>	ection elay w <b>emis</b> Sun	delay sion factors 2016 nmer VOC Fac grams/hour 0.519	(Delayin: ( s for Urba	seconds 155,817 16,484 <b>n Unres</b> 2016 mer NOx grams/ho	X <b>trict</b> Factor our	10 10 ed idling s or Wir	) ) peed: 2016 hterCOFac	Secor   	3600 3600 Sumn	2016 ner CO2 F	= 4 =	y in h 32.8		
Existing peak Peak hour inte <b>Step 6: MO</b>	hour ersec VES	interse tion de <b>2014</b>	ection elay w <b>emis</b> Sun	delay sion factors 2016 mmer VOC Fac grams/hour <b>0.519</b> ssions chan	( Delayin : ( ( s for Urba etor Sum	seconds 155,817 16,484 <b>n Unres</b> 2016 mer NOx grams/ho <b>###</b> grams p	X X Facto our	10 10 ed idling s or Wir 9 ay:	) peed: 2016 hter CO Fac grams/hour 6.363	I Secor I I I tor	3600 3600 Sumn 9	2016 ner CO2 F jrams/hou #####	= 4 =	y in h 32.8 45.8		
Existing peak Peak hour inte <b>Step 6: MO</b>	hour ersec VES	interse tion de <b>2014</b>	ection elay wi emis Sun temi:	delay 2016 mmer VOC Fac grams/hour <b>0.519</b> ssions chan Delay in	( Delayin : ( s for Urba stor Sum age in kilo Summ	seconds 155,817 16,484 2016 mer NOx grams/ho grams/ho grams p er VOC E	X xtricto Factor our cour cour cour coursion	10 10 ed idling s or Wir 9 ay: ons Summ	) peed: 2016 nter CO Fac grams/hour <b>6.363</b> er NOx Emis	I Secor I I tor	3600 3600 Sumn 9 Winte	2016 ner CO2 F grams/hou eeeee r CO Emis	= 4 =	y in h 32.8 45.8	mer CO2 Emissi	ons
Existing peak Peak hour inte Step 6: MO' Step 7: Cale	hour ersec VES	interse etion de <b>2014</b> te ne	ection elay wi emis Sun temi:	delay sion factors 2016 mmer VOC Fac grams/hour 0.519 ssions char Delay in Hours per Day	( Delayin : ( s for Urba stor Sum age in kilo Summ	seconds 155,817 16,484 <b>n Unres</b> 2016 mer NOx grams/ho <b>set</b> grams/ grams p er VOC E ilograms/	X <b>Atrict</b> Factor our <b>Der d</b> mission day	10 10 ed idling s or Wir 9 ay: ons Summ	) peed: 2016 nter CO Fac grams/hour <b>6.363</b> er NOx Emis lograms/dat	I Secor I I tor	3600 3600 Sumn 9 Winte	2016 ner CO2 F grams/hou eeee r CO Emis ograms/da	= 4 =	y in h 32.8 45.8	mer CO2 Emissi kilograms/day	ons
Existing peak Peak hour inte Step 6: MO' Step 7: Cale Existing Cond	hour ersec VES	interse etion de <b>2014</b> te ne	ection elay wi emis Sun temi:	delay 2016 mmer VOC Fac grams/hour <b>0.519</b> ssions chan Delay in lours per Day 432.8	( Delayin : ( s for Urba stor Sum age in kilo Summ	seconds 155,817 16,484 n Unres 2016 mer NOx grams/ho ser VOC E ilograms/ 0.225	X Atricto Facto our Der d	10 10 ed idling s or Wir 9 ay: ons Summ	) peed: 2016 nter CO Fac grams/hour <b>6.363</b> er NOx Emis lograms/day 0.598	I Secor I I tor	3600 3600 Sumn 9 Winte	2016 ner CO2 F grams/hou ##### r CO Emis ograms/da 2.754	= 4 =	y in h 32.8 45.8	mer CO2 Emissi kilograms/day 1,707.569	ons
Existing peak Peak hour inte Step 6: MO' Step 7: Cale Existing Cond	hour ersec VES cula	interse etion de <b>2014</b> te ne	ection elay wi emis Sun temi:	delay sion factors 2016 mmer VOC Fac grams/hour 0.519 ssions char Delay in Hours per Day	( Delayin : ( s for Urba stor Sum age in kilo Summ	seconds 155,817 16,484 <b>n Unres</b> 2016 mer NOx grams/ho <b>set</b> grams <b>p</b> er VOC E ilograms/ 0.225 0.024	X Facto our mission day	10 10 ed idling s or Wir 9 ay: ons Summ	) ) peed: 2016 iter CO Fac grams/hour <b>6.363</b> er NOx Emis lograms/da; 0.538 0.063	I Secor I I tor	3600 3600 Sumn 9 Winte kik	2016 ner CO2 F grams/hou ettes r CO Emis ograms/da 2.754 0.291	= 4 =	y in h 32.8 45.8	mer CO2 Emissi kilograms/day 1,707.563 180.648	ONS
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### **ALTERNATIVE FUELS VEHICLES**

4	A	В	C	D	E	F	G	Н	1	J	K	L
1		CMAQ Air	Quality An	alysis Wo	orksheet	for Alter	native Fuel	Vehicles				
2		FILL IN SHADE	D BOXES ONL	Y								
, 1		TIP YEAR:										
-								1 - 1 114				
		MPO:					Mu	nicipality:				
3		Project:					1					
0		Step 1: Details	s of Project:									
1												
2	Α.	Existing Fuel Ty	Quality Analysis Worksheet for Alternative Fuel Vehicles       Image: Control of the second sec									
4	в.	Alternative Fuel	Type/Technol	ogy Vehicle:	:			Propar	ne Car	e Car e Car vehicles Miles miles summer CO2 Factor grams/mile 334.689 295.865 Summer CO2		
6	c.	Number of Vehi	icles:					10	Vehicles			
8	n	Annual Miles Tr	aveled ner Ve	hicle:				10.000	Milee			
J .								10,000	mica			
0		•		_								
1		Note: Use 35 M	PH as a defaul	t if average	speed is not	known.	Speed Used:	35 MPH				
2 3			Sum		ator Cur	mar NOv Ea	atar Cu	mmar CO Faa	tor Cur		ator	
3 4			Sum		ictor Sur		ictor Su		tor Sur		Ctor	
4 5		Eviation Eval	Turne Mahiala	-	1			-				
6		-			þ		-					
7					ns in kiloan		ar (Seasonally			290.000	_	
8		step si calcal								Summer CO2	>	
9					1		1				1	
0		Step 4: Calcul	ate cost effe		first vear co		of emissions r			0,00011		
1												
2		Emission	Cost		in ka per ve	ar	per kilogram					
3		Summer VOC		1								
4		Summer NOx		1	2.6	=	\$382,076					
5		Summer CO		1	29.8	=	33527.66441					
6		Summer CO2		1	3,955.4	=						
7												
8												
9												
0												
1												
2												
3												



### **ANTI-IDLING STRATEGIES**

A	В	C	-		F				J	K	L	N
	CMAQ Air	Quality An	alysis W	orksheet	for Anti	-Idling Strateg	gies					
	FILL IN SHADE	D BOXES ONL	Y									
	TIP YEAR:											
	MPO:					Muni	icinality					
						Width	icipanty.					
	Project:											
	Step 1: Details	s of Project:										
								llowed, inco	rporating anti-			
	idling technolog	y into fleets, a	nd using LEC	) lights on tru	cks used to	o illuminate worksite	S.					
										<u>ilt)</u>	Default	
А.	Daily Hours of	dling Reduced	per Vehicle:				1.0	Hours/Da	y			
В.	Number of Veh	icles Affected:					100	Vehicles				
c.	Idling Vehicle F	uel Type:	Analysis Worksheet for Anti-Idling Strategies       Image: Control of the strategies         ONLY       Municipality:         Municipality:       Image: Control of the strategies         Image: Control of the strategies       Image: Control of the strategies         Image: Control of the strategies       Image: Control of the strategies         Image: Control of the strategies       Image: Control of the strategies         Image: Control of the strategies       Image: Control of the strategies       Image: Control of the strategies         Image: Control of the strategies       Image: Control of the strategies       Image: Control of the strategies       Image: Control of the strategies         Image: Control of the strategies       Image: Control of the strategies       Image: Control of the strategies       Image: Control of the strategies       Image: Control of the strategies         Image: Control of the strategies       Image: Control of the strategies       Image: Control of the strategies       Image: Control of the strategies       Image: Control of the strategies       Image: Control of the str									
D.	Days per Year	of Strategy in I	Place:				365	Days/Yr	Days/Yr			
E.	Idling Fuel Cons	sumption Rate:					1.0	Gal/Hr			1.0	
	-		or Idling Ve	ehicles:								
	510p 21 211133	ion ractors r	or running vi	emore a								
		VOC Factor		NOx Factor		CO Factor		CO2 Factor				
		grams/gallon		grams/gallon		grams/gallon		grams/gallon				
	(gr	ams/MCF of CI	IG) (gra	ams/MCF of C	(NG)	(grams/MCF of CNG	) (gra	ms/MCF of C	NG)			
		3.012		2.475		11.259		2584.230				
	Step 3: Calcul	ate emission	is reductio	ns in kilogr	ams per y	/ear:						
		VOC		NOx		CO		CO2				
		109.9						94,324.4				
	Step 4: Calcul	ate cost effe	ctiveness	(first year c	ost per kg	) of emissions re	duced)					
		Project		Emission Re	duction	First year cost						
	Emission	Cost		in kg per yea	ar							
	VOC	\$1,000,000										
	NOx	\$1,000,000	1	90.4	=	\$11,068						
	CO	\$1,000,000	1	411.0	=	\$2,433						
	CO2	\$1,000,000	1	94,324.4	=	\$11						



### **BIKE SHARE PROJECT**

	CMAQ Air (	Quality An	alysis W	orksheet	for Bike	Sharing Pro	oject					
	FILL IN SHADE	-	-									
_	TIP YEAR:											
	MPO:					Mu	nicipality:					
	Project:											
	Step 1: Details	of Project:										
									User Input			
^	Number of Bikes	in Project:					603	Bikes	blank for defau	<u>ult)</u>	<u>Default</u>	
		-										
	Average Bike Ti	·					1.1	Miles			1.1	
c.	Average Numbe	er of Trips per	Bike per Day	/: 			3.7	Trips			3.7	
D.	Bike Sharing Op	erating Days p	per Year:				251	Days			251	
	Step 2: Mode	Substitution	by Bike Sh	aring Projec	:t:							
	Note: A bike sha	aring project w	ould attract	new riders fi	rom different	t modes. Actual s	surveys can d	etermine th	ne extent of the	•		
	transition from o	lifferent mode	s to such pr	ogram. If site	specific dat	ta is unavailable,	use the defau	lts provide	d below.			
E.	Percentage of E	ikes Used Shi	fted from Wa	alking:			25%	Percent			25%	
	Percentage of E						41%	Percent			41%	
	-											
	Percentage of E						5%	Percent			5%	
H.	Percentage of E	Bikes Used Shi	fted from Ca	irs:			12%	Percent			12%	
I.	Percentage of E	Bikes Used Shi	fted from Pri	ivate Bikes:			8%	Percent			8%	
J.	Percentage of E	Bikes Used Shi	fted from Mo	otorcycles:			4%	Percent			4%	
к.	Percentage of E	Rikes Used Shi	fted from Ot	her/New Trip	s:		5%	Percent			5%	
	Total Percentag	e of Bikes Use	d Shifted fro	om Other Mod	es (Must b	e 100%) <sup>.</sup>	100%	Percent				
						e 100 kg.	40	Persons			40	
	Public Transit V	· · · ·	ncy.									
N.	Taxi Vehicle Oc	cupancy:					1.18	Persons			1.18	
0.	Car Vehicle Oco	cupancy:					1.18	Persons			1.18	
Ρ.	Motorcycle Veh	icle Occupano	:y:				1.16	Persons			1.16	
	Step 3: Emissi	ion Factors f	or Average	Commuter	Travel Spe	eed:						
	Note: Use 25 Mi		_			Speed Used:	25 MPH					
			1/00 -					-				
		Sum	mer VOC Fa grams/mile	ictor Sur	nmer NOx Fa grams/mile		mmer CO Fact grams/mile	or Si	ummer CO2 Fac grams/mile	ctor		
		2016 Bus	0.014		0.023		0.150		22.645			
		2016 Auto	0.169		0.252		2.879		398.914			
		6 Motorcycle	1.362		0.466		13.331		342.739			
	Step 4: Calcula					ar (Seasonally						
		5	Summer VOO		Summer NO:	×	Summer CO		Summer CO2			
_	04 - F		44.8		33.0		549.8		43,630.7			
	Step 5: Calcula		ctiveness	_		of emissions r	educed)					
		Project		Emission Re		First year cost						
	Emission	Cost	,	in kg per yea		per kilogram						
	Summer VOC	\$1,000,000	1	44.8		\$22,303						
	Summer NOx	\$1,000,000	1	33.0		\$30,312						
	Summer CO	\$1,000,000	1	549.8		\$1,819						
	Summer CO2	\$1,000,000	1	43,630.7	=	\$23						



### **INDUCED TRAVEL**

		JUAIITV An	IAIVSIS VV	nrichaat	TOP INCL							
	CMAQ Air	-	-	orkoneer	Tor mar	iced fraver						
	TIP YEAR:											
	MPO:			1		Mur	nicipality:					
	Project:		1									
	Step 1: Lane I	Ailes Reduce	ed by Proje	ct:								
						t will result from the pro	•	sely, this tool	could be			
	used to estimate	e the increase	in emissions	s associated	with an inc	rease in capacity in land	e-miles.					
A.	Reduction of Lo	cal Roads (L)	):				20	Lane-Miles				
в.	Reduction of Mi	nor & Major Co	ollector Road	s (C):			40	Lane-Miles				
с.	Reduction of Mi	nor Arterial R	oads (A):				0	Lane-Miles				
-	Step 2: Lane M	Aile Flasticity	for VMT									
			•	cle travel end	l changes i	n road capacity can res	ult in induced	travel electio	ities If site			
	specific data is	-			-				auco. Il olic			
								(bla	nk for defau	lt)	Default	
D.	Lane Miles Elas	ticity for Loca	Roads (EL)				0.255	1/Year			0.255	
Ε.	Lane Miles Elas	ticity for Minor	r & Major Coll	ector Roads	(EC):		0.759	1/Year			0.759	
F.	Lane Miles Elas											
	Earro mileo Elao	ticity for Minor	r Arterial Roa	ds (EA):			0.538	1/Year			0.538	
	Step 3: Estima			ds (EA):			0.538	1/Year			0.538	
	Step 3: Estima	ated Change	in VMT:		A) = VMT						0.538	
	Step 3: Estima Total Decrease	ated Change d Traffic (VM	in VMT: T): (L*EL) + (	C*EC) + (A*E			0.538	1/Year VMT			0.538	
	Step 3: Estima Total Decrease Step 4: Emiss	ated Change d Traffic (VM ion Factors f	in VMT: T): (L*EL) + ( for Average	C*EC) + (A*E	r Travel Sp		35.5				0.538	
	Step 3: Estima Total Decrease	ated Change d Traffic (VM ion Factors f	in VMT: T): (L*EL) + ( for Average	C*EC) + (A*E	r Travel Sp	need: Speed Used:					0.538	
	Step 3: Estima Total Decrease Step 4: Emiss	ated Change d Traffic (VM ion Factors f	in VMT: T): (L*EL) + ( for Average	C*EC) + (A*E	r Travel Sp		35.5				0.538	
	Step 3: Estima Total Decrease Step 4: Emiss Note: Use 35 M	d Traffic (VM ion Factors f PH as a defau 2016 Auto mmer VOC Fa	in VMT: T): (L*EL) + ( for Average It if average	C*EC) + (A*E Commuter speed is not 2016 Auto mmer NOx Fa	r Travel Sp known.	Speed Used: 2016 Auto Summer CO Factor	35.5 35 MPH	VMT 2016 Auto mer CO2 Fact	ior		0.538	
	Step 3: Estima Total Decrease Step 4: Emiss Note: Use 35 M	ted Change d Traffic (VM ion Factors f PH as a defau 2016 Auto mmer VOC Fa grams/mile	in VMT: T): (L*EL) + ( for Average It if average	C*EC) + (A*E Commuter speed is not 2016 Auto mmer NOx Fa grams/mile	r Travel Sp known.	Speed Used: 2016 Auto Summer CO Factor grams/mile	35.5 35 MPH	VMT 2016 Auto mer CO2 Fact grams/mile	lor		0.538	
	Step 3: Estima Total Decrease Step 4: Emiss Note: Use 35 M Su	d Traffic (VM ion Factors 1 PH as a defau 2016 Auto mmer VOC Fa grams/mile 0.173	in VMT: T): (L*EL) + ( for Average It if average ctor Sur	C*EC) + (A*E <b>Commuter</b> speed is not 2016 Auto mmer NOx Fa grams/mile 0.255	r Travel Sp known. Ictor	Speed Used: 2016 Auto Summer CO Factor grams/mile 2.973	35.5 35 MPH Sum	VMT 2016 Auto mer CO2 Fact	tor		0.538	
	Step 3: Estima Total Decrease Step 4: Emiss Note: Use 35 M Su	d Traffic (VM ion Factors 1 PH as a defau 2016 Auto mmer VOC Fa grams/mile 0.173 ate emission	in VMT: T): (L*EL) + ( for Average It if average ctor Sun ns reductio	C*EC) + (A*E Commuter speed is not 2016 Auto mmer NOx Fa grams/mile 0.255 ns in kilogr	r Travel Sp known. ctor ams per y	Speed Used: 2016 Auto Summer CO Factor grams/mile 2.973 rear (Seasonally Adju	35.5 35 MPH Sum	VMT 2016 Auto mer CO2 Fact grams/mile 352.030	tor		0.538	
	Step 3: Estima Total Decrease Step 4: Emiss Note: Use 35 M Su	d Traffic (VM ion Factors 1 PH as a defau 2016 Auto mmer VOC Fa grams/mile 0.173 ate emission Summer VOC	in VMT: T): (L*EL) + ( for Average It if average ctor Sun ns reductio	C*EC) + (A*E Commuter speed is not 2016 Auto mmer NOx Fa grams/mile 0.255 ns in kilogr Summer NOx	r Travel Sp known. ctor ams per y	Speed Used: 2016 Auto Summer CO Factor grams/mile 2.973 rear (Seasonally Adju Summer CO	35.5 35 MPH Sum	VMT 2016 Auto mer CO2 Fact grams/mile 352.030 Summer CO2	tor		0.538	
	Step 3: Estima Total Decrease Step 4: Emiss Note: Use 35 M Su Step 4: Calcula	d Traffic (VM ion Factors f PH as a defau 2016 Auto mmer VOC Fa grams/mile 0.173 ate emission Summer VOC 0.0	in VMT: T): (L*EL) + ( for Average It if average ctor Sun ns reductio	C*EC) + (A*E Commute: speed is not 2016 Auto mmer NOx Fa grams/mile 0.255 ns in kilogr Summer NO2 0.0	r Travel Sp known. ctor ams per y	Speed Used: 2016 Auto Summer CO Factor grams/mile 2.973 ear (Seasonally Adju Summer CO 0.1	35.5 35 MPH Sum sted):	VMT 2016 Auto mer CO2 Fact grams/mile 352.030	lor		0.538	
	Step 3: Estima Total Decrease Step 4: Emiss Note: Use 35 M Su Step 4: Calcula	d Traffic (VM ion Factors 1 PH as a defau 2016 Auto mmer VOC Fa grams/mile 0.173 ate emission Summer VOC 0.0 ate cost effe	in VMT: T): (L*EL) + ( for Average It if average ctor Sun ns reductio	C*EC) + (A*E Commuter speed is not 2016 Auto mmer NOx Fa grams/mile 0.255 ns in kilogr Summer NOx 0.0 first year c	r Travel Sp known. ctor ams per y c ost per kg	Speed Used: 2016 Auto Summer CO Factor grams/mile 2.973 rear (Seasonally Adju Summer CO 0.1 of emissions reduc	35.5 35 MPH Sum sted):	VMT 2016 Auto mer CO2 Fact grams/mile 352.030 Summer CO2	tor		0.538	
	Step 3: Estima Total Decrease Step 4: Emiss Note: Use 35 M Su Step 4: Calcul Step 5: Calcul	d Traffic (VM ion Factors 1 PH as a defau 2016 Auto mmer VOC Fa grams/mile 0.173 ate emission Summer VOC 0.0 ate cost effe Project	in VMT: T): (L*EL) + ( for Average It if average ctor Sun ns reductio	C*EC) + (A*E Commuter speed is not 2016 Auto mmer NOx Fa grams/mile 0.255 ns in kilogr Summer NOx 0.0 first year cr Emission Re	r Travel Sp known. ctor ams per y c ost per kg eduction	Speed Used: 2016 Auto Summer CO Factor grams/mile 2.973 ear (Seasonally Adju Summer CO 0.1 of emissions reduc First year cost	35.5 35 MPH Sum sted):	VMT 2016 Auto mer CO2 Fact grams/mile 352.030 Summer CO2	tor		0.538	
	Step 3: Estima Total Decrease Step 4: Emiss Note: Use 35 M Su Step 4: Calcula Step 5: Calcula Emission	d Traffic (VM ion Factors f PH as a defau 2016 Auto mmer VOC Fa grams/mile 0.173 ate emission Summer VOC 0.0 ate cost effe Project Cost	in VMT: T): (L*EL) + ( for Average It if average ctor Sun ns reductio	C*EC) + (A*E Commuter speed is not 2016 Auto mmer NOx Fa grams/mile 0.255 ns in kilogr Summer NO2 0.0 (first year communication) Emission Re in kg per yea	r Travel Sp known. ctor ams per y c ost per kg eduction ar	Speed Used: 2016 Auto Summer CO Factor grams/mile 2.973 ear (Seasonally Adju Summer CO 0.1 of emissions reduc First year cost per kilogram	35.5 35 MPH Sum sted):	VMT 2016 Auto mer CO2 Fact grams/mile 352.030 Summer CO2	lor			
	Step 3: Estima Total Decrease Step 4: Emiss Note: Use 35 M Su Step 4: Calcula Step 5: Calcula Emission Summer VOC	d Traffic (VM ion Factors f PH as a defau 2016 Auto mmer VOC Fa grams/mile 0.173 ate emission Summer VOC 0.0 ate cost effe Project Cost \$1,000,000	in VMT: T): (L*EL) + ( for Average It if average ctor Sum ns reduction ctiveness (	C*EC) + (A*E Commuter speed is not 2016 Auto mmer NOx Fa grams/mile 0.255 ns in kilogr Summer NO2 0.0 (first year cr Emission Re in kg per yea 0.0	r Travel Sp known. ctor ams per y c ost per kg eduction ar	Speed Used: 2016 Auto Summer CO Factor grams/mile 2.973 rear (Seasonally Adju Summer CO 0.1 of emissions reduc First year cost per kilogram \$159,913,970	35.5 35 MPH Sum sted):	VMT 2016 Auto mer CO2 Fact grams/mile 352.030 Summer CO2	lor			
	Step 3: Estima Total Decrease Step 4: Emiss Note: Use 35 M Su Step 4: Calcula Step 5: Calcula Emission Summer VOC Summer NOX	d Traffic (VM ion Factors f PH as a defau 2016 Auto mmer VOC Fa grams/mile 0.173 ate emission Summer VOC 0.0 ate cost effe Project Cost \$1,000,000 \$1,000,000	in VMT: T): (L*EL) + ( for Average It if average ctor Sum ns reduction ctiveness ( / /	C*EC) + (A*E Commuter speed is not 2016 Auto mmer NOx Fa grams/mile 0.255 ns in kilogr Summer NO2 0.0 (first year cr Emission Re in kg per yea 0.0 0.0	r Travel Sp known. ctor ams per y c ost per kg eduction ar =	Speed Used: 2016 Auto Summer CO Factor grams/mile 2.973 rear (Seasonally Adju Summer CO 0.1 of emissions reduc First year cost per kilogram \$159,913,970 \$108,695,334	35.5 35 MPH Sum sted):	VMT 2016 Auto mer CO2 Fact grams/mile 352.030 Summer CO2	lor			
	Step 3: Estima Total Decrease Step 4: Emiss Note: Use 35 M Su Step 4: Calcula Step 5: Calcula Emission Summer VOC	d Traffic (VM ion Factors f PH as a defau 2016 Auto mmer VOC Fa grams/mile 0.173 ate emission Summer VOC 0.0 ate cost effe Project Cost \$1,000,000	in VMT: T): (L*EL) + ( for Average It if average ctor Sum ns reduction ctiveness ( / /	C*EC) + (A*E Commuter speed is not 2016 Auto mmer NOx Fa grams/mile 0.255 ns in kilogr Summer NO2 0.0 (first year cr Emission Re in kg per yea 0.0	r Travel Sp known. ctor ams per y c ost per kg eduction ar = =	Speed Used: 2016 Auto Summer CO Factor grams/mile 2.973 rear (Seasonally Adju Summer CO 0.1 of emissions reduc First year cost per kilogram \$159,913,970	35.5 35 MPH Sum sted):	VMT 2016 Auto mer CO2 Fact grams/mile 352.030 Summer CO2	lor			



### SPEED REDUCTION PROJECTS

A	-	С		E			Н		J	K	L
	CMAQ Air	Quality An	alysis W	orksheet	for Spee	d Reductio	n Project	t			
	FILL IN SHADE	D BOXES ONL	.Y				-				
	TIP YEAR:										
	MPO:					Mu	nicipality:				
	Project:										
	Step 1: Details	of Project:									
		•	sion reduction	ons from redu	Icina hiahwa	y speeds to no le	ess than 55 M	IPH, below	which emission	ons	
	rise dramatically							,			
A	. Daily Vehicle Mi	les Traveled f	or Enforecm	ent Region:			10,000	Miles			
B.	Current Averag	e Speed:					65	MPH			
С	. Target Average	Speed - No L	ess than 55.	MPH:			60	MPH			
	Step 2: Emiss	ion Factors a	at 55 MPH a	nd 65 MPH:							
		Sum	nmer VOC Fa	actor Sur	nmer NOx Fa	ictor Su	mmer CO Fac	tor S	ummer CO2 Fa	ctor	
			grams/mile		grams/mile		grams/mile		grams/mile		
		55 MPH	0.152		0.278		2.732		318.880		
		65 MPH	0.152		0.302		3.001		321.274		
	Step 3: Estima	ted Emissio	n Factors a	t Current a	nd Target S	peed:					
		Sum	nmer VOC Fa	actor Sur	nmer NOx Fa	ictor Su	mmer CO Fac	tor S	ummer CO2 Fa	ctor	
			grams/mile		grams/mile		grams/mile		grams/mile		
		peed: 65 MPH	0.152		0.302		3.001		321.274		
		peed: 60 MPH	0.152		0.290		2.866		320.077		
	Step 4: Calcula			-		ar (Seasonally					
			Summer VO	2	Summer NO2	ĸ	Summer CO		Summer CO2	2	
			-0.1		45.0		500.1		4,451.2		
	Step 5: Calcul	ate cost effe	ctiveness	(first year c	ost per kg (	of emissions r	educed)				
		Project		Emission Re	duction	First year cost					
	Emission	Cost		in kg per yea	ar	per kilogram					
	Summer VOC	\$1,000,000	1	-0.1		\$8,537,046					
	Summer NOx	\$1,000,000	1	45.0	=	\$22,201					
	Summer CO	\$1,000,000	1	500.1	=	\$2,000					
	Summer CO2	\$1,000,000	1	4,451.2	=	\$225					
-											



### **TRANSIT SIGNAL PRIORITY**

			orksnee	t for Ira	nsit Signal	Priority			_						
FILL IN SHADED E	IOXES C	DNLY													
TIP YEAR:															
MPO:					Mur	nicipality:									
Project:															
Step 1: Project De	tails:		Street 1:			Street 2:			-						
Note: This coll estimates emission reductions from providing Transit Signal Priority (TSP) along a signal int bus vehicles; rail technologies cannot be used in this analysis.								tion or corridor to		Tool Output	ts - Not To	Be Changed by	User:		
A. Capacity at Intersecti	on:		1,200	Vehicles/L	.ane	1,000	Vehicles/	Lane		Weighted True	ck Percentag	e:			9.6%
B. Number of Lanes:			5.5	Lanes		3.0	Lanes			Street 1V/CR	atio:				0.68
C. Average Peak Hour V	olume:		4,500	Vehicle/H	our	2,500	Vehicle/H	lour		Street 2 V/C F	latio:				0.83
D. Percent Trucks:			10%	Trucks		9%	Trucks			Current Peak	Hour Street 1	& Transit Delay (s/	/eh);		19
Step 2: Traffic Sid	ınal Info	rmation:							-	Current Peak					21
Note: Detailed traffic			quired to esti	imate the effe	cts of transit sig	nal priority.		User Input							
		I . I				100	<u>ال</u> Seconds	lank for default)	Default			t Delay with TSP G ith TSP Granted (s			12
E. Average Existing Inter			L.										iven):		17%
F. Transit Average Daily Headways: 15					Minutes			Probability of I							
G. Transit Signal Priority			Jay:			18	Hours/Da				Current Average Intersection Delay to Buses (mins per trip):				6.32
H. Average Daily Transit	· ·					100	Riders/Da				Improved Average Intersection Delay to Buses due to TSP (mins per trip):			s per trip):	4.05
I. Number of Intersectio						5	Intersecti	ons				ay with no TSP (Ve			38.6
J. Average Corridor Trav	el Time fo	or Buses in C	One Direction:			30	Minutes			Intersection P	eak Hour Dela	ay with TSP (Veh-I	nr):		38.3
K. Average Existing Inter	section C	ycle Lengtł	n:			100	Seconds			Total Travel Ti	me Change d	ue to TSP:			-8%
L. Auto Occupancy:						1.18	Persons		1.18	Ridership Cha	inge due to TS	SP Travel Time Imp	rovements:		25,759
M. Peak Hour to Daily Co	nversion:					10			10	Passenger Vehicle Emissions without TSP Activation (g/day):					
N. Number of Weekdays	per year:					250	Days/Yr		250	VOC		NOs	CO		CO2
Effective Green to Cy	cle Lengt	h Ratio:				0.5			0.5	538		1,676	5,163	3	1,612,861
P. Green to Cycle Lengt	h Ratio wi	th TSP - Str	eet 1:			0.6				Passenger	Vehicle Em	issions with TS	P Activation (g	ı/day):	
Q. Green to Cycle Lengt						0.4				VOC		NOx	co		CO2
R. Travel Time Elasticity						-0.4			-0.4	534		1.662	5,119		1,599,020
S. Number of Transit Trip			a up.			144	Trips/Dav		0		al Dailu Em	issions (g/day):			(000,020
<ol> <li>Average Trip Length:</li> </ol>	is in boar	Directions.				16	Miles				ai Daily Cili	NOx	0		CO2
Step 3: Emission I		< 1.00- 1				10	miles		_	485		4.626	1.256		584,200
Step 3: Emission I	actors	ror lating '	venicies:							405 Improved D	aily Emissio		1,250	<u> </u>	504,200
		VOC Factor		NOx Factor		CO Factor		CO2 Factor		VOC	_	NOx	CO		CO2
2016 Lig		grams/hour 0.723		grams/hour 0.949		grams/hour 13.262		grams/hour 3962.370		311 Delay/VMT	mpact:	2,961	804		373,888
	Trucks	7.694		36.143		14.489		6216.290		Delayititi	impuot.				
	i Transit	6.399		60.982		16.562		7700.820				t Vehicle Hours of			1,366
Step 4: Emission I Note: Use 35 MPH as					SpeedUsed:	35 MPH						le Hours of Delay fo Hours of Delay op (			r: 3,556 -2.728
note: obe con in mas		-			-			Addition of Annual Vehicle Hour of Delay on Cross Streets (Street Net Change in Annual Vehicle Hours of Delay for All Vehicles:					2,193		
		mer VOC Fa	ctor Sur	nmer NOx Fa	otor Su	immer CO Fac	tor Su	mmer CO2 Facto	e in the second s	Eliminated Annual Auto VMT due to Improved Transit Service: Non-Transit Change (added Street 2 delay + reduced Street 1 VDC NOR NOR CO					10,286
2016 L ir	ght Duty	grams/mile 0.109		grams/mile 0.209		grams/mile 2.418		grams/mile 385.049							elayj (g/yr): CO2
Step 5: Calculate	emissio	ns reduct	ions in kilo	grams per y	ear (Season	ally Adjuste	d):			962		2,996	9,23	1	2,883,513
	S	ummer VOC 46.6	2	Summer NDx 429.4		Summer CO 149.8		Summer CO2 60,485.2							
Step 6: Calculate	cost ef		s (first yea		g of emissior			00,403.2							
Pr	oject		Emission Re-	duction	First year cost										
	Cost		in kg per yea		per kilogram										
	00,000		46.6 429.4		\$21,451 \$2,329										
	00,000	÷	423.4		\$6.677										
	000.000	1	60.485.2		\$17										



### **TRUCK STOP ELECTRIFICATION**

A		C	D	E	F	G	Н		J	K	L	M	
	CMAQ Air	Quality Ana	lysis W	orksheet	for True	ck Stop Elect	rification	1					
	FILL IN SHADE	D BOXES ONLY	,										
	TIP YEAR:												
	TIP TEAK:												
	MPO:					Mun	icipality:						
	Project:												
	Step 1: Details	s of Project:											
									User Input				
								<u>(b</u>	lank for defa	ult)	Default		
Α.	Average Daily	Hours of Elecitrif	fication Uti	lization per Ba	y:		2.0	Hours/Day	/				
B.	Number of Elec	trification Bays:					10	Bays					
c	Dave per Veer	Electrification Ba		ble:			365	Days/Yr			365		
с.	Days per rear	Electrification ba	ays Avalla	ible.			303	Days/11			305		
D.	Diesel Truck Id	ing Fuel Consum	ption Rate	e			1.0	Gal/Hr			1.0		
E.	Use of Electrici	ty by Each Electi	rification E	ay:			7.5	kWh/hr			7.5		
	Sten 2: Emiss	Step 2: Emission Factors for Electricity Usage:											
	otop zi zimos		LIGOLIIG	ity obliger									
		VOC Factor		NOx Factor		CO Factor		CO2 Factor					
		pounds/MWh		pounds/MWh		pounds/MWh		pounds/MWh					
		0.012		0.408		0.105		637.900					
	Step 3: Emiss	ion Factors for	r Idling V	ehicles:									
		VOC Factor		NOx Factor		CO Factor		CO2 Factor					
		grams/gallon		grams/gallon		grams/gallon		grams/gallon					
	04	7.694		36.143		14.489		6216.290					
	step 3: Calcul	ate emissions VOC	reductio	NOx	anis per y	co		C02					
		55.9		253.7		103.2		29.536.9					
	Stop & Coloui		tivonono		net per ke	of emissions re	duood)	29,000.9					
	step 4: Calcul	Project	uveness	Emission Re		First year cost	auceu)						
	Emission	Cost				per kilogram							
	VOC	\$1,000,000	1	in kg per yea 55.9		\$17,902							
	NOx	\$1,000,000	1	253.7		\$3,942							
	CO	\$1,000,000	1	103.2		\$9,693							
	C02	\$1,000,000	· /	29,536.9		\$3,033							
	002	\$1,000,000	1	29,536.9	-	\$34							

