

# California Air Resources Board

## Quantification Methodology

Strategic Growth Council  
Affordable Housing and Sustainable Communities Program

California Climate Investments



**Note:**

The California Air Resources Board (CARB) is accepting public comments on the Draft Affordable Housing and Sustainable Communities (AHSC) Benefits Calculator Tool and Draft AHSC Quantification Methodology until September 14, 2018 via [GGRFProgram@arb.ca.gov](mailto:GGRFProgram@arb.ca.gov). The Draft Benefits Calculator Tool and Draft Quantification Methodology are subject to change pending stakeholder comments and Final AHSC Guidelines. The Final AHSC Benefits Calculator Tool and Final AHSC Quantification Methodology will be available on the California Climate Investments resources webpage at: <http://www.arb.ca.gov/cci-resources>.

**DRAFT**  
**August 31, 2018**

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## Section A. Introduction

California Climate Investments is a statewide initiative that puts billions of Cap-and-Trade dollars to work facilitating greenhouse gas (GHG) emission reductions; strengthening the economy; improving public health and the environment; and providing benefits to residents of disadvantaged communities, low-income communities, and low-income households, collectively referred to as “priority populations.” Where applicable and to the extent feasible, California Climate Investments must maximize economic, environmental, and public health co-benefits to the State.

The California Air Resources Board (CARB) is responsible for providing guidance on estimating the GHG emission reductions and co-benefits from projects receiving monies from the Greenhouse Gas Reduction Fund (GGRF). This guidance includes quantification methodologies, co-benefit assessment methodologies, and benefit calculator tools. CARB develops these methodologies and tools based on the project components eligible for funding by each administering agency, as reflected in the program expenditure records available at: <http://www.arb.ca.gov/cci-expenditurerecords>.

For the Strategic Growth Council (SGC) Affordable Housing and Sustainable Communities (AHSC) Program, CARB staff developed this AHSC Quantification Methodology to provide guidance for estimating the GHG emission reductions and selected co-benefits of each proposed project type. This methodology uses calculations to estimate GHG emission reductions from avoided passenger vehicle miles traveled (VMT) as a result of land use, housing, and transportation strategies to support infill, compact, and affordable housing development projects.

The AHSC Benefits Calculator Tool automates methods described in this document, provides a link to a step-by-step user guide with a project example, and outlines documentation requirements. Projects will report the total project GHG emission reductions and co-benefits estimated using the AHSC Benefits Calculator Tool as well as the total project GHG emission reductions per dollar of GGRF funds requested. The AHSC Benefits Calculator Tool is available for download at: <http://www.arb.ca.gov/cci-resources>.

Using many of the same inputs required to estimate GHG emission reductions, the AHSC Benefits Calculator Tool estimates the following co-benefits and key variables from AHSC projects: VMT (in miles), energy and fuel cost savings (in dollars), travel cost savings (in dollars), net dwelling density (in dwelling units per acre), renewable energy generation (in kWh), trees planted, and select criteria and toxic air pollutant emissions (in pounds) – including nitrogen oxide (NO<sub>x</sub>), reactive organic gases (ROG), diesel particulate matter (diesel PM), and fine particulate matter less than 2.5 micrometers (PM<sub>2.5</sub>). Additional co-benefits for which CARB assessment methodologies were not incorporated into the Benefits Calculator Tool may also be

applicable to the project. Applicants should consult the AHSC guidelines, solicitation materials, and agreements to ensure they are meeting AHSC requirements. All CARB co-benefit assessment methodologies are available at: [www.arb.ca.gov/cci-cobenefits](http://www.arb.ca.gov/cci-cobenefits).

## Methodology Development

CARB and SGC developed this Quantification Methodology consistent with the guiding principles of California Climate Investments, including ensuring transparency and accountability.<sup>1</sup> CARB and SGC developed this Quantification Methodology to be used to estimate the outcomes of proposed projects, inform project selection, and track results of funded projects. The implementing principles ensure that the methodology would:

- Apply at the project-level;
- Provide uniform methods to be applied statewide, and be accessible by all applicants;
- Use existing and proven tools and methods;
- Use project-level data, where available and appropriate; and
- Result in GHG emission reduction estimates that are conservative and supported by empirical literature.

CARB assessed peer-reviewed literature and tools and consulted with experts, as needed, to determine methods appropriate for the AHSC project area types. CARB also consulted with SGC to determine project-level inputs available. The methods were developed to provide estimates that are as accurate as possible with data readily available at the project level.

In addition, the University of California, Berkeley, in collaboration with CARB, developed assessment methodologies for a variety of co-benefits such as providing cost savings, lessening the impacts and effects of climate change, and enhancing community engagement. As they become available, co-benefit assessment methodologies are posted at: [www.arb.ca.gov/cci-cobenefits](http://www.arb.ca.gov/cci-cobenefits).

## Tools

The AHSC Benefits Calculator Tool relies on project-specific outputs from the following tools:

The “California Emissions Estimator Model” (CalEEMod) version 2016.3.2 is a “state-of-the-practice” land use emissions calculator tool designed to quantify GHG and criteria air pollutant emissions associated with land use development projects, including transit-oriented and mixed-use developments. Lead agencies statewide use CalEEMod to evaluate the GHG emissions and criteria air pollutants of land use development projects

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<sup>1</sup> California Air Resources Board. [www.arb.ca.gov/cci-fundingguidelines](http://www.arb.ca.gov/cci-fundingguidelines)

pursuant to the California Environmental Quality Act and the National Environmental Protection Act, and for compliance with local air quality rules and regulations. CalEEMod includes a suite of mitigation measures so that a user may compare mitigated and unmitigated project emissions. This AHSC Quantification Methodology uses CalEEMod to estimate emissions associated with projects that include affordable housing or housing-related infrastructure. The California Air Pollution Control Officers Association (CAPCOA) developed the GHG emission reduction impacts of the mitigation measures and detailed the results in a study titled “Quantifying Greenhouse Gas Mitigation Measures” (CAPCOA Quantification Report).<sup>2</sup> The CAPCOA Quantification Report includes detailed fact sheets that describe the underlying research and data used to develop the reduction impacts (also called effects or elasticities) and provides project-level examples for each measure. The CalEEMod tool, User’s Guide, and other supporting documents can be accessed at: [www.caleemod.com](http://www.caleemod.com).

The “Methods to Find the Cost-Effectiveness of Funding Air Quality Projects for Evaluating Motor Vehicle Registration Fee Projects and Congestion Mitigation and Air Quality Improvement Projects” (CMAQ Methods) were used as the basis for developing the GHG emission reduction estimates for certain project features that are not captured in CalEEMod, specifically transit and connectivity (TAC) features.<sup>3</sup> The CMAQ Methods are a set of equations for evaluating the cost-effectiveness of certain types of transportation projects, including bicycle paths, vanpools, and new bus service. CARB and the California Department of Transportation developed the CMAQ Methods, which are used statewide by transportation agencies to assess criteria pollutant emission reductions from transportation projects competing for State motor vehicle fee and federal CMAQ funding. All of the CMAQ Methods equations and assumptions needed for this quantification method are included in this document, and some assumptions have been modified as necessary. Therefore, the equations used in this Quantification Methodology are referred to as TAC Methods. The CMAQ Methods document can be accessed at: <https://www.arb.ca.gov/planning/tsaq/eval/eval.htm>.

The National Renewable Energy Laboratory (NREL) PVWatts® Calculator is a web-based tool for estimating the electricity production of grid-connected roof- or ground-mounted solar photovoltaic systems. This AHSC Quantification Methodology uses PVWatts to estimate renewable energy generation co-benefits from projects that include solar photovoltaic systems. The PVWatts tool can be accessed at: <http://pvwatts.nrel.gov/>.

CalEEMod, the CMAQ Methods, and PVWatts are used statewide, subject to regular updates to incorporate new information, free of charge, and publicly available to anyone

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<sup>2</sup> California Air Pollution Control Officers Association. Quantifying Greenhouse Gas Mitigation Measures. August 2010. <http://www.capcoa.org/wp-content/uploads/2010/11/CAPCOA-Quantification-Report-9-14-Final.pdf>.

<sup>3</sup> California Air Resources Board. Methods to Find the Cost-Effectiveness of Funding Air Quality Projects for Evaluating Motor Vehicle Registration Fee Projects and Congestion Mitigation and Air Quality Improvement Projects. May 2005. <https://www.arb.ca.gov/planning/tsaq/eval/eval.htm>.

with internet access.

In addition to the tools above, the AHSC Benefits Calculator Tool relies on CARB-developed emission factors. CARB has established a single repository for emission factors used in CARB benefit calculator tools, referred to as the California Climate Investments Quantification Methodology Emission Factor Database (Database), available at: <http://www.arb.ca.gov/cci-resources>. The Database Documentation explains how emission factors used in CARB benefit calculator tools are developed and updated.

Applicants must use the AHSC Benefits Calculator Tool to estimate the GHG emission reductions and selected co-benefits of the proposed project. The AHSC Benefits Calculator Tool can be downloaded from: <http://www.arb.ca.gov/cci-resources>.

## Updates

CARB staff periodically review each quantification methodology to evaluate its effectiveness and update methodologies to make them more robust, user-friendly, and appropriate to the projects being quantified. CARB updated the AHSC Quantification Methodology from the previous version<sup>4</sup> to enhance the analysis and provide additional clarity. The changes made are listed below.

- Updated format to match the latest quantification methodology template
- Moved step-by-step quantification instructions to User Guide
- Updated the Tools sub-section to refer to the latest version of CalEEMod  
**Note:** CalEEMod version 2016.3.2 corrects some software issues but does not change the underlying VMT calculations used in this quantification methodology.
- Added description of the PVWatts Calculator Tool to the Tools sub-section
- Added language to explain new co-benefits estimated

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<sup>4</sup> Revised Quantification Methodology for the SGC FY2016-17 AHSC. October 2017.  
<https://www.arb.ca.gov/cc/capandtrade/auctionproceeds/quantification-archive.htm>

## Section B. Methods

The following section provides details on the methods supporting emission reductions in the AHSC Benefits Calculator Tool

### Project Components

SGC developed four project components that meet the objectives of the AHSC Program and for which there are methods to quantify GHG emission reductions.<sup>5</sup> Other project features may be eligible for funding under the AHSC Program; however, each project requesting Greenhouse Gas Reduction Fund (GGRF) funding must include at least one of the following components:

- Affordable Housing Development or Housing-Related Infrastructure
- Sustainable Transportation Infrastructure
- Transportation-Related Amenities

### General Approach

Methods used in the AHSC Benefits Calculator Tool for estimating the GHG emission reductions and air pollutant emission co-benefits by activity type are provided in this section. The Database Documentation explains how emission factors used in CARB benefits calculator tools are developed and updated.

These methods account for GHG emission reductions from avoided passenger VMT as a result of affordable housing and mixed-use developments, transit, and sustainable transportation infrastructure. In general, GHG emission reductions are estimated in the AHSC Benefits Calculator Tool using the approaches in Table 1. The AHSC Benefits Calculator Tool also estimates selected co-benefits and key variables using largely the same inputs used to estimate GHG emission reductions.

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<sup>5</sup> Strategic Growth Council. <http://sgc.ca.gov/programs/ahsc/resources/guidelines.html>



**Table 1. General Approach to Quantification by Project Component**

Affordable Housing Development or Housing-Related Infrastructure
<i>GHG Emission Reductions = GHG Emissions of Avoided Auto VMT</i>
New/Expanded Bus, Train, Shuttle, Ferry, or Vanpool Service
<i>GHG Emission Reductions = GHG Emissions of Displaced Autos – GHG Emissions of New Service Vehicle</i>
Capital Improvements
<i>GHG Emission Reductions = GHG Emissions of Displaced Autos</i>
Pedestrian Facilities, Bicycle Paths, Bicycle Lane, Bikeways, or Bike Share
<i>GHG Emission Reductions = GHG Emissions of Displaced Autos</i>

## CalEEMod Additional Benefits and Emission Calculations

Calculations supporting Steps 3.D through F in the AHSC Benefits Calculator Tool are provided below.

### Step 3.D: Calculate Additional Benefits

The following equations support these measures:

- LUT-1: Increase Density
- SDT-2: Provide Traffic Calming Measures
- TRT-4 (residents): Transit Subsidy for Residents. Note: The CalEEMod Transit Subsidy is applicable to non-residential land use types (for employees). This equation has been provided to apply transit subsidies to residents. For the purposes of estimating the percent of residents eligible for subsidy, use one eligible resident per dwelling unit.



**Equation 1: Increase Density (LUT-1)**

$$\% \text{ Density Increase} = 100 * \left[ \frac{\text{Project Dwelling Units per Acre} - \text{Net density}}{\text{Net Density}} \right]$$

Where,  
 % Density Increase = Percent net increase in dwelling units per acre Units %

Project Dwelling Units per Acre = Number of project dwelling units per acre Dwelling units per acre

Net density = Minimum net density requirements by Project Area Type as defined in the AHSC Guidelines (from Table 2) Dwelling units per acre

**Equation 2: VMT Reduction for Density (LUT-1)**

$$\% \text{ VMT Reduction} = 0.07 * \% \text{ Density Increase}$$

Where,  
 % VMT Reduction = Percent VMT reduction from increased density, capped at 30% Units %

% Density Increase = Percent net increase in dwelling units per acre (from Eq. 1) %

**Table 2. Net Density Lookup for Eq. 1**

AHSC Guideline Requirements	
Project Area Type	Minimum Net Density
TOD	30 du/acre
ICP	20 du/acre
RIPA	15 du/acre

**Equation 3: VMT Reduction for Traffic Calming Measures (SDT-2)**

$$\% \text{ VMT Reduction} = 1\%$$

Where,  
 % VMT Reduction = Percent VMT reduction from traffic calming measures Units %

**Equation 4: VMT Reduction for Transit Subsidy for Residents (TRT-4 (residents))**

$$\% \text{ VMT Reduction} = A * B * \left(\frac{C}{30}\right)$$

<i>Where,</i>		<u>Units</u>
<i>% VMT Reduction</i>	= Percent VMT reduction from transit subsidy for residents	%
<i>A</i>	= Percent VMT reduction per eligible resident (from Table 3)	%
<i>B</i>	= Percent of residents eligible for the subsidized or discounted transit program (i.e., 0-100)	%
<i>C</i>	= Number of years that the subsidy is funded or guaranteed under the proposed project or transit agency program (i.e., 0-30 years) <sup>6</sup>	%

**Note:** For the purposes of estimating the percent of residents eligible for subsidy, use one eligible resident per dwelling unit.

For example, a project providing a \$2,500 per year subsidy to 100% of residents for 3 years would calculate the % VMT reduction as: % VMT reduction = [20% \* 100 \* (3/30)] = 2%.

**Table 3. Adjustment Factor (A) Lookup for Eq. 4**

Transit Subsidy or Discount per Year per Eligible Resident	A=Percent Reduction in Commute VMT per Eligible Resident		
	Low Density Suburban <sup>7</sup>	Urban Center <sup>7</sup>	Urban <sup>7</sup>
From \$273.75 to \$543.84	1.5%	6.2%	6.2%
\$543.85 to \$1,087.69	3.3%	12.9%	12.9%
\$1,087.70 to \$2,175.39	7.9%	20.0%	20.0%
\$2,175.40 or greater	20.0%	20.0%	20.0%

**Note:** Subsidies below \$273.75 per Eligible Resident per Year may not use this measure.

**Step 3.E: Calculate the Annual VMT Reductions**

**Equation 5: Additional Percent VMT Reductions**

$$\text{Additional \% VMT Reductions} = \text{Eq. 2} + \text{Eq. 3} + \text{Eq. 4}$$

<i>Where,</i>		<u>Units</u>
<i>Additional % VMT Reduction</i>	= Percent VMT reductions from all additional CalEEMod benefits	%

<sup>6</sup> The subsidy/discount may include GGRF and other enforceable commitment funds.

<sup>7</sup> Refer to Project Setting designation based on the Project Area from Table 2.

**Equation 6: Additional VMT Reductions**

$$\text{Additional VMT Reductions} = \text{Unmitigated VMT} * \text{Additional \% VMT Reductions}$$

Where,		<u>Units</u>
<i>Additional VMT Reductions</i>	= VMT reductions from all additional CalEEMod benefits	VMT
<i>Unmitigated VMT</i>	= Unmitigated VMT from CalEEMod report	VMT
<i>Additional \% VMT Reductions</i>	= Percent VMT reductions from all additional CalEEMod benefits (from Eq. 5)	%

**Equation 7: Total Annual VMT Reductions**

$$\text{Total Annual VMT Reductions} = \text{Unmitigated VMT} - \text{Mitigated VMT} + \text{Additional VMT Reductions}$$

Where,		<u>Units</u>
<i>Total Annual VMT Reductions</i>	= Total VMT annual reductions from all CalEEMod benefits	VMT
<i>Unmitigated VMT</i>	= Unmitigated VMT from CalEEMod report	VMT
<i>Mitigated VMT</i>	= Mitigated VMT from CalEEMod report	VMT
<i>Additional VMT Reductions</i>	= VMT reductions from all additional CalEEMod benefits (from Eq. 6)	VMT

**Equation 8: Percent VMT Reduction**

$$\text{Percent VMT Reduction} = \frac{\text{Total Annual VMT Reductions}}{\text{Unmitigated VMT}}$$

Where,		<u>Units</u>
<i>Percent VMT Reduction</i>	= Percent VMT reduction for the project	%
<i>Total Annual VMT Reductions</i>	= Total VMT annual reductions from all CalEEMod benefits (from Eq. 7)	VMT
<i>Unmitigated VMT</i>	= Unmitigated VMT from CalEEMod report	VMT

The project Maximum Potential Reductions according to the Project Setting is shown in Table 4. If the Percent VMT Reduction is greater than the Maximum Potential Reduction for the Project Setting, adjust the Percent VMT Reduction.

**Table 4. Maximum Potential Reductions by Project Setting Type for Eq. 9**

Project Area Type	CalEEMod Project Setting Types*	Maximum Potential Reductions (Total maximum project VMT reduction) <sup>8</sup>
TOD	Urban	75%
ICP	Urban Center	40%
RIPA	Low Density Suburban	15%

\*Listed in order of decreasing maximum potential reductions

**Equation 9: Adjusted Percent VMT Reduction**

*Adjusted Percent VMT Reduction*

$$= \text{Maximum Potential Reduction by Project Setting}$$

Where,

*Adjusted Percent VMT Reduction* = Percent VMT reduction for the project, capped according to maximum by project setting type Units  
%

*Maximum Potential Reduction by Project Setting* = Total maximum percent VMT reduction for the project setting type (from Table 4) %

**Equation 10: Annual VMT Reductions**

$$\text{Annual VMT Reductions} = (\text{Adjusted})\text{Percent VMT Reduction} * \text{Unmitigated VMT}$$

Where, Units  
VMT  
*Annual VMT Reductions* = Annual CalEEMod VMT reductions for the project

*Adjusted Percent VMT Reduction* = Percent VMT reduction for the project, capped according to maximum by project setting type (from Eq. 9) %

*Unmitigated VMT* = Unmitigated VMT from the CalEEMod report VMT

<sup>8</sup> As defined in the CAPCOA Quantification Report. The interactions among transportation-related measures are complex and sometimes counter-intuitive. The maximum reduction values are derived from the percentage difference in per capita VMT compared against a statewide average and reflect the highest reduction levels justified by the literature as reviewed for the CAPCOA Quantification Report.

### Step 3.F: Calculate the Total GHG Emission Reductions and Air Pollutant Emission Estimates

#### Equation 11: Emission Estimates for Year 1

$$\text{Emission Estimates (Yr 1)} = \frac{\text{Annual CalEEMod VMT Reductions} * \text{AVEF}_{Yr 1}}{U}$$

<i>Where,</i>		<u>Units</u>
<i>Emission Estimates (Yr 1)</i>	= GHG or criteria and toxic air pollutant emission estimates for Year 1	MTCO <sub>2</sub> e or lbs.
<i>Annual CalEEMod VMT Reductions</i>	= Annual CalEEMod VMT reductions for the project (from Eq. 10)	VMT
<i>AVEF<sub>Yr 1</sub></i>	= Auto Vehicle Emission Factor by county for Year 1	g/mile
<i>U</i>	= Unit conversion factor (1,000,000 for grams to metric tons; 453.59 for grams to pounds)	g/MT or g/lb.

#### Equation 12: Emission Estimates for Year F

$$\text{Emission Estimates (Yr F)} = \frac{\text{Annual CalEEMod VMT Reductions} * \text{AVEF}_{Yr F}}{U}$$

<i>Where,</i>		<u>Units</u>
<i>Emission Estimates (Yr F)</i>	= GHG or criteria and toxic air pollutant emission estimates for Year F	MTCO <sub>2</sub> e or lbs.
<i>Annual CalEEMod VMT Reductions</i>	= Annual CalEEMod VMT reductions for the project (from Eq. 10)	VMT
<i>AVEF<sub>Yr F</sub></i>	= Auto Vehicle Emission Factor by county for Year F	g/mile
<i>U</i>	= Unit conversion factor (1,000,000 for grams to metric tons; 453.59 for grams to pounds)	g/MT or g/lb.

**Note:** The life of the project is defined as 30 years; therefore, Year F = Year 1 + 30.

**Equation 13: Total Emission Estimates**

$$Emission\ Estimates = \frac{Emission\ Estimates_{Yr\ 1} + Emission\ Estimates_{Yr\ F}}{2} * 30$$

<i>Where,</i>		
<i>Emission Estimates</i>	= Total GHG or criteria and toxic air pollutant emission estimates for the project life	<u>Units</u> MTCO <sub>2</sub> e or lbs.
<i>Emission Estimates (Yr 1)</i>	= GHG or criteria and toxic air pollutant emission estimates for Year 1	MTCO <sub>2</sub> e or lbs.
<i>Emission Estimates (Yr F)</i>	= GHG or criteria and toxic air pollutant emission estimates for Year F	MTCO <sub>2</sub> e or lbs.

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## TAC Methods—Additional Benefits and Emission Calculations

Calculations supporting the TAC Methods are provided below.

### New/Expanded Bus, Train, Shuttle, or Vanpool Service

#### Equation 14: Annual VMT of Displaced Autos from New/Expanded Service

$$\text{Annual Auto VMT Reduced from New/Expanded Service} = D * R * A * L$$

Where,

		<u>Units</u>
<i>D</i>	= Annual days of operation of new/expanded service (see Table 5)	Days
<i>R</i>	= Increase in daily ridership of new/expanded service	Riders/ day
<i>A</i>	= Adjustment factor for transit dependency (see Table 5)	N/A
<i>L</i>	= Length of average auto trip reduced (see Table 5)	Miles



**Table 5. Default Transit Service Values for Eq. 14**

Factor	Description	Default Values			
		Bus	Train <sup>9</sup>	Shuttle	Vanpool
D	Days of operation per year	260 (weekday service) 365 (daily service)	User-defined	260 (weekday service) 365 (daily service)	260 (weekday service) 365 (daily service)
R	Change in Daily ridership	Expected increase in daily ridership resulting from the implementation of the proposed AHSC project; applicants should not include existing ridership. For example, one additional bus rider commuting round trip per day is two bus trips per day.			
A	Adjustment factor to account for transit dependency	0.5 (local bus) 0.83 (long distance commuter)	User-defined	0.83	0.83
L	Length of average auto trip reduced	10.8 miles <sup>10</sup>	User-defined	16	35

**Note:** If the Ridership will vary over the life of the project, the applicant must calculate the Annual Auto VMT Reduced for the both first and last year of project operation. Applicants are required to work with transit agency partners to provide these values and document how these values were derived; the supporting documentation will be reviewed during the application process

<sup>9</sup> Default values for new train service are not available due to high variability. Applicants are required to obtain concurrence from transit agency partners on the required inputs and document how these inputs were derived; the supporting documentation will be reviewed during the application process.

<sup>10</sup> Average statewide trip length, per CalEEMod.

**Equation 15: Auto Emission Reductions for Year 1 of the New/Expanded Service**

$$\text{Auto Emission Reductions (Yr 1)} = \frac{(\text{Annual VMT Reduced}_{Yr 1}) * \text{AVEF}_{Yr 1}}{U}$$

<i>Where,</i>		<u>Units</u>
<i>Auto Emission Reductions (Yr 1)</i>	= Auto GHG or criteria and toxic air pollutant emission estimates for Year 1	MTCO <sub>2</sub> e or lbs.
<i>Annual VMT Reduced<sub>Yr 1</sub></i>	= Annual auto VMT reductions from new/expanded service for Year 1	VMT
<i>AVEF<sub>Yr 1</sub></i>	= Auto Vehicle Emission Factor by county for Year 1	g/mile
<i>U</i>	= Unit conversion factor (1,000,000 for grams to metric tons; 453.59 for grams to pounds)	g/MT or g/lb.

**Equation 16: Auto Emission Reductions for Year F of the New/Expanded Service**

$$\text{Auto Emission Reductions (Yr F)} = \frac{(\text{Annual VMT Reduced}_{Yr F}) * \text{AVEF}_{Yr F}}{U}$$

<i>Where,</i>		<u>Units</u>
<i>Auto Emission Reductions (Yr F)</i>	= Auto GHG or criteria and toxic air pollutant emission estimates for Year F	MTCO <sub>2</sub> e or lbs.
<i>Annual VMT Reduced<sub>Yr F</sub></i>	= Annual auto VMT reductions from new/expanded service for Year 1	VMT
<i>AVEF<sub>Yr F</sub></i>	= Auto Vehicle Emission Factor by county for Year F	g/mile
<i>U</i>	= Unit conversion factor (1,000,000 for grams to metric tons; 453.59 for grams to pounds)	g/MT or g/lb.

**Equation 17: New/Expanded Service Auto Useful Life (UL) Emission Reductions**

*Auto UL Emission Reductions*

$$= \frac{\text{Auto Emission Reductions}_{Yr 1} + \text{Auto Emission Reductions}_{Yr F}}{2} * UL$$

<i>Where,</i> <i>Auto UL Emission Reductions</i>	= Total auto GHG or criteria and toxic air pollutant emission estimates for the useful life of the new/expanded service	<u>Units</u> MTCO <sub>2</sub> e or lbs.
<i>Auto Emission Reductions (Yr 1)</i>	= Auto GHG or criteria and toxic air pollutant emission estimates for Year 1 (from Eq. 15)	MTCO <sub>2</sub> e or lbs.
<i>Auto Emission Reductions (Yr F)</i>	= Auto GHG or criteria and toxic air pollutant emission estimates for Year F (from Eq. 16)	MTCO <sub>2</sub> e or lbs.
<i>UL</i>	= Useful life, as defined as the number of years that the project has enforceable committed funds for operation of the new/expanded service	Years

**Equation 18: New/Expanded Service Vehicle Emissions for Year 1**

$$\text{Service Emissions (Yr 1)} = \frac{(SVMT_{Yr 1}) * SEF_{Yr 1}}{U}$$

<i>Where,</i> <i>Service Emissions (Yr 1)</i>	= Service vehicle GHG or criteria and toxic air pollutant emissions for Year 1 of the new/expanded service	<u>Units</u> MTCO <sub>2</sub> e or lbs.
<i>SVMT<sub>Yr 1</sub></i>	= Annual VMT for the new/expanded service vehicle	VMT
<i>SEF<sub>Yr 1</sub></i>	= Emission factor for the service vehicle for Year 1	g/mile
<i>U</i>	= Unit conversion factor (1,000,000 for grams to metric tons; 453.59 for grams to pounds)	g/MT or g/lb.

**Equation 19: New/Expanded Service Vehicle Emissions for Year F**

$$Service\ Emissions\ (Yr\ F) = \frac{(SVMT_{Yr\ F}) * SEF_{Yr\ F}}{U}$$

<i>Where,</i>		<u>Units</u>
<i>Service Emissions (Yr F)</i>	= Service vehicle GHG or criteria and toxic air pollutant emissions for Year F of the new/expanded service	MTCO <sub>2</sub> e or lbs.
<i>SVMT<sub>Yr F</sub></i>	= Annual VMT for the new/expanded service vehicle	VMT
<i>SEF<sub>Yr F</sub></i>	= Emission factor for the service vehicle for Year F	g/mile
<i>U</i>	= Unit conversion factor (1,000,000 for grams to metric tons; 453.59 for grams to pounds)	g/MT or g/lb.

**Equation 20: New/Expanded Service Vehicle UL Emissions**

$$Service\ UL\ Emissions = \frac{Service\ Emissions_{Yr1} + Service\ Emissions_{YrF}}{2} * UL$$

<i>Where,</i>		<u>Units</u>
<i>Service UL Emissions</i>	= Total service vehicle GHG or criteria and toxic air pollutant emission estimates for the useful life of the new/expanded service	MTCO <sub>2</sub> e or lbs.
<i>Service Emissions (Yr 1)</i>	= Service vehicle GHG or criteria and toxic air pollutant emissions for Year 1 of the new/expanded service (from Eq. 18)	MTCO <sub>2</sub> e or lbs.
<i>Service Emissions (Yr F)</i>	= Service vehicle GHG or criteria and toxic air pollutant emissions for Year F of the new/expanded service (from Eq. 19)	MTCO <sub>2</sub> e or lbs.
<i>UL</i>	= Useful life, as defined as the number of years that the project has enforceable committed funds for operation of the new/expanded service	Years

**Equation 21: New/Expanded Service Total Emission Reductions Estimate**

*New/Expanded Service Total Emission Reductions*

$$= \text{Auto UL Emission Reductions} - \text{Service UL Emissions}$$

<i>Where,</i>		<u>Units</u>
<i>New/Expanded Service Total Emission Reductions</i>	= Total GHG or criteria and toxic air pollutant emission estimates for the useful life of the new/expanded service	MTCO <sub>2e</sub> or lbs.
<i>Auto UL Emission Reductions</i>	= Total auto GHG or criteria and toxic air pollutant emission estimates for the useful life of the new/expanded service (from Eq. 17)	MTCO <sub>2e</sub> or lbs.
<i>Service UL Emissions</i>	= Total service vehicle GHG or criteria and toxic air pollutant emission estimates for the useful life of the new/expanded service (from Eq. 20)	MTCO <sub>2e</sub> or lbs.

**New/Expanded Ferry Service**

**Equation 22: Annual VMT of Displaced Autos from New/Expanded Ferry Service**

$$\text{Annual Auto VMT Reduced from New/Expanded Ferry Service} = D * R * A * L$$

<i>Where,</i>		<u>Units</u>
<i>D</i>	= Annual days of operation of new/expanded service	Days
<i>R</i>	= Increase in daily ridership of new/expanded service	Riders/day
<i>A</i>	= Adjustment factor for transit dependency	N/A
<i>L</i>	= Length of average auto trip reduced	Miles

**Note:** If the Ridership will vary over the life of the project, the applicant must calculate the Annual Auto VMT Reduced for the both first and last year of project operation. Applicants are required to work with transit agency partners to provide these values and document how these values were derived; the supporting documentation will be reviewed during the application process.

**Equation 23: Auto Emission Reductions for Year 1 of the New/Expanded Ferry Service**

$$\text{Auto Emission Reductions (Yr 1)} = \frac{(\text{Annual VMT Reduced}_{Yr 1}) * \text{AVEF}_{Yr 1}}{U}$$

<p>Where,  <i>Auto Emission Reductions (Yr 1)</i></p>	<p>= Auto GHG or criteria and toxic air pollutant emission estimates for Year 1</p>	<p><u>Units</u>                  MTCO<sub>2</sub>e                  or lbs.</p>
<p><i>Annual VMT Reduced<sub>Yr 1</sub></i></p>	<p>= Annual auto VMT reductions from new/expanded service for Year 1</p>	<p>VMT</p>
<p><i>AVEF<sub>Yr 1</sub></i></p>	<p>= Auto Vehicle Emission Factor by county for Year 1</p>	<p>g/mile</p>
<p><i>U</i></p>	<p>= Unit conversion factor (1,000,000 for grams to metric tons; 453.59 for grams to pounds)</p>	<p>g/MT or g/lb.</p>

**Equation 24: Auto Emission Reductions for Year F of the New/Expanded Ferry Service**

$$\text{Auto Emission Reductions (Yr F)} = \frac{(\text{Annual VMT Reduced}_{Yr F}) * \text{AVEF}_{Yr F}}{U}$$

<p>Where,  <i>Auto Emission Reductions (Yr F)</i></p>	<p>= Auto GHG or criteria and toxic air pollutant emission estimates for Year F</p>	<p><u>Units</u>                  MTCO<sub>2</sub>e                  or lbs.</p>
<p><i>Annual VMT Reduced<sub>Yr F</sub></i></p>	<p>= Annual auto VMT reductions from new/expanded service for Year 1</p>	<p>VMT</p>
<p><i>AVEF<sub>Yr F</sub></i></p>	<p>= Auto Vehicle Emission Factor by county for Year F</p>	<p>g/mile</p>
<p><i>U</i></p>	<p>= Unit conversion factor (1,000,000 for grams to metric tons; 453.59 for grams to pounds)</p>	<p>g/MT or g/lb.</p>

**Equation 25: New/Expanded Ferry Service Auto UL Emission Reductions**

*Auto UL Emission Reductions*

$$= \frac{\text{Auto Emission Reductions}_{Yr 1} + \text{Auto Emission Reductions}_{Yr F}}{2} * UL$$

<i>Where,</i> <i>Auto UL Emission Reductions</i>	= Total auto GHG or criteria and toxic air pollutant emission estimates for the useful life of the new/expanded service	<u>Units</u> MTCO <sub>2</sub> e or lbs.
<i>Auto Emission Reductions (Yr 1)</i>	= Auto GHG or criteria and toxic air pollutant emission estimates for Year 1 (from Eq. 15)	MTCO <sub>2</sub> e or lbs.
<i>Auto Emission Reductions (Yr F)</i>	= Auto GHG or criteria and toxic air pollutant emission estimates for Year F (from Eq. 16)	MTCO <sub>2</sub> e or lbs.
<i>UL</i>	= Useful life, as defined as the number of years that the project has enforceable committed funds for operation of the new/expanded service	Years

**Equation 26: New/Expanded Ferry Emissions for Year 1**

$$\text{Service Emissions (Yr 1)} = \frac{(\text{Fuel Consumption}_{Yr 1}) * FEF}{U}$$

<i>Where,</i> <i>Service Emissions (Yr 1)</i>	= Service vehicle GHG or criteria and toxic air pollutant emissions for Year 1 of the new/expanded service	<u>Units</u> MTCO <sub>2</sub> e or lbs.
<i>Fuel Consumption<sub>Yr 1</sub></i>	= Amount of fuel consumed by the ferry in Year 1	Gallons of diesel
<i>FEF</i>	= Carbon intensity emission factor for the ferry, according to the type of fuel consumed	g/unit of fuel
<i>U</i>	= Unit conversion factor (1,000,000 for grams to metric tons; 453.59 for grams to pounds)	g/MT or g/lb.



**Equation 27: New/Expanded Ferry Emissions for Year F**

$$Service\ Emissions\ (Yr\ F) = \frac{(Fuel\ Consumption_{Yr\ F}) * FEF}{U}$$

<i>Where,</i>		<u>Units</u>
<i>Service Emissions (Yr F)</i>	= Service vehicle GHG or criteria and toxic air pollutant emissions for Year F of the new/expanded service	MTCO <sub>2e</sub> or lbs.
<i>Fuel Consumption<sub>Yr F</sub></i>	= Amount of fuel consumed by the ferry in Year F	Gallons of diesel
<i>FEF</i>	= Carbon intensity emission factor for the ferry, according to the type of fuel consumed	g/unit of fuel
<i>U</i>	= Unit conversion factor (1,000,000 for grams to metric tons; 453.59 for grams to pounds)	g/MT or g/lb.

**Equation 28: New/Expanded Ferry Service Vehicle UL Emissions**

$$Service\ UL\ Emissions = \frac{Service\ Emissions_{Yr1} + Service\ Emissions_{YrF}}{2} * UL$$

<i>Where,</i>		<u>Units</u>
<i>Service UL Emissions</i>	= Total ferry GHG or criteria and toxic air pollutant emission estimates for the useful life of the new/expanded service	MTCO <sub>2e</sub> or lbs.
<i>Service Emissions (Yr 1)</i>	= Ferry GHG or criteria and toxic air pollutant emissions for Year 1 of the new/expanded service (from Eq. 26)	MTCO <sub>2e</sub> or lbs.
<i>Service Emissions (Yr F)</i>	= Ferry GHG or criteria and toxic air pollutant emissions for Year F of the new/expanded service (from Eq. 27)	MTCO <sub>2e</sub> or lbs.
<i>UL</i>	= Useful life, as defined as the number of years that the project has enforceable committed funds for operation of the new/expanded service	Years

**Equation 29: New/Expanded Ferry Service Total Emission Reductions Estimate**

*New/Expanded Ferry Service Total Emission Reductions*

$$= \text{Auto UL Emission Reductions} - \text{Service UL Emissions}$$

<i>Where,</i>		<u>Units</u>
<i>New/Expanded Service Total Emission Reductions</i>	= Total GHG or criteria and toxic air pollutant emission estimates for the useful life of the new/expanded ferry service	MTCO <sub>2e</sub> or lbs.
<i>Auto UL Emission Reductions</i>	= Total auto GHG or criteria and toxic air pollutant emission estimates for the useful life of the new/expanded ferry service (from Eq. 25)	MTCO <sub>2e</sub> or lbs.
<i>Ferry Service UL Emissions</i>	= Total ferry GHG or criteria and toxic air pollutant emission estimates for the useful life of the new/expanded service (from Eq. 28)	MTCO <sub>2e</sub> or lbs.

**Capital Improvements**

**Equation 30: Annual VMT of Displaced Autos from Capital Improvements**

$$\text{Annual Auto VMT Reduced} = D * R * A * L$$

<i>Where,</i>		<u>Units</u>
<i>D</i>	= Annual days of operation of new/expanded service (365 for capital improvements)	Days
<i>R</i>	= Increase in daily ridership of new/expanded service	Riders/day
<i>A</i>	= Adjustment factor for transit dependency	N/A
<i>L</i>	= Length of average auto trip reduced	Miles

**Note:** If the Ridership will vary over the life of the project, the applicant must calculate the Annual Auto VMT reduced for the first and last year of the project operation. Applicants are required to work with transit agency partners to provide these values and document how these values were derived; the supporting documentation will be reviewed during the application process.

**Equation 31: Auto Emission Reductions for Year 1 of the Capital Improvement**

$$\text{Auto Emission Reductions (Yr 1)} = \frac{(\text{Annual VMT Reduced}_{Yr 1}) * \text{AVEF}_{Yr 1}}{U}$$

<i>Where,</i>		
<i>Auto Emission Reductions (Yr 1)</i>	= Auto GHG or criteria and toxic air pollutant emission estimates for Year 1	<u>Units</u> MTCO <sub>2</sub> e or lbs.
<i>Annual VMT Reduced<sub>Yr 1</sub></i>	= Annual auto VMT reductions from the capital improvement for Year 1	VMT
<i>AVEF<sub>Yr 1</sub></i>	= Auto Vehicle Emission Factor by county for Year 1	g/mile
<i>U</i>	= Unit conversion factor (1,000,000 for grams to metric tons; 453.59 for grams to pounds)	g/MT or g/lb.

**Equation 32: Auto Emission Reductions for Year F of the Capital Improvement**

$$\text{Auto Emission Reductions (Yr F)} = \frac{(\text{Annual VMT Reduced}_{Yr F}) * \text{AVEF}_{Yr F}}{U}$$

<i>Where,</i>		
<i>Auto Emission Reductions (Yr F)</i>	= Auto GHG or criteria and toxic air pollutant emission estimates for Year F	<u>Units</u> MTCO <sub>2</sub> e or lbs.
<i>Annual VMT Reduced<sub>Yr F</sub></i>	= Annual auto VMT reductions from the capital improvement for Year F	VMT
<i>AVEF<sub>Yr F</sub></i>	= Auto Vehicle Emission Factor by county for Year F	g/mile
<i>U</i>	= Unit conversion factor (1,000,000 for grams to metric tons; 453.59 for grams to pounds)	g/MT or g/lb.

**Equation 33: Capital Improvement Auto UL Emission Reductions**

*Auto UL Emission Reductions*

$$= \frac{\text{Auto Emission Reductions}_{Yr 1} + \text{Auto Emission Reductions}_{Yr F}}{2} * UL$$

<i>Where,</i> <i>Auto UL Emission Reductions</i>	= Total auto GHG or criteria and toxic air pollutant emission estimates for the useful life of the capital improvement	<u>Units</u> MTCO <sub>2</sub> e or lbs.
<i>Auto Emission Reductions (Yr 1)</i>	= Auto GHG or criteria and toxic air pollutant emission estimates for Year 1 (from Eq. 31)	MTCO <sub>2</sub> e or lbs.
<i>Auto Emission Reductions (Yr F)</i>	= Auto GHG or criteria and toxic air pollutant emission estimates for Year F (from Eq. 32)	MTCO <sub>2</sub> e or lbs.
<i>UL</i>	= Useful life, as defined as the number of years that the project has enforceable committed funds for maintenance of the capital improvement	Years

**Pedestrian Facilities, Bicycle Paths, Bicycle Lane, or Bikeways**

**Equation 34: Auto VMT Reductions of Displaced Autos from Bicycle and Pedestrian Facilities**

$$\text{Auto VMT Reduced} = D * ADT * (A + C) * L$$

<i>Where,</i> <i>D</i>	= Annual days of use of new facility (See Table 6)	<u>Units</u> Days
<i>ADT</i>	= Annual average daily traffic on parallel road	Two-way trips/day
<i>A</i>	= Adjustment factor for bike use (See Table 7)	N/A
<i>C</i>	= Activity Center Credit for destinations near project (see Table 8)	N/A
<i>L</i>	= Length of average auto trip reduced (see Table 6)	Miles

**Table 6. Bicycle and Pedestrian Facility Inputs for Eq. 34**

Factor	Description	Default Values
D	Days of use per year of new facility	200
ADT	Annual Average Daily Traffic (two-way traffic volume in trips/day on parallel road. Use applicable value from project data (Maximum = 30,000))	Use project-specific data.
A	Adjustment factor to account for bike use	Use applicable value from Table 7
C	Activity Center Credit near project	Use applicable value from Table 8
L	Length of walk or bike trip in one direction	1.0 mile per walk trip 1.8 miles per bike trip

**Table 7. Adjustment Factor (A) Lookup for Eq. 34**

Average Daily Traffic (ADT)	Length of Bike Project (one direction)	A (for cities >250,000 and non-university towns <250,000)	A (for university towns with population <250,000)
ADT ≤ 12,000 vehicles per day	≤ 1 mile	.0019	.0104
	> 1 & ≤ 2 miles	.0029	.0155
	> 2 miles	.0038	.0207
12,000 < ADT ≤ 24,000 vehicles per day	≤ 1 mile	.0014	.0073
	> 1 & ≤ 2 miles	.0020	.0109
	> 2 miles	.0027	.0145
24,000 < ADT ≤ 30,000 vehicles per day Maximum is 30,000	≤ 1 mile	.0010	.0052
	> 1 & ≤ 2 miles	.0014	.0078
	> 2 miles	.0019	.0104

**Table 8. Activity Center (C) Lookup for Eq. 34**

Count your Activity Centers. If there are...	Within 1/2 mile of Project Area	Within 1/4 mile of Project Area
3	.0005	.001
More than 3 but fewer than 7	.0010	.002
7 or more	.0015	.003

**Activity Center examples:** Bank, church, hospital or HMO, light rail station (park & ride), office park, post office, public library, shopping area or grocery store, university, or junior college. These metrics should be evaluated for the project location site and surrounding area which can extend a distance from the housing development not to exceed one-half (½) mile.

**Equation 35: Auto Emission Reductions for Year 1 of Bicycle or Pedestrian Facility**

$$Auto\ Emission\ Reductions\ (Yr\ 1) = \frac{(Annual\ VMT\ Reduced_{Yr\ 1}) * AVEF_{Yr\ 1}}{U}$$

Where,		<u>Units</u>
Auto Emission Reductions (Yr 1)	= Auto GHG or criteria and toxic air pollutant emission estimates for Year 1	MTCO <sub>2e</sub> or lbs.
Annual VMT Reduced <sub>Yr 1</sub>	= Annual auto VMT reductions from the bicycle or pedestrian facility for Year 1	VMT
AVEF <sub>Yr 1</sub>	= Auto Vehicle Emission Factor by county for Year 1	g/mile
U	= Unit conversion factor (1,000,000 for grams to metric tons; 453.59 for grams to pounds)	g/MT or g/lb.

**Equation 36: Auto Emission Reductions for Year 1 of Bicycle or Pedestrian Facility**

$$Auto\ Emission\ Reductions\ (Yr\ F) = \frac{(Annual\ VMT\ Reduced_{Yr\ F}) * AVEF_{Yr\ F}}{U}$$

Where,		<u>Units</u>
Auto Emission Reductions (Yr F)	= Auto GHG or criteria and toxic air pollutant emission estimates for Year F	MTCO <sub>2e</sub> or lbs.
Annual VMT Reduced <sub>Yr F</sub>	= Annual auto VMT reductions from the bicycle or pedestrian facility for Year F	VMT
AVEF <sub>Yr F</sub>	= Auto Vehicle Emission Factor by county for Year F	g/mile
U	= Unit conversion factor (1,000,000 for grams to metric tons; 453.59 for grams to pounds)	g/MT or g/lb.

**Equation 37: Bicycle and Pedestrian Facility Auto UL Emission Reductions**

*Auto UL Emission Reductions*

$$= \frac{\text{Auto Emission Reductions}_{Yr 1} + \text{Auto Emission Reductions}_{Yr F}}{2} * UL$$

<i>Where,</i>		<u>Units</u>
<i>Auto UL Emission Reductions</i>	= Total auto GHG or criteria and toxic air pollutant emission estimates for the useful life of the bicycle or pedestrian facility	MTCO <sub>2</sub> e or lbs.
<i>Auto Emission Reductions (Yr 1)</i>	= Auto GHG or criteria and toxic air pollutant emission estimates for Year 1 (from Eq. 35)	MTCO <sub>2</sub> e or lbs.
<i>Auto Emission Reductions (Yr F)</i>	= Auto GHG or criteria and toxic air pollutant emission estimates for Year F (from Eq. 36)	MTCO <sub>2</sub> e or lbs.
<i>UL</i>	= Useful life, as defined as 20 years for pedestrian and Class 1 facilities and 15 years for Class 2 and Class 4 facilities	Years

**Bike Share**

The emission reductions from Bike Share projects that result in an increase in bike trips are calculated as the emission reductions from displaced autos.

**Equation 38: Auto VMT Reductions from Bike Share**

*Auto VMT Reduced* =  $T * A * L$

<i>Where,</i>		<u>Units</u>
<i>T</i>	= Total number of trips using bike share expected in first year of service	Trips
<i>A</i>	= Adjustment factor to account for induced demand and recreational use (see Table 9)	N/A
<i>L</i>	= Length of bike trip in one direction (see Table 9)	Miles

**Table 9. Bike Share Inputs for Eq. 38**

Factor	Description	Default Values
T	Total number of bike trips using bike share bikes expected in the first year of service	Use project-specific data
A	Adjustment factor to account for induced demand and non-utilitarian and/or non-commute use	Default is 0.5
L	Length of bike trip in one direction	1.8 miles per bike trip



**Note:** Applicants are encouraged to work with bike share partners to develop a reasonable estimate for bike trips based on project features and amenities installed as part of the proposed AHSC project; supporting documentation on how the input was derived will be reviewed during the application process. As an example, if a new bike share project includes installation of 20 bikes for a residential community for commuting purposes, it is reasonable to assume a fraction of the bikes will be used for a fraction of the year. An applicant who assumes 50% of the 20 bikes would be used on weekdays (i.e., 260 days) instead of driving would result in 5200 trips eliminated per year (where 10 bike trips each way results in 20 one-way trips).

**Equation 39: Auto Emission Reductions for Year 1 of Bike Share**

$$\text{Auto Emission Reductions (Yr 1)} = \frac{(\text{Annual VMT Reduced}_{Yr 1}) * \text{AVEF}_{Yr 1}}{U}$$

<i>Where,</i>		<u>Units</u>
<i>Auto Emission Reductions (Yr 1)</i>	= Auto GHG or criteria and toxic air pollutant emission estimates for Year 1	MTCO <sub>2</sub> e or lbs.
<i>Annual VMT Reduced<sub>Yr 1</sub></i>	= Annual auto VMT reductions from the bike share for Year 1	VMT
<i>AVEF<sub>Yr 1</sub></i>	= Auto Vehicle Emission Factor by county for Year 1	g/mile
<i>U</i>	= Unit conversion factor (1,000,000 for grams to metric tons; 453.59 for grams to pounds)	g/MT or g/lb.

**Equation 40: Auto Emission Reductions for Year F of Bike Share**

$$\text{Auto Emission Reductions (Yr F)} = \frac{(\text{Annual VMT Reduced}_{Yr F}) * \text{AVEF}_{Yr F}}{U}$$

<i>Where,</i>		<u>Units</u>
<i>Auto Emission Reductions (Yr F)</i>	= Auto GHG or criteria and toxic air pollutant emission estimates for Year F	MTCO <sub>2</sub> e or lbs.
<i>Annual VMT Reduced<sub>Yr F</sub></i>	= Annual auto VMT reductions from the bike share for Year F	VMT
<i>AVEF<sub>Yr F</sub></i>	= Auto Vehicle Emission Factor by county for Year F	g/mile
<i>U</i>	= Unit conversion factor (1,000,000 for grams to metric tons; 453.59 for grams to pounds)	g/MT or g/lb.

**Equation 41: Bike Share Auto UL Emission Reductions**

*Auto UL Emission Reductions*

$$= \frac{\text{Auto Emission Reductions}_{Yr 1} + \text{Auto Emission Reductions}_{Yr F}}{2} * UL$$

<i>Where,</i>		
<i>Auto UL Emission Reductions</i>	= Total auto GHG or criteria and toxic air pollutant emission estimates for the useful life of the bike share	<u>Units</u> MTCO <sub>2</sub> e or lbs.
<i>Auto Emission Reductions (Yr 1)</i>	= Auto GHG or criteria and toxic air pollutant emission estimates for Year 1 (from Eq. 39)	MTCO <sub>2</sub> e or lbs.
<i>Auto Emission Reductions (Yr F)</i>	= Auto GHG or criteria and toxic air pollutant emission estimates for Year F (from Eq. 40)	MTCO <sub>2</sub> e or lbs.
<i>UL</i>	= Useful life, as defined as 10 years for a bike share project	Years

