APPENDIX D

QUANTIFICATION METHODOLOGY

Clean Mobility in Schools Pilot Project
For Fiscal Year 2018-19

Mobile Source Control Division
California Air Resources Board
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List of Acronyms and Abbreviations

Acronym	Term
bhp	brake horse power
CARB	California Air Resources Board
Diesel PM	diesel particulate matter
GGRF	Greenhouse Gas Reduction Fund
GHG	greenhouse gas
kWh	kilowatt hours
lbs	pounds
MJ	megajoule
$MTCO_2e$	metric tons of carbon dioxide equivalent
NOx	nitrous oxide
$PM_{2.5}$	particulate matter with a diameter less than 2.5 micrometers
PV	photovoltaic
ROG	reactive organic gas
scf	standard cubic foot
UTV	utility terrain vehicle
VMT	vehicle miles traveled

List of Definitions

Term	Definition
Baseline vehicle	The vehicle that is currently owned/in operation that will be replaced by a new zero- or near zero-emission vehicle purchase, or the vehicle that would have been purchased if not for this project (e.g., 2020 diesel bus).
Charging infrastructure	For the purposes of the Clean Mobility in Schools Quantification Methodology, charging infrastructure is a quantifiable project element when it supports vehicles that are not proposed for funding by GGRF (including Clean Mobility in Schools). Charging infrastructure that supports vehicles that will be funded by GGRF is not a quantifiable project element because the emission reductions associated with the charging infrastructure will already be included in the vehicle's quantification of benefits.
Co-benefit	A social, economic, or environmental benefit as a result of the proposed project in addition to the GHG reduction benefit.
Energy/fuel cost savings	Changes in energy and fuel costs to the operator as a result of changing the quantity of energy or fuel used, conversion to an alternative energy or fuel source, and renewable energy or fuel generation.

Term	Definition
Key variable	Project characteristics that contribute to a project's GHG emission reductions and signal an additional benefit (e.g., passenger VMT reductions, renewable energy generated).
New service	Project type that identifies project elements that result in a new transportation service. This may include expansion of an existing service. Examples: establishing a new car sharing program for school district staff or adding new vehicles to an existing car sharing service.
Project element	A single component of the proposed project, further defined in the Clean Mobility in Schools solicitation materials.
Project type	For the purposes of the Clean Mobility in Schools Quantification Methodology, eligible projects fall into five project types that meet the objectives of the pilot project and for which there are methods to quantify GHG emission reductions.
Quantification period	Number of years that the project element will provide GHG emission reductions. Sometimes also referred to as "Useful Life" or "Project Implementation Time Frame."
Replacement	Identifies project elements that replace baseline fossil fuel vehicles with zero- or near zero-emission vehicles without resulting in new service.
Travel cost savings	Changes in travel costs to the user as a result of switching travel modes.

Section A. Introduction

California Climate Investments is a statewide initiative that puts billions of Cap-and-Trade dollars to work facilitating 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.

CARB is responsible for providing guidance on estimating the GHG emission reductions and co-benefits from projects receiving monies from the GGRF. This guidance includes quantification methodologies, co-benefit assessment methodologies, and benefits calculator tools. CARB develops these methodologies and tools based on the elements eligible for funding by each administering agency, as reflected in the program expenditure records available at: www.arb.ca.gov/cci-expenditurerecords.

For the CARB Clean Mobility in Schools Pilot Project, CARB staff developed this Clean Mobility in Schools Quantification Methodology to provide guidance for estimating the GHG emission reductions and selected co-benefits of each proposed element. This methodology estimates GHG emission reductions from new and subsidized transportation service, vehicle replacement, and renewable energy projects.

The Clean Mobility in Schools 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 Clean Mobility in Schools Benefits Calculator Tool as well as the total project GHG emission reductions per thousand dollars of GGRF funds requested. The Clean Mobility in Schools 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 Clean Mobility in Schools Benefits Calculator Tool will estimate the following co-benefits and key variables from Clean Mobility in Schools projects:

- ROG emission reductions (lbs)
- NO_x emission reductions (lbs)
- $PM_{2.5}$ emission reductions (lbs)
- diesel PM emission reductions (lbs)
- passenger VMT reductions (miles)
- fossil fuel use reductions (gallons)
- renewable energy generated (kWh)
- fossil fuel energy use reductions (kWh)
- travel cost savings ($)
- energy/fuel cost savings ($)

Additional co-benefits for which CARB assessment methodologies were not incorporated into the Clean Mobility in Schools Benefits Calculator Tool may also be applicable to the project. Applicants should consult the Clean Mobility in Schools solicitation materials[1] to ensure they are meeting Clean Mobility in Schools requirements. All CARB co-benefit assessment methodologies are available at: www.arb.ca.gov/cci-cobenefits.

Methodology Development

CARB developed this Quantification Methodology consistent with the guiding principles of California Climate Investments, including ensuring transparency and accountability.[2] CARB developed this Clean Mobility in Schools Quantification Methodology to be used to estimate the outcomes of proposed projects, inform project selection, and track results of funded projects. CARB also consulted with Clean Mobility in Schools program staff to determine project-level inputs available. 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 Clean Mobility in Schools project types. The methods were developed to provide estimates that are as accurate as possible with data readily available at the project level.

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, specifically transit and connectivity (TAC) features.[3] 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 and toxic 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

[1] https://ww2.arb.ca.gov/our-work/programs/low-carbon-transportation-investments-and-air-quality-improvement-program/low
[2] California Air Resources Board. www.arb.ca.gov/cci-fundingguidelines
[3] 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. www.arb.ca.gov/planning/tsaq/eval/eval.htm.

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: www.arb.ca.gov/planning/tsaq/eval/eval.htm.

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 strengthening community engagement. Co-benefit assessment methodologies are posted at: www.arb.ca.gov/cci-cobenefits.

Tools

The Clean Mobility in Schools Benefits Calculator Tool relies on project-specific outputs from the following tools:

The National Renewable Energy Laboratory PVWatts® Calculator is a web-based tool that estimates the electricity production of a grid-connected roof- or ground-mounted solar PV system based on simple inputs. PVWatts calculates estimated values for the proposed system's monthly and annual electricity production. The tool is publicly available to anyone with internet access and is free of charge. It is subject to regular updates to incorporate new information. The tool can be accessed at: http://pvwatts.nrel.gov/.

In addition to the tool above, the Clean Mobility in Schools Benefits Calculator Tool relies on CARB-developed emission factors. CARB has established a single repository for emission factors used in CARB benefits 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's benefits calculator tools are developed and updated.

Applicants must use the Clean Mobility in Schools Benefits Calculator Tool to estimate the GHG emission reductions and co-benefits of the proposed project. The Draft Benefits Calculator Tool and Draft Quantification Methodology are subject to change, pending stakeholder comments and Final Clean Mobility in Schools Grant Solicitation. The Clean Mobility in Schools Benefits Calculator Tool can be downloaded from: http://www.arb.ca.gov/cci-resources.

Section B. Methods

The following section provides details on the methods supporting emission reductions in the Clean Mobility in Schools Benefits Calculator Tool.

Project Elements and Project Types

For quantification purposes, CARB defined six **Project Types** and, contained within those project types, eleven **Project Elements** that meet the objectives of Clean Mobility in Schools and for which there are methods to quantify GHG emission reductions.[4]

Other project features may be eligible for funding under Clean Mobility in Schools, even if no quantification methodology is provided here; however, each project requesting GGRF funding must include at least one of the listed project elements shown in Table 1 below.

Table 1. Project Elements by Project Type

Project Element	Project Type
School Buses (New service)	New Service
Other School District Fleet Vehicles (New service)	
Car Share (New service)	
Charging Infrastructure (To support new service vehicles not funded by GGRF)	
Bicycle Sharing	
School Buses (Replacement)	Vehicle Replacement
Other School District Fleet Vehicles (Replacement)	
Car Share (Replacement)	
Motorized Utility Vehicles	
Charging Infrastructure (To support replacement vehicles not funded by GGRF)	
Lawn and Garden Equipment	Equipment Replacement
Solar Installation	Solar PV Generation
Bicycle Paths or Lanes, and Pedestrian Facilities	Active Transportation Infrastructure
Car Share/Bicycle Sharing Vouchers or Subsidies	Shared Mobility Service Subsidies
Public Transit Vouchers or Subsidies	Transit Subsidies

[4] https://ww2.arb.ca.gov/our-work/programs/low-carbon-transportation-investments-and-air-quality-improvement-program/low

General Approach

Methods used in the Clean Mobility in Schools Benefits Calculator Tool for estimating the GHG emission reductions, air pollutant emission co-benefits, and key variables by project type are provided in this section. These methods account for emission reductions from displaced vehicle miles traveled, vehicle and equipment replacement, and the generation and use of renewable fuels/energy. The Database Documentation explains how emission factors used in CARB benefits calculator tools are developed and updated.

In general, the GHG and air pollutant emission reductions are estimated in the Clean Mobility in Schools Benefits Calculator Tool using the quantification approaches by project type outlined in Table 2 below.

Table 2. General Approach to Quantification by Project Type

Project Types and Quantification Approaches
New Service & Shared Mobility Service Subsidies
Emission Reductions = Emission Reductions from Displaced Autos – Emissions from New Service
Vehicle Replacement
Emission Reductions = Emission Reductions from Displaced (Baseline) Vehicle – Emissions from New Vehicle
Equipment Replacement
Emission Reductions = Emission Reductions from Displaced (Baseline) Equipment – Emissions from New Equipment
Solar PV Generation
Emission Reductions = Emission Reductions from Displaced Grid Emissions
Active Transportation Infrastructure
Emission Reductions = Emission Reductions from Displaced Autos
Transit Subsidies
Emission Reductions = Emission Reductions from Displaced Autos

A. Emission Reductions from New Service & Shared Mobility Service Subsidies

Equation 1 estimates both the GHG and air pollutant emission reductions from New Service and Shared Mobility Service Subsidies, calculated as the difference between the emission reductions from displaced autos and emissions associated with operation of the new service.

Equation 1: Emission Reduction from New Service

$$E = E_{Reduced} - E_{New}$$

Where,			Units
E	=	Net emission reductions	$MTCO_2e$ or lbs
$E_{Reduced}$	=	Total emission reductions from displaced auto VMT	$MTCO_2e$ or lbs
E_{New}	=	Total emissions from new service	$MTCO_2e$ or lbs

Equation 2 calculates the total emission reductions associated with auto VMT displaced by the new service.

Equation 2: Emission Reductions from Displaced Auto VMT

$$E_{Reduced} = \frac{E_{Reduced\_Yr1} + E_{Reduced\_YrF}}{2} \times QP$$

Where,			Units
$E_{Reduced}$	=	Total emission reductions from displaced auto VMT	$MTCO_2e$ or lbs
$E_{Reduced\_Yr1}$	=	Emission reductions from displaced auto VMT in first year	$MTCO_2e$/year or lbs/year
$E_{Reduced\_YrF}$	=	Emission reductions from displaced auto VMT in final year	$MTCO_2e$/year or lbs/year
QP	=	Quantification period	years

Equation 3 calculates the annual emission reductions associated with auto VMT displaced by the new service.

Equation 3: Annual Emission Reductions from Displaced Auto VMT

$$E_{Reduced\_Yr} = \frac{AutoVMT_{Displaced\_Yr} \times EF_{Yr}}{CF}$$

Where,			Units
$E_{Reduced\_Yr}$	=	Annual emission reductions from displaced auto VMT	$MTCO_2e$/year or lbs/year
$AutoVMT_{Displaced\_Yr}$	=	Estimated VMT displaced in the first or final year attributed to the operation of the new service	miles/year
EF_{Yr}	=	Emission factor in the first or final year (based on weighted fleet average)	grams/mile
CF	=	Conversion factor	grams/MT or grams/lb

Equation 4 calculates the annual auto VMT displaced by the new service.

Equation 4: Annual Auto VMT Displaced

$$AutoVMT_{Displaced\_Yr} = R_{Yr} \times V_{Yr} \times T_{Yr} \times A \times L$$

Where,			Units
$AutoVMT_{Displaced\_Yr}$	=	Annual auto VMT displaced in the first or final year	miles/year
R_{Yr}	=	Number of riders per vehicle in the first or final year. Default: 1 for bikeshare.	rider(s)/vehicle
V_{Yr}	=	Number of vehicles directly associated with the project in the first or final year	vehicles
T_{Yr}	=	Number of annual trips per vehicle expected directly associated with the project in the first or final year	trips/vehicle
A	=	Adjustment factor to account for transit dependency and induced trips. Use documented, project-specific data; system average developed from recent, statistically-valid survey; or default. Default: 0.5 for local service and bikeshare; 0.83 for long distance service, shuttle, and vanpools; 0.27 for car share services.	unitless
L	=	Estimated length of average vehicle trip directly associated with the project	mile(s)/trip

Equation 5 calculates the total emissions associated with operation of the new service.

Equation 5: Emissions from New Service

$$E_{New} = \frac{E_{New\_Yr1} + E_{New\_YrF}}{2} \times QP$$

Where,			Units
E_{New}	=	Total emissions from new service	$MTCO_2e$ or lbs
E_{New_Yr1}	=	Emissions from new service in first year	$MTCO_2e$/year or lbs/year
E_{New_YrF}	=	Emissions from new service in final year	$MTCO_2e$/year or lbs/year
QP	=	Quantification period	years

Equation 6 calculates the annual emissions associated with operation of the new service.

Equation 6: Annual Emissions from New Service

$$E_{New\_Yr} = \frac{NSVMT \times NSEF_{Yr} \times HDR \times \%RE}{CF}$$

Where,			Units
E_{New_Yr}	=	Annual emissions from new service in first or final year	$MTCO_2e$/year or lbs/year
NSVMT	=	Estimated annual VMT attributed to the operation of the new service in first or final year	miles
$NSEF_{Yr}$	=	Emission factor based on service type, in the first or final year	grams/mile
HDR	=	Hybrid discount rate, if applicable (0.8)	unitless
%RE	=	Percent renewable electricity purchased/generated, if applicable[5]	unitless
CF	=	Conversion factor	grams/MT or grams/lb

Equation 7 calculates the annual VMT from the new service.

Equation 7: Annual VMT of New Service

$$NSVMT = V_{Yr} \times T_{Yr} \times L$$

Where,			Units
NSVMT	=	Annual new service VMT in first or final year	miles/year
V_{Yr}	=	Number of vehicles directly associated with the project in first or final year	vehicles
T_{Yr}	=	Number of annual trips per vehicle expected in first or final year directly associated with the project	trips/vehicle
L	=	Estimated length of average vehicle trip directly associated with the project	mile(s)/trip

B. Emission Reductions from Vehicle Replacement

Equation 8 estimates both the GHG and air pollutant emission reductions from Vehicle Replacement as the difference between the emissions associated with the baseline vehicle and emissions associated with the new vehicle.

Equation 8: Emission Reduction from Vehicle Replacement

$$E = E_{Vehicle\_Baseline} - E_{Vehicle\_New}$$

Where,			Units
E	=	Net emission reductions	$MTCO_2e$ or lbs
$E_{Vehicle\_Baseline}$	=	Total emissions from baseline vehicle	$MTCO_2e$ or lbs
$E_{Vehicle\_New}$	=	Total emissions from new vehicle	$MTCO_2e$ or lbs

Equation 9 calculates the emissions associated with the baseline and new vehicles.

Equation 9: Emissions from Baseline and New Vehicle

$$E_{Vehicle} = AnnualE_{Vehicle/UTV} \times QP \times V$$

Where,			Units
$E_{Vehicle}$	=	Total emissions from baseline or new vehicle(s)	$MTCO_2e$ or lbs
$AnnualE_{Vehicle/UTV}$	=	Annual emissions per vehicle from baseline or new vehicle	$MTCO_2e$/year or lbs/year
QP	=	Quantification period	years
V	=	Number of vehicles directly associated with the project	vehicles

Equation 10 calculates the annual emissions associated with the baseline and new vehicles (except for UTVs).

Equation 10: Annual Emissions from Baseline and New Vehicle (except for UTVs)

$$AnnualE_{Vehicle} = \frac{AnnualVMT \times VehicleEF_{Yr} \times HDR \times \%RE}{CF}$$

Where,			Units
$AnnualE_{Vehicle}$	=	Annual emissions per vehicle from baseline or new vehicle	$MTCO_2e$/year or lbs/year
$AnnualVMT$	=	Estimated annual VMT of the new vehicle	miles/year
$VehicleEF_{Yr}$	=	Emission factor, based on project-specific inputs, in the first or final year	grams/mile
HDR	=	Hybrid discount rate, if applicable (0.8)	unitless
$\%RE$	=	Percent renewable electricity purchased/generated, if applicable[6]	unitless
CF	=	Conversion factor	grams/MT or grams/lb

Equation 11 calculates the annual emissions associated with the baseline and new UTVs.

Equation 11: Annual Emissions from Baseline and New UTV

$$AnnualE_{UTV\_Baseline} = \frac{FC_{Baseline} \times CC_{Fuel}}{CF} \; OR \; AnnualE_{UTV\_New} = \frac{EU_{New} \times CC_{Electricity}}{CF}$$

Where,			Units
$AnnualE_{UTV}$	=	Annual emissions per UTV from baseline or new UTV	$MTCO_2e$/year or lbs/year
$FC_{Baseline}$	=	Fuel consumption of the baseline UTV	gallons/year or scf/year
CC_{Fuel}	=	Carbon content (depends on the fuel type)	grams/gallon
EU_{New}	=	Electricity use of the new UTV	kWh/year
$CC_{Electricity}$	=	Carbon content of electricity	grams/kWh
CF	=	Conversion factor	grams/MT or grams/lb

Equation 12 calculates the fuel usage associated with the baseline UTV.

Equation 12: Fuel Usage for Baseline UTV

$$FC_{Baseline} = BSFC \times HP \times LF \times AA \times GC$$

Where,			Units
$FC_{Baseline}$	=	Fuel consumption of the baseline UTV	gallons/year
$BSFC$	=	Brake-specific fuel consumption (fuel-specific)	gallons/bhp per hour
HP	=	Maximum rated horsepower of UTV	bhp
LF	=	Load factor	unitless
AA	=	Average annual hours of operation	hours/year
GC	=	Gallon conversion (fuel-specific)	gallons/lb or gallons/scf

Equation 13 calculates the electricity usage associated with the new UTV.

Equation 13: Electricity Usage for New UTV

$$EU_{New} = \frac{FC_{Baseline} \times ED_{Baseline}}{ED_{Electricity} \times EER}$$

Where,			Units
EU_{New}	=	Electricity use of the new UTV	kWh/year
$FC_{Baseline}$	=	Fuel consumption of the baseline UTV	gallons/year
$ED_{Baseline}$	=	Energy density of the baseline UTV's fuel type	MJ/gallon
$ED_{Electricity}$	=	Energy density of electricity	MJ/kWh
EER	=	Energy efficiency ratio of electricity relative to the baseline UTV's fuel type	unitless

C. Emission Reductions from Equipment Replacement

Equation 14 estimates both the GHG and air pollutant emission reductions from Equipment Replacement by accounting for the difference between the emissions associated with the baseline equipment and emissions associated with the new equipment.

Equation 14: Emission Reduction from Equipment Replacement

$$E = N \times LGEF$$

Where,			Units
E	=	Emission reductions	$MTCO_2e$
N	=	Number of pieces of lawn and garden equipment	pieces of equipment
LGEF	=	Lawn and garden equipment emission factor (accounts for emission reductions from displaced equipment and emissions from new equipment)	MT/piece of equipment

D. Emission Reductions from Solar PV Generation

Equation 15 estimates both the GHG and air pollutant emission reductions from Solar PV Generation as the amount of solar energy the applicant will generate, displacing grid emissions.

Equation 15: Emission Reduction from Solar PV Generation

$$E = \sum_{n=1}^{30} \left(1 - R_{degradation}\right)^{n-1} \times PV_{production} \times EF_{electricity}$$

Where,			Units
E	=	Emission reductions	$MTCO_2e$ or lbs
30	=	Estimated useful life of solar PV systems[7]	years
n	=	Any given year	unitless
$R_{degradation}$	=	Rate of system degradation. Default: 0.5.	% per year
$PV_{production}$	=	Annual electricity generated based on PVWatts Calculator	kWh per year
$EF_{electricity}$	=	Most recent emission factor for electricity, based on project-specific inputs	$MTCO_2e$ per kWh; lbs per kWh

E. Emission Reductions from Active Transportation Infrastructure

Equation 16 estimates both the GHG and air pollutant emission reductions from Active Transportation Infrastructure as the emission reductions from displaced auto VMT.

Equation 16: Emission Reductions from Displaced Auto VMT

$$E = \frac{E_{Reduced\_Yr1} + E_{Reduced\_YrF}}{2} \times QP$$

Where,			Units
E	=	Total emission reductions	$MTCO_2e$ or lbs
$E_{Reduced\_Yr1}$	=	Emission reductions from displaced auto VMT in first year	$MTCO_2e$/year or lbs/year
$E_{Reduced\_YrF}$	=	Emission reductions from displaced auto VMT in final year	$MTCO_2e$/year or lbs/year
QP	=	Quantification period. Default: 20 years for Class I, 15 years for Class II and Class IV bicycle lanes, and 20 years for pedestrian facilities.	years

Equation 17 calculates the annual emission reductions associated with auto VMT displaced by the project.

Equation 17: Annual Emission Reductions from Displaced Auto VMT

$$E_{Reduced\_Yr} = \frac{AutoVMT_{Displaced\_Yr} \times EF_{\mathrm{Yr}}}{CF}$$

Where,			Units
$E_{Reduced\_Yr}$	=	Emission reductions from displaced auto VMT in first or final year	$MTCO_2e$/year or lbs/year
$AutoVMT_{Displaced\_Yr}$	=	Estimated annual VMT displaced in first or final year attributed to use of the active transportation infrastructure	miles/year
EF_{Yr}	=	Emission factor in the first or final year (based on weighted fleet average)	grams/mile
CF	=	Conversion factor	grams/MT or grams/lb

Equation 18 calculates the annual auto VMT displaced by the project.

Equation 18: Annual Auto VMT Displaced

$$AutoVMT_{Displaced\_Yr} = D_{Yr} \times ADT_{Yr} \times (A + C) \times L$$

Where,			Units
$AutoVMT_{Displaced\_Yr}$	=	Annual auto VMT displaced in the first or final year	miles/year
D_{Yr}	=	Days of use per year. Default: 200 days.	days/year
ADT_{Yr}	=	Annual average daily traffic (two-way traffic volume on parallel road). Use applicable value from project data (maximum is 30,000)	trips/day
A	=	Adjustment factor to account for bike/pedestrian use. Use applicable value from Table 3.	unitless
C	=	Key destination credit. Use applicable value from Table 4.	unitless
L	=	Average trip length in one direction. Default: 1.5 miles for bikes, 0.3 miles for pedestrians.	miles/trip

Table 3. Adjustment Factor (A) Lookup Table for Equation 18

Average Daily Traffic (ADT)	Length of Bike/Ped 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	0.0019	0.0104
	> 1 & ≤ 2 miles	0.0029	0.0155
	> 2 miles	0.0038	0.0207
12,000 < ADT ≤ 24,000 vehicles per day	≤ 1 mile	0.0014	0.0073
	> 1 & ≤ 2 miles	0.0020	0.0109
	> 2 miles	0.0027	0.0145
24,000 < ADT ≤ 30,000 vehicles per day Maximum is 30,000	≤ 1 mile	0.0010	0.0052
	> 1 & ≤ 2 miles	0.0014	0.0078
	> 2 miles	0.0019	0.0104

Table 4. Key Destination Credit (C) Lookup Table for Equation 18

Count your Key Destinations. If there are…	Within 1/2 mile of Project Area	Within 1/4 mile of Project Area
Fewer than 3	0	0
3	0.0005	0.001
More than 3 but fewer than 7	0.0010	0.002
7 or more	0.0015	0.003

Applicants should evaluate the number of Key Destinations around each Class I bike path, Class II bike lane, Class IV bikeway, or walkway separately. Applicants should count the number of Key Destinations within ¼ mile and ½ mile of each proposed facility. Eligible Key Destinations include the following:

- Bank or post office
- Child care center
- Grocery store
- Medical center
- Office park
- Pharmacy
- Place of worship
- Public library
- Public park
- School, university, or college
- Transit station

F. Emission Reductions from Transit Subsidies

Equation 19 estimates both the GHG and air pollutant emission reductions from Transit Subsidies as the emission reductions from displaced auto VMT.

Equation 19: Emission Reductions from Displaced Auto VMT

$$E = \frac{E_{Reduced\_Yr1} + E_{Reduced\_YrF}}{2} \times QP$$

Where,			Units
E	=	Total emission reductions	$MTCO_2e$ or lbs
$E_{Reduced\_Yr1}$	=	Emission reductions from displaced auto VMT in first year	$MTCO_2e$/year or lbs/year
$E_{Reduced\_YrF}$	=	Emission reductions from displaced auto VMT in final year	$MTCO_2e$/year or lbs/year
QP	=	Quantification period	years

Equation 20 calculates the annual emission reductions associated with auto VMT displaced by the project.

Equation 20: Annual Emission Reductions from Displaced Auto VMT

$$E_{Reduced\_Yr} = \frac{AutoVMT_{Displaced\_Yr} \times EF_{\mathrm{Yr}}}{CF}$$

Where,			Units
$E_{Reduced\_Yr}$	=	Emission reductions from displaced auto VMT in first or final year	$MTCO_2e$/year or lbs/year
$AutoVMT_{Displaced\_Yr}$	=	Estimated annual VMT displaced in first or final year attributed to use of transit subsidies	miles/year
EF_{Yr}	=	Emission factor in the first or final year (based on weighted fleet average)	grams/mile
CF	=	Conversion factor	grams/MT or grams/lb

Equation 21 calculates the annual auto VMT displaced by the project.

Equation 21: Annual Auto VMT Displaced

$$AutoVMT_{Displaced\_Yr} = R_{Yr} \times A \times L$$

Where,			Units
$AutoVMT_{Displaced\_Yr}$	=	Annual auto VMT displaced in the first or final year	miles/year
R_{Yr}	=	Annual increase in unlinked passenger trips directly associated with the first or final year	riders
A	=	Adjustment factor to account for transit dependency and induced trips. Use documented, project-specific data or system average developed from recent, statistically-valid survey or default. Default: 0.5 for local service or 0.83 for long distance service, shuttle, and vanpools.	unitless
L	=	Estimated length of average unlinked passenger trip directly associated with the proposed project, calculated as passenger-miles divided by unlinked trips. Applicants may use data reported to National Transit Database for similar service.	mile(s) per rider

Section C. References

The following references were used in the development of this Quantification Methodology and the Clean Mobility in Schools Benefits Calculator Tool.

California Air Resources Board. (2018). California Climate Investments Quantification Methodology Emission Factor Database. http://www.arb.ca.gov/cci-resources

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