California Air Resources Board

Quantification Methodology

Strategic Growth Council

Affordable Housing and Sustainable Communities

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, the Draft AHSC Quantification Methodology and the AHSC User Guide until **November 30, 2023** via the *GGRF Program Email.* 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*.

DRAFT
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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 benefits 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*.

For the SGC AHSC Program, CARB 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 VMT from land use, housing, and transportation strategies that support infill, compact, and affordable housing development projects, in addition to GHG emission reductions from solar PV electricity generation.

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. Applicants will estimate and SGC 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 on the *California Climate Investments resources webpage*.

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: Passenger VMT reductions (miles);Net density (dwelling units per acre); Renewable energy generation (kWh); Local and remote ROG emission reductions (lbs); Local and remote NOx emission reductions (lbs); Local and remote PM2.5 emission reductions (lbs); Local diesel PM10 emission reductions (lbs); Fossil fuel use reductions (gallons); Travel cost savings ($); and Energy and fuel cost savings ($). Key variables are project characteristics that contribute to a project's GHG emission reductions] and signal an additional benefit (e.g., renewable energy generated). Additional co-benefits for

which CARB assessment methodologies were not incorporated into the AHSC Benefits Calculator Tool may also be applicable to the project. Applicants should consult the *SGC AHSC Webpage* for AHSC guidelines, solicitation materials, and agreements to ensure they are meeting AHSC requirements. All CARB co-benefit assessment methodologies are available on the *California Climate Investments co-benefits webpage*.

Methodology Development

CARB and SGC developed this Quantification Methodology consistent with the guiding principles of California Climate Investments, including ensuring transparency and accountability, per the *California Climate Investments Funding Guidelines*. CARB and SGC developed this AHSC 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 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.

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)" were the basis for developing the GHG emission reduction estimates for transit and connectivity project features.[1] The CMAQ Methods are equations for evaluating the cost-effectiveness of certain types of transportation projects, such as bicycle paths, vanpools, and new bus services. 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 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 presented in this Quantification

[1] California Air Resources Board and California Department of Transportation. *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. The CMAQ Methods Guide is available on the *CARB CMAQ Program webpage*

Methodology are referred to as Transit and Connectivity Methods. The CMAQ Methods Guide is available on the *CARB CMAQ Program webpage*

To develop VMT reduction estimates for projects that include affordable housing developments, the AHSC Benefits Calculator Tool uses information from the California Statewide Travel Demand Model[2], metropolitan planning organizations[3], the Institute of Transportation Engineers Trip Generation Manual and Parking Generation Manual[4], and the California Air Pollution Control Officers Association "Quantifying Greenhouse Gas Mitigation Measures" report[5] and California Emissions Estimator Model®[6]. The AHSC Benefits Calculator Tool adapts a methodology from this model for ease of use and alignment with the specific requirements of the AHSC Program.

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 on the *California Climate Investments co-benefits webpage*.

The AHSC Quantification Methodology and AHSC Benefits Calculator Tool are applicable only to AHSC project types and should not be used to estimate GHG emission reductions or co-benefits for any projects which do not meet AHSC Program requirements.

Tools

The AHSC Benefits Calculator Tool relies on project-specific outputs from the National Renewable Energy Laboratory PVWatts® Calculator, a web-based tool that estimates the electricity production of grid-connected roof- or ground-mounted solar PV systems. PVWatts calculates estimated values for the proposed system's monthly and annual electricity production. For projects that include solar PV systems, the AHSC Benefits Calculator Tool relies on estimates of solar PV electricity generation from PVWatts. PVWatts is publicly available to anyone with internet access, free of charge, and subject to regular updates to incorporate new information. The tool can be accessed at the *NREL webpage*.

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[2] California Department of Transportation. *California Statewide Travel Demand Model.* 2016. Available through the *Travel Demand Model webpage*.

[3] The Association of Monterey Bay Area Governments, Butte County Association of Governments, Metropolitan Transportation Commission, Sacramento Area Council of Governments, San Luis Obispo Council of Governments, and Southern California Association of Governments provided trip length data for this AHSC Quantification Methodology.

[4] Institute of Transportation Engineers. *Trip Generation Manual, 11th Edition*. 2021 found on the *ITE Trip and Generation Manual webpage*.

[5] California Air Pollution Control Officers Association. *Quantifying Greenhouse Gas Mitigation Measures*. 2010. *Available through report PDF*.

[6] California Air Pollution Control Officers Association. *California Emissions Estimator Model, version 2016.3.2*. 2017.Available through the *Caleemod website*.

In addition to the tool above, the AHSC 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 on the *California Climate Investments resources webpage*. The Database Documentation explains how emission factors used in CARB benefits calculator tools are developed and updated.

Applicants must use the AHSC Benefits Calculator Tool to estimate the GHG emission reductions and co-benefits of the proposed project. The AHSC Benefits Calculator Tool and User Guide can be downloaded from the *California Climate Investments resources webpage*.

Updates

CARB staff periodically review each quantification methodology and benefits calculator tool to evaluate their 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 to enhance the analysis and provide additional clarity (email the *GGRF Program Email* to request a copy of previous versions). The changes include:

- Included instructions in the User Guide and reconfigured the Shared Mobility tab in the AHSC Benefits Calculator Tool for applicants that wish to estimate benefits of shared mobility projects using the Clean Mobility Projects Benefits Calculator Tool. In a previous round, benefits of shared mobility projects were estimated using the calculator tool for the Clean Mobility Options Pilot Program;
- Removed bikeshare from the list of project types in the Active Transportation tab of the AHSC Benefits Calculator Tool. Benefits from bikeshare can instead be estimated using the Clean Mobility Projects Benefits Calculator Tool and entered in the Shared Mobility Inputs tab of the AHSC Benefits Calculator Tool;
- Updated the Default Lookup Table values;
- Added a list of key terms and definitions to the AHSC Benefits Calculator Tool;
- Updated Quantification Methodology reference to ITE Trip Generation Manual 11th Edition; and
- Clarified language in the Quantification Methodology and User Guide where necessary and to respond to public feedback.

Section B. Methods

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

Project Components

SGC developed ten project components that meet the objectives of the AHSC program and for which there are methods to quantify GHG emission reductions based on the *program guidelines*. Other project features may be eligible for funding under the AHSC; however, each project requesting GGRF funding must include at least one of the following:

- Construction or substantial rehabilitation of affordable housing, including mixed-use development, and related infrastructure;
- Grid-connected solar PV system;
- New bicycle facility (bicycle boulevard with traffic calming, Class I bike path, Class II bike lane, Class IV separated bikeway, or Class II to IV conversion);
- New Walkways;
- New or expanded transit service (select from local bus, long distance commuter bus, ferry, heavy rail, light rail, streetcar, cable car, trolley bus, shuttle, vanpool, or bus rapid transit vehicle);
- Capital improvement that encourages mode shift;
- New or expanded carshare, carpool, on-demand transit service, or micro mobility;
- Transit passes for residents;
- New micro mobility subsidies; and
- Transit fare reductions for community members that encourage mode-shift.

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 emission reductions from avoided passenger VMT and the generation of solar PV electricity. In general, the GHG Emission Reductions and are estimated in the AHSC Benefits Calculator Tool using the quantification approaches in Table 1. The AHSC Benefits Calculator Tool also estimates air pollutant emission co-benefits and key variables using many of the same inputs used to estimate GHG emission reductions.

Table 1. General Approach to Quantification by Project Component

Affordable housing development or residential transit subsidy
Emissions from avoided passenger VMT
Solar PV electricity generation
Emissions from avoided grid electricity production
New bicycle facility or walkway
Emissions from displaced autos (less emissions from electric bikes and collection and distribution vehicles, if applicable)
New or expanded transit service and shared mobility
Emissions from displaced autos less emissions from new service vehicle
Capital improvements or transit fare reductions
Emissions from displaced autos

A. Emission Reductions from Affordable Housing Development and Residential Subsidies

Both the GHG emission reductions and air pollutant emission reductions from affordable housing developments and subsidies are estimated as the difference between the avoided passenger VMT from the project compared to a baseline scenario lacking VMT reduction measures. Equations 1 through 4 are used to estimate unmitigated VMT for the baseline scenario. [7]

Equation 1: Average Daily Trips per Dwelling Unit

$$Average\ Daily\ Trips = \frac{(Weekday\ Trips * 5) + Saturday\ Trips + Sunday\ Trips}{7\ days}$$

Table 2. Variable Definitions for Equation 1: Average Daily Trips per Dwelling Unit

Variable	Variable Definition	Units
Average Daily Trips	Average daily trip rate per dwelling unit for applicable dwelling type	Trips/dwelling unit-day
Weekday Trips	Average weekday trip rate er dwelling unit for applicable dwelling type	Trips/dwelling unit
Saturday Trips	Average Saturday tri rate per dwelling unit for applicable dwelling type	Trips/dwelling unit
Sunday Trips	Average Sunday trip rate per dwelling unit for applicable dwelling type	Trips/dwelling unit

Equation 2: Primary Trip Length

$$Primary\ Trip\ Length = (H\text{-}W\ Length * H\text{-}W\ Share) + (H\text{-}S\ Length * H\text{-}S\ Share) + (H\text{-}O\ Length * H\text{-}O\ Share)$$

[7] Equations 1 through 4 use a methodology and trip type and link percentages described in Appendices A and D of the *User's Guide for CalEEMod Version 2016.3.2*. Available through the *CalEEMod User-guide*. Trip rates are derived from the *Trip Generation Manual, 11thEdition* accessible through the *ITE Trip and Generation Manual webpage*. Trip lengths not provided by metropolitan planning organizations are calculated for multi-county regions from the California Statewide Travel Demand Model. Available thorough the *travel demand model webpage*.

Table 3. Variable Definitions for Equation 2: Primary Trip Length

Variable	Variable Definition	Units
Primary Trip Length	County-Specific average length of urban or rural primary-home-base trip	Miles
H-W Length	County-specific average length of urban or rural trip between home and work	Miles
H-W Share	Statewide default percentage or primary home-base trips which are between home and work (42.3%)	%
H-S Length	County-specific average length of urban or rural trip between home and shopping	Miles
H-S Share	Statewide default percentage or primary home-based trips which are between home and shopping (19.6%)	%
H-O Length	County-specific average length or urban or rural trip between home and locations other than work or shopping	Miles
H-O Share	Statewide default percentage or primary home-based trips which are between home and other locations (38.1%)	%

Equation 3: Overall Trip Length

$$\begin{aligned} &Overall\ Trip\ Length \\ &= (Primary\ Trip\ Length * Primary\ Share) \\ &+ (Primary\ Trip\ Length * 25\% * Diverted\ Share) \\ &+ (0.1\ miles * Passby\ miles\ Share) \end{aligned}$$

Table 4. Variable Definitions for Equation 3: Overall Trip Length

Variable	Variable Definition	Units
Overall Trip Length	County-specific average length of urban or rural overall home-based trip	Miles
Primary Trip Length	County-specific average length of urban and rural primary home-based trip, from Equation 2	Miles
Primary Share	Statewide average percentage of home-based trips which are primary (86%)	%
Diverted Share	Statewide average percentage of home-based trips which are diverted (11%)	%
Pass-by Share	Statewide average percentage of home-based trips which are pass-by (3%)	%

Equation 4: Annual Unmitigated VMT

$$Annnual\ Unmitigated\ VMT = Average\ Daily\ Trips * Overall\ Trip\ Length * Total\ Units * 365\ days$$

Table 5. Variable Definitions for Equation 4: Annual Unmitigated VMT

Variable	Variable Definition	Units
Annual Unmitigated VMT	Annual VMT by residents of housing development without VMT mitigation measures	Miles/year
Average Daily Trips	Average daily trip rate per dwelling unit for applicable dwelling type, from Equation 1	Trips/dwelling unit*day
Overall Trip Length	Count-specific average length or urban or rural overall home-based trip, from Equation 3	Miles
Total Units	Number of dwelling units in affordable housing development	Dwelling units

Equations 5 through 16 are used to calculate the expected percent reductions in passenger VMT[8] resulting from the characteristics of the affordable housing development.

[8] Equations 5 through 16 use methodologies and elasticities described in the *Quantifying Greenhouse Gas Mitigation Measures* report. *Access through the report PDF.*

Equation 5: VMT Reductions from Increased Density

$$Density\ VMT\ Reductions = \left(\frac{Density - Required\ Density}{Required\ Density}\right) * 7\%$$

Table 6. Variable Definitions for Equation 5: VMT Reductions from Increased Density

Variable	Variable Definition	Units
Density VMT Reductions	VMT reductions associated with increased net density over required baseline, capped at 30%	%
Density	Net density of affordable housing development	Dwelling units/acre
Required Density	Required baseline net density per Project Area Type, defined by the AHSC Guidelines (See Table 7)	Dwelling units/acre

Table 7. Minimum Net Density by Project Area Type

Project Area Type	Minimum Net Density (Dwelling units per acre)
TOD	30
ICP	20
RIPA	15

Equations 6 and 7 are applicable to mixed-use developments only.

Equation 6: Land Use Index

$$Land\ Use\ Index = -\left(\frac{4 * (0.01 * ln0.01) + \left(\left(\frac{RS}{RS+MS}\right) * ln\left(\frac{RS}{RS+MS}\right)\right) + \left(\left(\frac{MS}{RS+MS}\right) * ln\left(\frac{MS}{RS+MS}\right)\right)}{ln6}\right)$$

Table 8. Variable Definitions for Equations 6: Land Use Index

Variable	Variable Definition	Units
Land Use Index	Measure of diversity of land use in mixed-use development	N/A
RS	Space for residential uses in mixed-use development	Square feet
MS	Publicly accessible space for commercial or social services uses in mixed-use development	Square feet

Equation 7: VMT Reductions from Increased Land Use Diversity

$$Diversity\ VMT\ Reductions = \left(\frac{Land\ Use\ Index - 0.15}{0.15}\right) * 9\%$$

Table 9. Variable Definitions for Equation 7: VMT Reductions from Increased Land Use Diversity

Variable	Variable Definition	Units
Diversity VMT Reductions	VMT reductions associated with increased net density over required baseline, capped at 30%, with increase in land use diversity capped at 500%	%
Land Use Index	Measure of diversity of land use in mixed-use development, from Equation 6	N/A

Equation 8: VMT Reductions from Increased Destination Accessibility

$$Accessibility\ VMT\ Reductions = \left(\frac{housing\ development\ employment\ density - county\ employment\ density}{county\ employment\ density}\right) * 7\%$$

Table 10. Variable Definitions for Equation 8: Reductions from Increased Destination Accessibility

Variable	Variable Definition	Units
Accessible VMT Reductions	VMT reductions associated with increased employment density caped at 30%	%
Employment Density	Number of jobs per acres of specific geography, obtained through Policy Map.[9]	Jobs/acre

Equation: 9 VMT Reductions form Integration of Affordable Housing

$$Affordability\ VMT\ Reductions = \left(\frac{Affordable\ Units}{Total\ Units}\right) * 4\%$$

Table 11. Variable Definitions for Equation 9: Reductions from Integration of Affordable Housing

Variable	Variable Definition	Units
Affordability VMT Reductions	VMT reductions associated with integration of affordable dwelling units into housing development, capped at 4%	%
Affordable Units	Number of affordable dwelling units in affordable housing development	Dwelling units
Total units	Number of dwelling units in affordable housing development	Dwelling units

[9] Employment Density is obtained through the Policy Map mapping tool which uses Data from the EPA Smart Location Database. Access the mapping tool through the *Policy Map webpage*.

Equation 10: VMT Reductions from Land Use Measures

$$Land\ Use\ VMT\ Reductions = 1 - (1 - Density\ VMT\ Reductions) * (1 - Diversity\ VMT\ Reductions) * (1 - Accessibility\ VMT\ Reductions) * (1 - Affordability\ VMT\ Reductions)$$

Table 12. Variable Definitions for Equation 10: Total VMT Reductions from Land Use Measures

Variable	Variable Definition	Units
Land Use VMT Reductions	VMT reductions associated with all land use measures, capped according to Project Area Type (See Table 13)	%
Density VMT Reductions	VTM reductions associated with increased density over required baselines, capped at 35%, from Equation 5	%
Diversity VMT Reductions	VMT reductions associated with increased land use diversity over baselines, capped at 30%, from Equation 7	%
Accessibility VMT Reductions	VMT reductions associated with increases destination accessibility capped at 30%, from Equation 8	%
Affordability VMT Reductions	VMT reductions associated with integration of affordable dwelling units into housing development, capped at 4%m from Equation 9	%

Table 13. Maximum VMT Reductions by Project Area Type[10]

Project Area Type	Land Use Measures	Land Use, Parking, and Traffic Calming Measures	Total
TOD	65%	70%	75%
ICP	30%	35%	40%
RIPA	5%	10%	15%

[10] VMT reduction caps are aligned with the "urban" location type from the *Quantifying Greenhouse Gas Mitigation Measures* report for TOD, "compact infill" for ICP, and "suburban" for RIPA. *Access through the report PDF*.

Equation 11: VMT Reductions from Limited Parking Supply

$$Parking\ Supply\ VMT\ Reductions = \left(\frac{Total\ Units * Parking\ Rate - Parking\ Space}{Total\ Units * Parking\ Rate}\right) * 50\%$$

Table 14. Variable Definitions for Equation 11: VMT Reductions from Limited Parking Supply

Variable	Variable Definition	Units
Parking Supply VMT Reductions	VMT reductions associated with limited residential parking supply, capped at 12.5%	%
Total Units	Number of dwelling units in affordable housing development	Dwelling units
Parking Rate	Average peak parking demand per dwelling unit for applicable dwelling type	Vehicles/units
Parking Space	Number of residential parking spaced in affordable housing development	Parking spaces

Equation 12: VMT Reductions from Unbundled Parking Cost

$$Unbundled\ Parking\ VMT\ Reductions = Unbundled\ Cost * \left(\frac{12\ months}{\$4{,}000}\right) * 0.4 * 85\%$$

Table 15. Variable Definitions for Equation 12: VMT Reductions from Unbundled Parking Cost

Variable	Variable Definition	Units
Unbundled Parking VMT Reductions	VMT reductions associated with unbundled residential parking cost, capped at 20%	%
Unbundled Cost	Monthly unbundled cost for on-site residential parking	$/month

Equation 13: Total VMT Reductions from Parking Measures

$$Parking\ VMT\ Reductions = 1 - (1 - Parking\ Supply\ VMT\ Reductions) * (1 - Unbundled\ Parking\ VMT\ Reductions)$$

Table 16. Variable Definitions for Equation 13: Total VMT Reductions from Parking Measures

Variable	Variable Definition	Units
Parking VMT Reductions	VMT reductions associated with all parking measures, capped at 20%	%
Parking Supply VMT Reductions	VMT reductions associated with limited residential parking supply, capped at 12.5%, from Equation 11	%
Unbundled Parking VMT Reductions	VMT reductions associated with unbundled residential parking costs, capped at 20%, from Equation 12	%

Equation 14: VMT Reductions from Traffic Calming Measures

$$Traffic\ Calming\ VMT\ Reductions = 1\%$$

Table 17. Variable Definitions for Equation 14: VMT Reductions from Traffic Calming Measures

Variable	Variable Definition	Units
Traffic Calming VMT Reductions	VMT reductions associated with traffic calming measures within ½ mile of affordable housing development	%

Equation 15: VMT Reductions from Residential Transit Subsidy

$$Subsidy\ VMT\ Reductions = Elasticity * \frac{Recipients}{Total\ Units} * \frac{Duration}{30\ years}$$

Table 18. Variable Definitions for Equation 15: VMT Reduction from Residential Transit Subsidy

Variable	Variable Definition	Units
Subsidy VMT Reductions	VMT reductions associated with transit passes for residents, capped at 20%	%
Elasticity	Elasticity of VMT specific to annual value of transit passes to residents and urban and rural project setting	N/A
Recipients	Number of dwelling units receiving transit passes in affordable housing development	Dwelling units
Total units	Number of dwelling units in affordable housing development	Dwelling units
Duration	Number of years for which transit passes are funded	years

Equation 16: Total VMT Reductions

$$Total\ VMT\ Reductions = Land\ Use\ VMT\ Reductions + Parking\ VMT\ Reductions + Traffic\ Calming\ VMT\ Reductions + Subsidy\ VMT\ Reductions$$

Table 19. Variable Definitions for Equation 16: Total VMT Reductions

Variable	Variable Definition	Units
Total VMT Reductions	VMT reductions associated with all mitigation measures, capped according to Project Area Type (See Table 13)	%
Lande Use VMT Reductions	VMT reductions associated with all land use measures, capped according to Project Area Type, from Equation 10	%
Parking VMT Reductions	VMT reductions associated with all parking measures, capped at 20%, from Equation 13	%
Traffic Calming VMT Reductions	VMT reductions associated with traffic calming measures withing ½ mile of affordable housing development, from Equation 14	%
Subsidy VMT Reductions	VM T Reductions Associated with transit passes for residents, capped at 20%, from Equation 15	%

Equation 17: Annual Avoided VMT

$$Annual\ Avoided\ VMT = Annual\ Unmitigated\ VMT * Total\ VMT\ Reductions$$

Table 20. Variable Definitions for Equation 17: Annual Avoided VMT

Variable	Variable Definition	Units
Annual Avoided VMT	Annual reductions in baseline residential VMT	Miles/year
Annual unmitigated VMT	Annual VMT by residents of housing development without VMT mitigation measures, from Equation 4	Miles/year
Total VMT Reductions	VMT reductions associated with all mitigation measures, from Equation 16	%

Equation 18: Total Avoided VMT

$$Total\ Avoided\ VMT = Annnual\ Avoided\ VMT * 30\ years$$

Table 21. Variable Definitions for Equation 18: Total Avoided VMT

Variable	Variable Definition	Units
Total Avoided VMT	Reductions in baselines residential VMT for quantification period of affordable housing development (30 years)	Miles
Annual Avoided VMT	Annual reductions in baseline residential VMT	Miles/year

Equation 19 is used to estimate emission reductions from the avoided VMT associated with the affordable housing development and transit subsidies for residents.

Equation 19: Auto Emission Reductions from Affordable Housing Development and Residential Transit Subsidies

$$Emission\ Reductions = \left(\frac{Annual\ Avoided\ VMt * EF_{yr1} + Annual\ Avoided\ VMT * EF_{yrf}}{2}\right) * 30\ years * U^{-1}$$

Table 22. Variable Definition for Equation 19: Auto Emission Reductions for Affordable Housing Development and Transit Subsidies

Variable	Variable Definition	Units
Auto Emission Reductions	Auto GHG or criteria and toxic air pollutant emission reductions for quantification period of affordable housing development (30 years)	$MTCO_{2e}$ or lbs
Annual Avoided VMT	Annual reductions in baselines residential VMT, from Equation 17	Miles/year
EF_{yr1}	County-specific auto vehicle emission factor for first year of project life	g/mile
EF_{yrF}	County-specific auto vehicle emission factor for final year of project life	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

B. Solar PV Generation

The emission reductions from grid-connected solar PV projects are calculated as the emission reductions from avoided fossil-fuel-based electricity generation.[11]

Equation 20: Emission Reductions from Solar

$$Emission\ Reductions = \sum_{n=1}^{30} (1 - Degradation)^{n-1} * Production * EF$$

Table 23. Variable Definitions for Equation 20: Emission Reductions from Solar PV

Variable	Variable Definition	Units
Emission Reductions	GHG or criteria and toxic air pollutant emission reductions for useful life of solar PV system (30 years)	$MTCO_{2e}$ or lbs
Degradation	Annual Rate of system degradation (0.5%)	%/year
Production	Annual electricity generation estimates using PVWatts Calculator	kWh/year
EF	Emission factor for California grid electricity	$MTCO_{2e}$/kWh or lbs/kWh

[11] The 30-year useful life was obtained from the National Renewable Energy Laboratory "Life Cycle Greenhouse Gas Emissions from Solar Photovoltaics" fact sheet. *Access through the factsheet PDF*. The estimated rate of system degradation was obtained from the National Renewable Energy Laboratory Technical Report "Photovoltaic Degradation Rates – An Analytical Review." 2012. *Access through the report PDF*.

C. New Bicycle Facility or Walkway

The GHG emission reductions from new bicycle facilities or walkways are calculated as the emission reductions from displaced autos.

Equation 21: VMT Reductions from Bicycle Facility or Walkway

$$VMT\ Displaced = D * ADT * (A + C) * GFA * L$$

Table 25. Variable Definitions for Equation 21: VMT Reductions from Bicycle Facility or Walkway

Variable	Variable Definition	Units
VMT Displaced	Annual passenger VMT replaced by cycling or walking trips	Miles/year
D	Default annuals days of use of new facility (200)	Days/year
ADT	Average two-way daily traffic on road parallel to facility	Vehicle trips/day
A	Adjustment factor for active transportation (See Table 24)	N/A
C	Credit for Key Destinations near facility (See Table 25)	N/A
GFA	Growth factor adjustment *1.54 for new Class I bike paths and Class IV bikeways; 1.0 for new Class II bike lanes, 0.54 for Class II to IV Conversion; 0.46 for new bicycle boulevards)	N/A
L	Average length of auto trip replaced (1.5 miles for cycling; 0.3 miles for walking)	miles

Table 24.Active Transportation Adjustment Factors

Average Daily Traffic (vehicle trips per day)	One-way Facility Length (miles)	Adjustment Factor for Population >250,000 or Non-university Town with Population < 250,000	Adjustment Factor University Town with Population <250,000
1 to 12,000	≤ 1	0.0019	0.0104
1 to 12,000	1.01 to 2	0.0029	0.0155
1 to 12,000	> 2	0.0038	0.0207
12,001 to 24,000	≤ 1	0.0014	0.0073
12,001 to 24,000	1.01 to 2	0.0020	0.0109
12,001 to 24,000	> 2	0.0027	0.0145
24,001 to 30,000	≤ 1	0.0010	0.0052
24,001 to 30,000	1.01 to 2	0.0014	0.0078
24,001 to 30,000	> 2	0.0019	0.0104

Table 25. Key Destinations Credit

Number of Key Destinations	Credit Within ½ Mile of Facility	Credit Within ¼ Mile of Facility
0 to 2	0	0
3	0.0005	0.001
4 to 6	0.0010	0.002
≥ 7	0.0015	0.003

Equation 22: Auto Emission Reductions from Bicycle Facility or Walkway

$$Auto\ Emission\ Reductions = \left(\frac{VMT\ Displaced * EF_{yr1} + VMT\ Displaced * EF_{yrf}}{2}\right) * UL * U^{-1}$$

Table 26. Variable Definitions for Equation 22: Auto Emission Reductions from Bicycle or Walkway

Variable	Variable Definition	Units
Auto Emission Reductions	Auto GHG or criteria and toxic air pollutant emission reductions for useful life of bicycle or walkway	$MTCO_{2e}$ or lbs
VMT Displaced	Annual passenger VMT replaced by cycling or walking trips, from Equation 21	Miles/year
EF_{yr1}	County-specific auto vehicle emission factor for first year of useful life	g/mile
EF_{yrF}	County-specific auto vehicle emission factor for final year of useful life	g/mile
UL	Useful life of bicycle facility or walkways (20 years for Class I bike path or walkways; 15 years for Class II bike lane, Class IV separated bikeways, or bicycle boulevard)	years
U	Unit conversion factor (1,000,000 for grams to metric tons; 453.59 for grams to pounds)	g/MT or g/lb

D. New or Expanded Bus, Cable Car, Rail, Streetcar, Shuttle, Trolley Bus, Bus Rapid Transit, or Van Service

The emission reductions from new or expanded transit service are calculated as the emission reductions from displaced autos less the new emissions from transit vehicles.

Equation 23: VMT Reductions from New or Expanded Transit Service

$$VMT\ Displaced = R * A * L$$

Table 27. Variable Definitions for Equation 27: VMT Reductions for New or Expanded Transit Service

Variable	Variable Definition	Units
VMT Displaced	Annual passenger VMT replaced by transit trips	Miles/year
R	Increase in annual transit ridership in first or last year of service	Trips/year
A	Adjustment factor for transit dependency (default or user-defined, see Appendix A)	Unitless
L	Length of average auto trip replaced (default or user-defined; see Appendix A)	miles

Equation 24: Auto Emission Reductions from New or Expanded Transit Service

$$Auto\ Emission\ Reductions = \left(\frac{VMT\ Displaced * EF_{yr1} + VMT\ Displaced * EF_{yrf}}{2}\right) * UL * U^{-1}$$

Table 28. Variable Definitions for Equation 24: Auto Emission from New or Expanded Transit Service

Variable	Variable Definition	Units
Auto Emission Reductions	Auto GHG or criteria and toxic air pollutant emission reductions for quantification period of new or expanded service	$MTCO_{2e}$ or lbs
VMT Displaced$_{yr1}$	Annual passenger VMT replaced by transit trips in first year of service, from Equation 23	Miles/year
VMT Displaced$_{yrF}$	Annual passenger VMT replaced by transit trips in last year of service, from Equation 23	Miles/year
EF_{yr1}	County-specific auto vehicle emission factor for first year of service	g/mile
EF_{yrF}	County-specific auto vehicle emission factor for final year of service	g/mile
UL	Quantification period for transit service	years
U	Unit conversion factor (1,000,000 for grams to metric tons; 453.59 for grams to pounds)	g/MT or g/lb

Equation 25 is applicable only to rail vehicles, when information on the additional fuel consumed rather than the VMT to operate new or expanded service is available.

Equation 25: Rail Vehicle VMT from Fuel Consumption

$$Rail\ Vehicle\ VMT = Fuel\ Consumed * Consumption\ Rate^{-1} * U^{-1}$$

Table 29. Variable Definitions for Equation 25: Rail Vehicle VMT from Fuel Consumption

Variable	Variable Definition	Units
Rail Vehicle VMT	Annual VMT of rail vehicles to operate new or expanded service	Miles/year
Fuel Consumed	Annual fuel consumed by rail vehicles to operate new or expanded service	Units of fuel/year
Consumption Rate	Statewide average fuel consumption rate for locomotives	Gallons of diesel/miles
U	Unit conversion factor for diesel gallon equivalent	Units of fuel/diesel gallon equivalent

Equation 26: Transit Vehicle Emissions

$$Transit\ Vehicle\ Emissions = Transit\ VMT * EF_{yrM} * UL * U^{-1}$$

Table 30. Variable Definitions for Equation 26: Transit Vehicle Emissions

Variable	Variable Definition	Units
Transit Vehicle Emissions	Transit vehicle GHG or criteria and toxic air pollutant emissions for quantification period of new or expanded service	$MTCO_{2e}$ or lbs
Transit VMT	Annual VMT of transit vehicles to operate new or expanded service	Miles/year
EF_{yrM}	Transit vehicle emission factor for middle year of service	g/mile
UL	Quantification period for transit service	Years
U	Units conversion factor (1,000,000 for grams to metric tons' 453.59 for grams to pounds)	g/MT or g/lb

Equation 27: Net Emission Reductions from New or Expanded Transit Service

$$Net\ Emission\ Reductions = Auto\ Emission\ Reductions - Transit\ Vehicle\ Emissions$$

Table 31. Variable Definitions for Equation 27: Net Emission for Transit Service

Variable	Variable Definition	Units
Net Emission Reductions	GHG or criteria and toxic air pollutant emissions reductions for quantification period of new or expanded transit service	$MTCO_{2e}$ or lbs
Auto Emission Reductions	GHG or criteria and toxic air pollutant emissions reductions for quantification period of new or expanded transit service, from Equation 24	$MTCO_{2e}$ or lbs
Transit Vehicle Emissions	Transit vehicle GHG or criteria and toxic air pollutant emissions reductions for quantification period of new or expanded transit service, from Equation 26	$MTCO_{2e}$ or lbs

E. New or Expanded Ferry Service

The emission reductions from new or expanded ferry service are calculated as the emission reductions from displaced autos less the new emissions from the ferry.

Equation 28: VMT Reductions from New or Expanded Ferry Service

$$VMT\ Displaced = D * R * A * L$$

Table 32. Variable Definitions for Equation 28 VMT Reductions from Ferry Service

Variable	Variable Definition	Units
VMT Displaced	Annual passenger VMT replaced by ferry trips	Miles/year
D	Annual days of operation of Ferry service	Days/year
R	Increase in daily ferry ridership in first or last year of service	Trips/day
A	Adjustment factor for transit dependency (default or user-defined, See Appendix A)	N/A
L	Length of average auto trip replaced (default or user-defined; see Appendix A)	miles

Equation 29: Auto Emission Reductions from New or Expanded Ferry Service

$$Auto\ Emission\ Reductions = \left(\frac{VMT\ Displaced * EF_{yr1} + VMT\ Displaced * EF_{yrf}}{2}\right) * UL * U^{-1}$$

Table 33. Variable Definitions for Equation 29: Auto Emission Reductions for Ferry Service

Variable	Variable Definition	Units
Auto Emission Reductions	Auto GHG or criteria and toxic air pollutant emission reductions for quantification period of new or expanded service	$MTCO_{2e}$ or lbs
VMT Displaced$_{yr1}$	Annual passenger VMT replaced by ferry trips in first year of service, from Equation 28	Miles/year
VMT Displaced$_{yrF}$	Annual passenger VMT replaced by ferry trips in last year of service, from Equation 28	Miles/year
EF_{yr1}	County-specific auto vehicle emission factor for first year of service	g/mile
EF_{yrF}	County-specific auto vehicle emission factor for final year of service	g/mile
UL	Quantification period for ferry service	years
U	Unit conversion factor (1,000,000 for grams to metric tons; 453.59 for grams to pounds)	g/MT or g/lb

Equation 30: Ferry Emissions

$$Ferry\ Emissions = Fuel\ Consumption * EF * UL * U^{-1}$$

Table 34. Variable Definitions for Equation 30: Ferry Emissions

Variable	Variable Definition	Units
Ferry Emissions	Ferry GHG or criteria and toxic air pollutant emissions for quantification period of new or expanded service	$MTCO_{2e}$ or lbs
Fuel Consumption	Annual quantity of fuel consumed by ferry to operate new or expanded service	Gal, scf, kWh, or kg
EF	Fuel-specific carbon intensity emission factor or ferry	g/unit of fuel
UL	Quantification period for ferry service	years
U	Unit conversion factor (1,000,000 for grams to metric tons; 453.59 for grams to pounds)	g/MT or g/lb

Equation 31: Net Emission Reductions from New or Expanded Ferry

$$Net\ Emission\ Reductions = Auto\ Emission\ Reductions - Ferry\ Reductions$$

Table 35. Variable Definitions for Net Emission Reductions from Ferry Service

Variable	Variable Definition	Units
Net Emission Reductions	GHG or criteria and toxic air pollutant emission reductions for quantification period or new or expanded ferry service	$MTCO_{2e}$ or lbs
Auto Emission Reductions	Auto GHG or criteria and toxic air pollutant emission reductions for quantification period of new or expanded service, from Equation 29	$MTCO_{2e}$ or lbs
Ferry Emissions	Ferry GHG or criteria and toxic air pollutant emissions for quantification period of new or expanded service, from Equation 30	$MTCO_{2e}$ or lbs

F. Capital Improvements and Fare Reductions

The GHG emission reductions from capital improvements and fare reductions that result in mode shift to transit are calculated as the emission reductions from displaced autos.

Equation 32: VMT Reductions from Capital Improvement or Fare Reductions

$$VMT\ Displaced = D * R * A * L$$

Variable	Variable Definition	Units
VMT Displaced	Annual passenger VMT replaced by transit trips	Miles/year
D	Annual days of operation of transit service utilizing capital improvement or when fare reductions is provided	Days/year
R	Increase in daily transit ridership in first or last year of service	Trips/day
A	Adjustment factor for transit dependency (default or user-defined, See Appendix A)	N/A
L	Length of average auto trip replaced (default or user-defined; see Appendix A)	miles

Equation 33: Auto Emission Reductions from Capital Improvements or Fare Reductions

$$Auto\ Emission\ Reductions = \left(\frac{VMT\ Displaced * EF_{yr1} + VMT\ Displaced * EF_{yrf}}{2}\right) * UL * U^{-1}$$

Table 33. Variable Definitions for Equation 33: Auto Emission Reductions from Capital Improvements or Fare Reductions

Variable	Variable Definition	Units
Auto Emission Reductions	Auto GHG or criteria and toxic air pollutant emission reductions for quantification period of capital improvement or fare reduction	$MTCO_{2e}$ or lbs
VMT Displaced	Annual passenger VMT replaced by transit, from Equation 32	Miles/year
EF_{yr1}	County-specific vehicle emission factor for first year of service	g/mile
EF_{yrF}	County-specific vehicle emission factor for final year of service	g/mile
UL	Quantification period for transit utilizing capital improvement or fare reduction	years
U	Unit conversion factor (1,000,000 for grams to metric tons; 453.59 for grams to pounds)	g/MT or g/lb

G. Shared Mobility

Please refer to the CARB Clean Mobility Benefits Quantification Methodology to see equations for estimating emission reductions and co-benefits from new or expanded service and subsidies of shared mobility projects such as carshare, carpool, on-demand transit service and micro mobility (bikeshare, scooter-share, moped-share). The Clean Mobility Benefits Quantification Methodology and Calculator tool can be found on the *California Climate Investments resources webpage*.

Section C. Appendix A: Default Lookup Tables

CARB staff developed these recommended values for applicants to use for the length of the average unlinked passenger trip and baseline average fare cost, by agency or statewide, by mode, and by type of service (Directly Operated (DO) or Purchased Transportation (PT)) using 2021 Annual data from the National Transit Database, supplemented by the previously used 2017 data for transit services that are absent from the 2021 data due to COVID-19 service interruptions or other reasons (identified in bold)[12]. These values were calculated by dividing passenger miles traveled by unlinked passenger trips. Adjustment factors were developed by the Institute of Transportation Studies based on a review of research on transit dependency and data from the 2013 California Household Travel Survey[13].

Table 36. Length of Average Trip and Adjustment Factor by Mode

Mode Type	Mode	Length of Average Trip for DO (Miles/Trip)	Length of Average Trip For PT (Miles/Trip)	Adjustment Factor
Commuter Bus (Express/Intercity)	CB	23.15	22.61	0.705
Cable Car	CC	**1.26**	-	0.479
Commuter Rail	CR	25.63	33.55	0.867
Demand Response	DR	5.81	8.88	0.540
Demand Response Transportation Network Company	DR	-	4.64	-
Demand Response Taxi	DR	-	9.10	0.540
Ferry Boat	FB	12.01	23.70	1.00
Heavy Rail	HR	9.24	-	0.794
Light Rail	LR	6.03	-	0.685
Bus (Local)	MB	3.29	4.20	0.561 (Transit bus) 0.585 (Shuttle)
Monorail/Automated Guideway	MG	-	3.18	0.479
Bus Rapid Transit	RB	4.61	-	0.542

[12] Federal Transit Administration. National Transit Database. Available through the *NTD webpage*.
[13] Handy, Susan, Elisa Barbour, Alissa Kendall, Jamey Volker (2019) Updated Default Values for Transit Dependency and Average Length of Unlinked Transit Passenger Trips, for Calculations Using TAC Methods for California Climate Investments Programs. Institute of Transportation Studies, University of California, Davis. *Study PDF*.

Mode Type	Mode	Length of Average Trip for DO (Miles/Trip)	Length of Average Trip For PT (Miles/Trip)	Adjustment Factor
Streetcar Rail	SR	**1.43**	-	0.479
Trolley Bus	TB	1.53	-	0.479
Vanpool	VP	31.72	48.56	0.879
Hybrid Rail	YR	6.86	7.29	0.738

Table 37. Length of Average Trip and Average Fare Cost by Transit Agency

Agency	Mode	Type of Service	Length of Average Trip	Average Fare Cost per Trip
Access Services	DR	TX	12.04	$2.56
Access Services	DR	PT	10.76	$2.41
Access Services	DT	PT	14.69	$2.39
Alameda-Contra Costa Transit District	CB	DO	13.68	$4.46
Alameda-Contra Costa Transit District	DR	PT	7.71	$2.60
Alameda-Contra Costa Transit District	MB	DO	3.89	$1.20
Alameda-Contra Costa Transit District	MB	PT	12.60	$1.21
Alameda-Contra Costa Transit District	RB	DO	3.07	$0.44
Altamont Corridor Express	CR	PT	55.57	$9.18
Anaheim Transportation Network	DR	PT	1.35	-
Anaheim Transportation Network	MB	PT	2.32	$0.80
Antelope Valley Transit Authority	CB	PT	56.54	$6.56
Antelope Valley Transit Authority	DR	PT	8.86	$1.23
Antelope Valley Transit Authority	MB	PT	5.41	$1.08
Butte County Association of Governments	DR	PT	2.89	$2.66
Butte County Association of Governments	MB	PT	4.92	$1.81
California Vanpool Authority	VP	DO	31.72	$3.49
Central Contra Costa Transit Authority	DR	PT	7.32	$1.96
Central Contra Costa Transit Authority	MB	DO	4.32	$0.97
Central Contra Costa Transit Authority	MB	PT	14.60	-
City and County of San Francisco	DR	PT	6.76	$2.39
City and County of San Francisco	LR	DO	0.74	$0.25
City and County of San Francisco	MB	DO	2.01	$0.32
City and County of San Francisco	TB	DO	1.53	$0.23
City of Commerce	DR	DO	4.99	-
City of Commerce	MB	DO	3.83	-
City of Culver City	DR	DO	1.69	$0.83
City of Culver City	MB	DO	4.43	$0.46

Agency	Mode	Type of Service	Length of Average Trip	Average Fare Cost per Trip
City of Elk Grove	CB	PT	14.06	$2.81
City of Elk Grove	DR	PT	4.68	$6.63
City of Elk Grove	MB	PT	3.44	$1.06
City of Fairfield, California	CB	PT	23.56	$3.90
City of Fairfield, California	DR	PT	10.18	$1.92
City of Fairfield, California	MB	PT	2.86	$0.40
City of Fresno	DR	PT	5.74	$1.22
City of Fresno	MB	DO	2.88	$0.31
City of Gardena	DR	DO	2.59	**$0.50**
City of Gardena	MB	DO	3.34	**$0.77**
City of Glendale	DR	PT	3.04	**$1.09**
City of Glendale	MB	PT	2.18	$0.01
City of La Mirada	DR	PT	2.34	$0.64
City of Los Angeles	CB	PT	10.91	$0.83
City of Los Angeles	DR	PT	3.81	$0.26
City of Los Angeles	DR	TX	2.38	$1.38
City of Los Angeles	MB	PT	1.19	**$0.37**
City of Modesto	DR	PT	4.50	$2.96
City of Modesto	DR	TX	5.33	$1.58
City of Modesto	MB	PT	4.19	$0.89
City of Montebello	DR	TX	1.80	$0.69
City of Montebello	MB	DO	3.30	$0.68
City of Montebello	MB	PT	2.47	$1.29
City of Norwalk	DR	PT	2.47	$0.69
City of Norwalk	MB	DO	4.20	**$0.88**
City of Pasadena	DR	PT	2.94	$0.13
City of Pasadena	MB	PT	1.99	$0.10
City of Petaluma	DR	PT	4.09	$1.02
City of Petaluma	MB	PT	2.73	$0.41
City of Redondo Beach	DR	PT	5.40	**$0.85**
City of Redondo Beach	MB	PT	3.60	**$0.84**
City of Riverside	DR	DO	5.63	$2.47
City of San Luis Obispo	MB	PT	3.10	$1.80
City of Santa Clarita	CB	PT	24.78	$0.86
City of Santa Clarita	DR	PT	6.54	$0.98
City of Santa Clarita	MB	PT	4.23	$0.15
City of Santa Maria	DR	PT	8.30	**$0.44**
City of Santa Maria	MB	PT	3.49	**$1.02**
City of Santa Monica	DR	PT	1.84	$0.57

Agency	Mode	Type of Service	Length of Average Trip	Average Fare Cost per Trip
City of Santa Monica	DR	TN	1.57	$0.57
City of Santa Monica	MB	DO	3.36	$0.40
City of Santa Rosa	DR	PT	3.99	$1.35
City of Santa Rosa	MB	DO	2.75	$0.29
City of Santa Rosa	MB	PT	3.61	$20.05
City of Torrance	DR	TX	3.47	$1.97
City of Torrance	MB	DO	4.95	$0.01
City of Tulare	DR	PT	4.21	$1.14
City of Tulare	MB	PT	6.06	$0.60
City of Turlock	DR	PT	7.09	$2.01
City of Turlock	MB	PT	3.34	$1.36
City of Visalia	CB	PT	51.99	$2.89
City of Visalia	DR	PT	6.38	$3.61
City of Visalia	MB	PT	6.68	$0.93
County of Placer	CB	PT	24.74	$6.61
County of Placer	DR	DO	10.80	$3.50
County of Placer	DR	PT	4.22	$0.82
County of Placer	MB	DO	7.76	$1.24
County of Placer	MB	PT	3.32	$0.64
County of Placer	VP	PT	33.91	$4.68
County of Sonoma	DR	PT	12.17	$0.71
County of Sonoma	MB	PT	8.33	$0.57
El Dorado County Transit Authority	CB	DO	31.03	$5.37
El Dorado County Transit Authority	DR	DO	11.22	$10.25
El Dorado County Transit Authority	MB	DO	8.97	$1.47
Foothill Transit	MB	PT	6.07	$0.66
Gold Coast Transit District	DR	PT	6.29	$0.73
Gold Coast Transit District	MB	DO	3.58	$0.15
Golden Empire Transit District	DR	DO	5.17	$6.13
Golden Empire Transit District	MB	DO	3.46	$0.87
Golden Gate Bridge, Highway and Transportation District	DR	PT	11.99	$5.67
Golden Gate Bridge, Highway and Transportation District	FB	DO	12.01	$9.44
Golden Gate Bridge, Highway and Transportation District	MB	DO	18.84	$6.22
Imperial County Transportation Commission	DR	PT	26.67	$2.48

Agency	Mode	Type of Service	Length of Average Trip	Average Fare Cost per Trip
Imperial County Transportation Commission	MB	PT	9.91	$0.05
Kings County Area Public Transit Agency	DR	PT	2.90	$2.42
Kings County Area Public Transit Agency	MB	PT	5.21	$1.02
Kings County Area Public Transit Agency	VP	PT	38.69	$3.70
Laguna Beach Municipal Transit	MB	DO	2.22	$0.04
Livermore / Amador Valley Transit Authority	DR	PT	4.75	$3.82
Livermore / Amador Valley Transit Authority	MB	PT	4.27	$1.98
Long Beach Transit	DR	PT	4.14	$1.67
Long Beach Transit	MB	DO	3.12	$0.01
Los Angeles County Metropolitan Transportation Authority	DR	DO	2.49	-
Los Angeles County Metropolitan Transportation Authority	HR	DO	5.24	$0.14
Los Angeles County Metropolitan Transportation Authority	LR	DO	6.61	$0.13
Los Angeles County Metropolitan Transportation Authority	MB	DO	2.86	$0.11
Los Angeles County Metropolitan Transportation Authority	MB	PT	3.79	$0.01
Los Angeles County Metropolitan Transportation Authority	RB	DO	5.85	$0.13
Los Angeles County Metropolitan Transportation Authority	VP	PT	46.98	$7.49
Marin County Transit District	DR	PT	6.77	$4.46
Marin County Transit District	MB	PT	5.63	$1.06
Metropolitan Transportation Commission	VP	PT	56.57	$7.43
Monterey-Salinas Transit	CB	DO	40.49	$16.91
Monterey-Salinas Transit	DR	PT	8.57	$1.23
Monterey-Salinas Transit	MB	DO	6.90	$1.42
Monterey-Salinas Transit	MB	PT	3.70	$1.27
Napa Valley Transportation Authority	CB	PT	16.63	$1.11
Napa Valley Transportation Authority	DR	PT	2.61	$3.21
Napa Valley Transportation Authority	MB	PT	9.54	$0.75
North County Transit District	CR	PT	26.44	$5.58
North County Transit District	DR	PT	13.48	$14.64
North County Transit District	MB	PT	4.34	$0.85
North County Transit District	YR	PT	7.29	$1.18
Omnitrans	DR	PT	9.85	$4.87

Agency	Mode	Type of Service	Length of Average Trip	Average Fare Cost per Trip
Omnitrans	MB	DO	5.63	$1.69
Omnitrans	MB	PT	3.77	$1.55
Orange County Transportation Authority	CB	DO	21.11	$1.68
Orange County Transportation Authority	CB	PT	19.28	$1.44
Orange County Transportation Authority	DR	PT	10.46	$4.26
Orange County Transportation Authority	DR	TX	4.76	$3.09
Orange County Transportation Authority	DT	PT	3.02	$3.44
Orange County Transportation Authority	MB	DO	4.41	$0.70
Orange County Transportation Authority	MB	PT	5.12	$0.53
Orange County Transportation Authority	VP	PT	36.82	$6.47
Paratransit, Inc.	DR	DO	9.82	**$4.20**
Paratransit, Inc.	DR	PT	10.46	$7.07
Paratransit, Inc.	DT	PT	8.37	$4.47
Peninsula Corridor Joint Powers Board dba: Caltrain	CR	PT	22.28	$25.68
Peninsula Corridor Joint Powers Board dba: Caltrain	MB	PT	3.47	-
Pomona Valley Transportation Authority	DR	PT	6.02	$0.33
Pomona Valley Transportation Authority	DR	TX	4.34	$1.45
Pomona Valley Transportation Authority	DT	PT	4.81	$1.94
Redding Area Bus Authority	DR	PT	6.36	$3.53
Redding Area Bus Authority	MB	PT	5.30	$1.14
Riverside County Transportation Commission	VP	PT	39.33	$6.72
Riverside Transit Agency	CB	DO	26.21	$1.56
Riverside Transit Agency	CB	PT	23.22	$2.08
Riverside Transit Agency	DR	PT	11.38	$5.13
Riverside Transit Agency	DT	PT	17.51	$4.05
Riverside Transit Agency	MB	DO	6.84	$0.73
Riverside Transit Agency	MB	PT	11.80	$1.52
Sacramento Regional Transit District	DR	DO	5.82	$3.58
Sacramento Regional Transit District	LR	DO	5.78	$1.43
Sacramento Regional Transit District	MB	DO	3.73	$1.38
San Bernardino County Transportation Authority	VP	PT	40.47	$7.66
San Diego Association of Governments	VP	PT	55.11	$6.61
San Diego Metropolitan Transit System	CB	PT	26.10	$6.78
San Diego Metropolitan Transit System	DR	PT	10.04	$4.26
San Diego Metropolitan Transit System	DR	TX	12.05	$4.58

Agency	Mode	Type of Service	Length of Average Trip	Average Fare Cost per Trip
San Diego Metropolitan Transit System	LR	DO	6.32	$0.99
San Diego Metropolitan Transit System	MB	DO	5.32	$1.68
San Diego Metropolitan Transit System	MB	PT	3.86	$1.23
San Francisco Bay Area Rapid Transit District	HR	DO	13.65	$3.50
San Francisco Bay Area Rapid Transit District	MG	PT	3.18	$5.78
San Francisco Bay Area Rapid Transit District	YR	DO	6.86	$2.88
San Francisco Bay Area Water Emergency Transportation Authority	FB	PT	23.70	$7.32
San Francisco Municipal Railway	CC	DO	1.26	$4.34
San Francisco Municipal Railway	DR	PT	6.17	$2.29
San Francisco Municipal Railway	LR	DO	2.73	$0.77
San Francisco Municipal Railway	MB	DO	2.15	$0.77
San Francisco Municipal Railway	SR	DO	1.43	$0.77
San Francisco Municipal Railway	TB	DO	1.48	$0.77
San Joaquin Council	VP	PT	47.37	$7.05
San Joaquin Regional Transit District	CB	PT	44.32	$5.30
San Joaquin Regional Transit District	DR	PT	7.29	$3.97
San Joaquin Regional Transit District	DR	TX	5.13	$4.77
San Joaquin Regional Transit District	DT	PT	5.83	$3.73
San Joaquin Regional Transit District	MB	DO	3.51	$0.66
San Joaquin Regional Transit District	MB	PT	4.55	$0.59
San Luis Obispo Regional Transit Authority	DR	DO	7.11	$3.12
San Luis Obispo Regional Transit Authority	MB	DO	12.09	$0.62
San Mateo County Transit District	DR	PT	8.14	$2.08
San Mateo County Transit District	DR	TX	15.51	$1.73
San Mateo County Transit District	DT	PT	11.89	$2.38
San Mateo County Transit District	MB	DO	3.57	$1.15
San Mateo County Transit District	MB	PT	5.20	$1.30
Santa Barbara Metropolitan Transit District	MB	DO	4.09	$0.17
Santa Clara Valley Transportation Authority	DR	PT	8.08	$2.71
Santa Clara Valley Transportation Authority	DT	PT	10.68	$2.86
Santa Clara Valley Transportation Authority	LR	DO	6.44	$1.10
Santa Clara Valley Transportation Authority	MB	DO	5.00	$1.10
Santa Clara Valley Transportation Authority	MB	PT	4.50	$2.65
Santa Cruz Metropolitan Transit District	CB	DO	30.59	$4.43
Santa Cruz Metropolitan Transit District	DR	DO	6.36	$2.95

Agency	Mode	Type of Service	Length of Average Trip	Average Fare Cost per Trip
Santa Cruz Metropolitan Transit District	DT	PT	7.23	$2.09
Santa Cruz Metropolitan Transit District	MB	DO	4.41	$4.70
Solano County Transit	CB	PT	13.78	$4.17
Solano County Transit	DR	PT	3.59	$3.72
Solano County Transit	MB	PT	2.82	$1.22
Sonoma-Marin Area Rail Transit District	CR	DO	25.63	$5.75
Southern California Regional Rail Authority	CR	PT	39.20	$7.73
SunLine Transit Agency	DR	DO	8.00	$1.37
SunLine Transit Agency	MB	DO	6.05	$0.12
SunLine Transit Agency	VP	PT	57.99	$7.50
The Eastern Contra Costa Transit Authority	DR	PT	4.74	$4.18
The Eastern Contra Costa Transit Authority	DR	TN	6.17	$4.00
The Eastern Contra Costa Transit Authority	MB	PT	4.52	$0.37
Transit Joint Powers Authority for Merced County	DR	PT	5.87	$0.92
Transit Joint Powers Authority for Merced County	MB	PT	6.36	$1.63
University of California, Davis (Unitrans)	MB	DO	2.16	$12.78
Ventura County Transportation Commission	CB	PT	26.77	**$1.60**
Ventura County Transportation Commission	DR	PT	2.80	**$1.75**
Ventura County Transportation Commission	MB	PT	4.37	**$0.85**
Victor Valley Transit Authority	CB	PT	52.89	$13.08
Victor Valley Transit Authority	DR	PT	13.92	$3.29
Victor Valley Transit Authority	MB	PT	6.85	$1.52
Victor Valley Transit Authority	VP	PT	45.48	$6.23
Western Contra Costa Transit Authority	CB	PT	28.39	$1.79
Western Contra Costa Transit Authority	DR	PT	6.08	$0.59
Western Contra Costa Transit Authority	MB	PT	6.27	$0.42
Yolo County Transportation District	DR	PT	11.29	$4.83
Yolo County Transportation District	MB	PT	11.50	$2.54
Yuba-Sutter Transit Authority	CB	PT	39.30	$6.69
Yuba-Sutter Transit Authority	DR	PT	5.86	$5.67
Yuba-Sutter Transit Authority	MB	PT	3.04	$1.04

Section D. References

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

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