California Air Resources Board

Greenhouse Gas Quantification Methodology for the California State Transportation Agency Transit and Intercity Rail Capital Program

Greenhouse Gas Reduction Fund
FY 2016-17

February 4, 2016

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Section A. Introduction

The California Air Resources Board (ARB) is responsible for providing the quantification methodology to estimate greenhouse gas (GHG) emission reductions from projects receiving monies from the Greenhouse Gas Reduction Fund (GGRF). For the California State Transportation Agency's (CalSTA) Transit and Intercity Rail Capital Program (TIRCP), ARB staff developed this GHG emission reduction quantification methodology to be used by grant applicants to estimate proposed project GHG emission reductions for the 2016 TIRCP Guidelines. ARB staff will 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.

This methodology uses calculations to estimate the reduction in vehicle miles traveled (VMT) and associated reduction in GHG emissions based on specific transportation characteristics of the proposed TIRCP projects. These calculations are based on 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) and ARB-developed GHG emission factors.

Methodology Development

ARB staff followed a set of principles to guide the development of the quantification methodology. These principles ensure that the methodology for TIRCP projects will:

- Apply at the project-level;
- Align with the project types proposed for funding;
- Provide uniform methodologies that can be applied statewide, and be accessible by all applicants;
- Support the analysis of GHG emission reductions from the proposed projects;
- Use existing and proven methods; and
- Use project-level data when available and verified by CalSTA for estimated ridership increases and corresponding VMT reductions.

The methodology fits these objectives, and provides a uniform approach to quantify GHG emission reductions in metric tons of carbon dioxide equivalent ($MTCO_2e$).

ARB released a draft FY 2016-17 quantification methodology for public comment in December 2015.

Tools

This methodology is based on the CMAQ Methods which is a set of equations for evaluating the cost-effectiveness of certain types of transportation projects. The CMAQ Methods were developed by ARB and the Department of Transportation (Caltrans) and are used statewide by transportation agencies to evaluate criteria pollutant emission reductions from transportation projects competing for State motor vehicle fee and federal CMAQ funding.

Building on the CMAQ Methods, the GHG emission reductions used in this methodology are calculated based on well-to-wheels (WTW) emission factors, fuel energy density values, and fuel economy values. Emission factors were developed through ARB's Low Carbon Fuel Standard (LCFS) Program, fuel energy density values were developed through the California-modified Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation (CA-GREET 2.0), and fuel economy values were developed from ARB's Mobile Source Emission Factor Model (EMFAC 2014). The WTW method accounts for the emissions produced from the production and distribution of the different fuel types, including hydrogen and electricity, as well as any associated exhaust emissions. The description of the derivation of the emission factors is included in Appendix B.

Applicants must use this methodology, in conjunction with the accompanying calculator tool, to estimate the GHG emission reductions from their proposed TIRCP projects.

The calculator tool can be downloaded here:
http://www.arb.ca.gov/cc/capandtrade/auctionproceeds/quantification.htm

Updates

ARB updated the prior quantification methodology to enhance the analysis and provide additional clarity. The major changes include:

- Emission factors now include upstream GHG emission sources. This WTW approach quantifies the emissions resulting from the production and distribution of the different fuel types, including hydrogen and electricity, and any associated exhaust emissions. This approach is consistent with other GGRF programs and ARB's LCFS Program.
- Lookup tables for the emission factors based on EMFAC 2014 and a WTW approach with a description of the derivation of the emission factors.
- Methods to calculate reductions from ferry transit, shuttle and vanpool services as well as displaced fuel resulting from reduced VMT and idling.
- Information from the approved ARB Funding Guidelines for Agencies Administering California Climate Investments (Funding Guidelines) on reporting after a project is selected for funding (see Section D for details).
- Additional definitions and clarity to the text based on lessons learned.

TIRCP Project Types

TIRCP will fund capital improvements that will modernize California's intercity, commuter, and urban rail (train) systems, bus, ferry, shuttle bus and vanpool transit systems to reduce GHG emissions; improve/expand transit service and increase ridership; integrate existing bus and rail operations with each other and with high-speed rail; and improve safety.

For GHG quantification purposes, eligible TIRCP projects fall into the four project types described in Table 1 below. Some projects may include more than one project component, such as those that provide operational improvements that reduce travel time (generating ridership gains) and also deploy new, lower-emitting vehicles that replace current vehicles.

Table 1. Description of TIRCP Project Type(s)

Project Types	Description
New/Expanded Service	Expansion of transit (e.g., rail (train), bus, ferry, shuttle and vanpool) service through new service or additional routes.
System and Efficiency Improvements that Result in Increased Ridership	Any system or efficiency improvements that result in increased ridership for existing routes, including projects that increase service levels, reliability, or decrease travel times.
Cleaner Vehicles/ Technology/ Fuels	Use of cleaner vehicles, technologies, or fuels that result in GHG emission reductions.
Displaced Fuel	Any system or efficiency improvements that result in displaced fuel from existing transit services, including projects that reduce transit VMT and idling.

GHG Emission Reductions Quantification Approach

The metric used to assess the effectiveness of the project to reduce GHG emissions per dollar of GGRF funds will be reported by the applicant as:

$$\frac{Total\ Project\ GHG\ Reductions\ in\ Metric\ Tons\ of\ CO_2e}{Total\ GGRF\ Funds\ Requested\ (\$)}$$

GGRF Funds Requested is the dollar amount requested through TIRCP and total GGRF funds requested from any other GGRF programs to which the applicant has or may apply. Section B describes the process for estimating the GHG emission reductions for proposed TIRCP projects in FY 2016-17. Additional documentation and reporting requirements are provided in sections C and D.

Requirements for program implementation and reporting are subject to change based on future revisions that apply to the program (e.g., legislation, updates to ARB's Funding Guidelines, etc.). Implementing agencies/grantees should note that additional reporting may be required for some types of projects or be modified based on the evolving needs of the program. For example, the requirements and methods of data collection are still under development for Phase 2 reporting and will be published at a later date.

Program Assistance

ARB staff will review the quantification portions of the TIRCP project applications to ensure that the methods described in this document were properly applied to estimate the GHG emission reductions for the proposed project. Applicants should use the following resources for additional questions and comments:

- Questions on this quantification document should be sent to GGRFProgram@arb.ca.gov.
- For more information on ARB's efforts to support implementation of GGRF investments, see: www.arb.ca.gov/auctionproceeds.
- Questions not related to this quantification document but pertaining to the TIRCP should be sent to TIRCPcomments@dot.ca.gov.

Section B. Quantification Methodology

This methodology estimates the GHG emission reductions of a proposed TIRCP project based on estimated ridership increases and corresponding passenger auto VMT reductions, as well as the use of cleaner vehicles or displaced fuel. Applicants must use this quantification methodology to estimate the total GHG emission reductions from the proposed project as defined in this methodology.

The following is a summary of the steps TIRCP applicants will follow to estimate and report the GHG emission reductions for a proposed project. Detailed instructions for each step are provided on subsequent pages. An example project showing how to use this quantification methodology is included in Appendix C.

Step 1. Identify the Project Type(s) and Method(s) Needed for the Proposed Project (Table 2)

Step 2. Determine the Calculator Inputs Needed

Step 3. Estimate GHG Emission Reductions Using the Calculator Tool

Note: Applicants may have more than one project type and can use multiple methods to quantify the GHG emission reductions from the different components.

Step 1: Identify the Project Type(s) and Method(s) Needed for the Proposed Project

The applicant must identify at least one project type from Table 2 that best defines the proposed project. The applicant may identify more than one project component.

All equations and calculations are included in the calculator tool developed by ARB staff as part of this quantification methodology; detailed documentation is included in Appendix A. In general, GHG emissions reductions are calculated using the methods shown in Table 2.

Table 2. Description of TIRCP GHG Emission Reduction Method(s)

Project Type and Method	Method Section Reference
New/Expanded Service	
$GHG\ Emission\ Reductions = GHG\ Emissions\ of\ Displaced\ Autos - GHG\ Emissions\ of\ New/Expanded\ Service\ Vehicle$	Step 2.A
System and Efficiency Improvements that Result in Increased Ridership	
$GHG\ Emission\ Reductions = GHG\ Emissions\ of\ Displaced\ Autos$	Step 2.B
Cleaner Vehicles/Technology/Fuels	
$GHG\ Emission\ Reductions = GHG\ Emissions\ of\ Displaced\ Service\ Vehicle - GHG\ Emissions\ of\ New\ Service\ Vehicle$	Step 2.C
Displaced Fuel	
$GHG\ Emission\ Reductions = GHG\ Emissions\ of\ Displaced\ Fuel$	Step 2.D

Step 2: Determine the Calculator Inputs Needed

The following subsections describes the data inputs needed to estimate the GHG emission reductions for proposed projects with the calculator tool per project type.

A. New/Expanded Service

Table 3. Input Requirements for New/Expanded Service

Project Inputs	
Project Type	New/Expanded Service
Transit Service Type	Train, Bus, Ferry, Shuttle or Vanpool
Year 1 (Yr1)	First year of operation
Year F (YrF)	Final year of operation, calculated as "Yr 1 + Useful Life." For new/expanded service projects, the useful life is the number of years the service is funded under the proposed project.
Displaced Auto Inputs	
County	Where the majority of the service occurs
Yr 1 Days of Operation (D)	Use: documented project specific data or default Default: 260 for weekday service or 365 for daily service
Yr1 Average Unlinked Daily Ridership (R)	Average daily ridership expected based on project data. For example, one bus rider commuting round trip per day is two bus trips per day. Ridership should be calculated as average ridership per day of service, so that D*R is equal to annual ridership expected from the project.
YrF D	Use: documented project specific data or default Default: 260 for weekday service or 365 for daily service
YrF R	Average daily ridership expected based on project data.
Adjustment factor for transit dependency (A)	Use documented project specific data or system average developed from a recent, statistically valid survey or default. Default: 0.5 for local bus service or 0.83 for long distance commuter service, shuttle and vanpool
Length of average auto trip reduced (L)	Use value based on specific project or lookup by agency by mode from Table D-1. If no data exist by agency, use statewide average by mode from Table D-2.
New/Expanded Service Vehicle Inputs	
Fuel Type	Fuel type of the vehicle proposed for new/expanded transit service
Annual Units of Fuel	Estimated annual fuel required for train or ferry proposed for new/expanded transit service. Alternatively, the applicant may leave blank and use Train VMT.
Engine Model Year (MY)	Engine MY of the vehicle proposed for new/expanded transit service
Annual VMT	Annual VMT of the vehicle proposed for new/expanded transit service

B. System and Efficiency Improvements that Result in Increased Ridership

Table 4. Input Requirements for System and Efficiency Improvements

Project Inputs	
Project Type	System and Efficiency Improvements
Transit Service Type	Train, Bus, Ferry, Shuttle or Vanpool
Year 1 (Yr1)	First year of operation
Year F (YrF)	Final year of operation, calculated as "Year 1 + Useful Life." Useful life is the number of years the project is expected to provide net GHG benefits or useful life of the equipment. Use: 10 years for advance technologies (i.e., electric, hydrogen fuel cell buses); for others, use Federal Transit Administration guidance available here: www.**fta**.dot.gov/documents/**C_5010_1D_**Finalpub.pdf.
Displaced Auto Inputs	
County	Where the majority of the service occurs
Yr 1 Days of Operation (D)	Use: documented project specific data or default Default: 260 for weekday service or 365 for daily service
Yr1 Average Unlinked Daily Ridership (R)	Average daily ridership expected based on project data. For example, one bus rider commuting round trip per day is two bus trips per day. Ridership should be calculated as average ridership per day of service, so that D*R is equal to annual ridership expected from the project.
YrF D	Use: documented project specific data or default Default: 260 for weekday service or 365 for daily service
YrF R	Average daily ridership expected based on project data.
Adjustment factor for transit dependency (A)	Use documented project specific data or system average developed from a recent, statistically valid survey or default. Default: 0.5 for local bus service or 0.83 for long distance commuter service, shuttle and vanpool
Length of average auto trip reduced (L)	Use value based on specific project or lookup by agency by mode from Table D-1. If no data exist by agency, use statewide average by mode from Table D-2.

C. Cleaner Vehicles/Technology/Fuels

Table 5. Input Requirements for Cleaner Vehicle/Technology/Fuels

Project Inputs	
Project Type	Cleaner Vehicle/Technology/Fuels
Transit Service Type	Train, Bus, Ferry, Shuttle or Vanpool
Year 1 (Yr1)	First year of operation
Year F (YrF)	Final year of operation, calculated as "Year 1 + Useful Life." Use: 10 years for advance technologies (i.e., electric, hydrogen fuel cell buses); for others, use Federal Transit Administration guidance available here: www.**fta**.dot.gov/documents/**C_5010_1D**_Finalpub.pdf.
New/Expanded Service Vehicle Inputs	
Fuel Type	Fuel type of the new vehicle proposed to replace the displaced vehicle
Annual Units of Fuel	Estimated annual fuel required for the ferry proposed to replace the displaced ferry. For new trains, when converting from diesel fuel usage to other fuel types, enter the annual gallons of diesel fuel for the displaced train. The method used to calculate GHG emissions assumes that a new fuel type will have the same energy requirements as a diesel counterpart and allow all submitted applications to be compared on a level playing field. For new diesel fueled trains, use annual fuel required for the train proposed to replace the displaced train. Alternatively, the applicant may leave blank and use Train VMT.
Engine Model Year (MY)	Engine MY of new vehicle proposed to replace the displaced vehicle
Annual VMT	Use the annual VMT of the displaced vehicle (the GHG emission reductions the project will be calculated per mile between the new and displaced vehicle).
Displaced Vehicle or Fuel Inputs	
Fuel Type	Fuel type of the displaced vehicle
Annual Units of Fuel	Annual fuel consumption of the displaced train or ferry
Engine Model Year (MY)	Engine MY of the displaced vehicle
Annual VMT	Annual VMT of the displaced vehicle

D. Displaced Fuel

Table 6. Input Requirements for Displaced Fuel

Project Inputs	
Project Type	Displaced Fuel
Transit Service Type	Train, Bus, Ferry, Shuttle or Vanpool
Year 1 (Yr1)	First year of operation
Year F (YrF)	Final year of operation, calculated as "Year 1 + Useful Life." Useful life is the number of years the project is expected to provide net GHG benefits. Use: 10 years for advance technologies (i.e., electric, hydrogen fuel cell buses); for others, use Federal Transit Administration guidance available at: www.**fta**.dot.gov/documents/**C 5010 1D** Finalpub.pdf.
Displaced Service Vehicle or Fuel Inputs	
Fuel Type	Type of displaced fuel
Annual Units of Fuel	Estimated annual fuel displaced
Engine Model Year (MY)	
Annual VMT	

Step 3: Estimate GHG Emission Reductions Using the Calculator Tool

Once the applicant has compiled all of the required inputs from Step 2, the applicant should download the calculator tool and enter project specific data to estimate GHG emission reductions. An overview of the calculator tool is provided below.

The calculator tool can be downloaded here:
http://www.arb.ca.gov/cc/capandtrade/auctionproceeds/quantification.htm

Read Me Tab

- On the Read Me Tab, enter the Project Name and the contact information for person who can answer project specific questions from staff reviewers on the quantification calculations. This file will be submitted with other required documents. Project names are not to exceed 20 characters. Please abbreviate as needed.

Project Name:	
Contact Name:	
Contact Phone Number:	
Contact Email:	
Date Completed:	

Inputs Tab

- Headers in red indicate a field that requires input by the project applicant. For each row, applicants must work from left to right and enter all relevant data. Some cells may not be applicable to the project. These cells will be blacked out and will be locked based on inputs. Applicants should use as many rows as necessary to characterize all relevant features of the proposed project. Definitions are provided in the definitions tab, including how to determine Year 1, Year F, and adjustment factor. Inputs must be substantiated in the documentation provided to ARB.

Section C. Documentation

Applicants must report the Net GHG Benefits and provide documentation of the calculations and inputs used. The Net GHG Benefits are equal to the Total Project GHG Emission Reductions estimated in the calculator tool.

Applicants are required to provide electronic documentation that is complete and sufficient to allow the calculations to be reviewed and replicated. Paper copies of supporting materials must be available upon request by ARB staff.

Documentation must include, at a minimum:

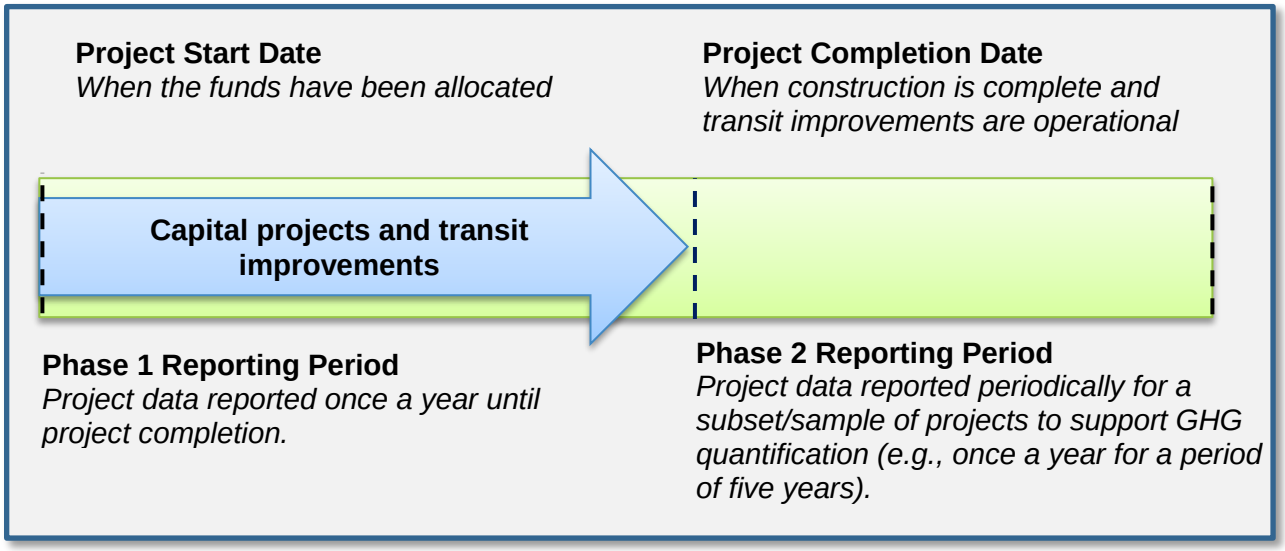
- Project application;
- Populated calculator tool file (in .xlsm);
- Project description, including excerpts or specific references to the location in the TIRCP proposal of the project information necessary to complete the applicable portions of the quantification methodology; and
- Project data support, including:
    - Documentation of the project data used in Step 2 to estimate ridership, project VMT, adjustment factor for transit dependency (A), length of average auto trip reduced (L), new or displaced vehicle data (useful life, model year, etc.) and fuel savings;
    - References to public documents that are the source of the project data.

Section D. Reporting after Funding Award

Accountability and transparency are essential elements for all projects funded by the GGRF. Each administering agency is required to track and report on the benefits of the California Climate Investments funded under their program(s) and each funding recipient has the obligation to provide the necessary data or access to data for their project to support reporting on project outcomes.

In 2015, ARB developed the Funding Guidelines for Agencies Administering California Climate Investments (Funding Guidelines)[1] using GGRF monies. These Funding Guidelines describe the reporting requirements and set the minimum project-level reporting requirements for projects funded. Volume III of the Funding Guidelines summarizes the major reporting components that CalSTA must report to ARB. Because much of this data comes directly from TIRCP projects, TIRCP funding recipients will need to provide project data to CalSTA to support these reporting requirements.

Table 7 and the figure below show the project phases and when reporting is required.



[1] California Air Resources Board. Funding Guidelines for Agencies Administering California Climate Investments. December 21, 2015. http://www.arb.ca.gov/cc/capandtrade/auctionproceeds/arb-funding-guidelines-for-ca-climate-investments.pdf

Table 7. Quantification and Reporting By Project Phase

	Timeframe	Quantification Methodology Section
Project Selection	Covers the period from solicitation to selection of projects and funding awards.	All applicants use methods in this QM to estimate GHG reductions based on application data.
Phase 1	Covers the period from the beginning of the project until it becomes operational or the initial implementation is completed.	Funded projects use methods in this QM, as needed, to update GHG estimates based on project changes.
Phase 2	Starts after Phase 1 is complete and a project becomes operational.	GHG reductions achieved are quantified and reported for a subset of funded projects.

Phase 1 reporting is required for all TIRCP funding recipients during project implementation (e.g., initial construction). This quantification methodology provides guidance on how to estimate project benefits to satisfy Phase 1 reporting requirements. At a minimum, ARB expects that TIRCP funding recipients will report to CalSTA once a year during project construction (for projects with a capital component) or during implementation (for transit without a capital component) and once at the end of the project.

Phase 2 reporting is required for only a subset of TIRCP projects and is intended to document actual project benefits achieved after the project becomes operational. Phase 2 data collection and reporting will not be required for every project. CalSTA will be responsible for identifying the subset of individual projects that must complete Phase 2 reporting, identifying who will be responsible for collecting Phase 2 data, and for reporting the required information to ARB. ARB will work with CalSTA to address Phase 2 procedures, including but not limited to:

- The timelines for Phase 2 reporting (i.e., when does Phase 2 reporting begin, how long will Phase 2 reporting be needed).
- As applicable, approaches for determining the subset of projects that need Phase 2 reporting (i.e., how many X projects out of Y total projects are required to have Phase 2 reporting).
- Methods for monitoring or measuring the necessary data to quantify and document achieved GHG reductions and other select project benefits.
- Data to be collected, including data field needed to support quantification of GHG emission benefits.
- Reporting requirements for transmitting the data to ARB or CalSTA for program transparency and use in reports.

Once the Phase 2 quantification method and data needs are determined, ARB will develop and post the final ARB approved Phase 2 methodology for use in Phase 2 reporting.

Appendix A. Methods Supporting the Calculator Tool

Methods used in the calculator tool for estimating the GHG emission reductions by project type are provided in the subsections below. The GHG Emissions are quantified using the equations below for Year 1 and Year F.

A. New/Expanded Service

GHG Emission Reductions from New/Expanded Service are calculated as:

$$GHG\ Emission\ Reductions = GHG\ Emissions\ of\ Displaced\ Autos - GHG\ Emissions\ of\ New/Expanded\ Service\ Vehicle$$

GHG Emissions of Displaced Autos

$$\boldsymbol{GHG\ Emissions\ of\ Displaced\ Autos} = \frac{[(\boldsymbol{AutoVMT}) * (\boldsymbol{AVEF})]}{1{,}000{,}000}$$

Where:

$$\boldsymbol{AutoVMT} = Annual\ Auto\ VMT\ Reduced\ in\ miles\ per\ year = [(\boldsymbol{D}) * (\boldsymbol{R}) * (\boldsymbol{A}) * (\boldsymbol{L})]$$

Where:

D = Days of operation per year

R = Average unlinked daily ridership

A = Adjustment factor to account for transit dependency
Use: documented project specific data or system average developed from a recent, statistically valid survey or default
Default: 0.5 for local bus service or 0.83 for long distance commuter service

L = Length (miles) of average auto trip reduced.
Use: documented project specific data or system average developed from a recent, statistically valid survey or lookup by agency by mode from Table D-1. If no data exist by agency, use statewide average by mode from Table D-2.

$$\boldsymbol{GHG\ Emissions\ of\ Displaced\ Autos} = \frac{[(\boldsymbol{AutoVMT}) * (\boldsymbol{AVEF})]}{1{,}000{,}000}$$

Where:

AVEF = Auto Vehicle Emission Factor (in gCO2e per mile)*

* See Table A-1.

GHG Emissions of New/Expanded Service Vehicle

Train $= \frac{[(\boldsymbol{TrainF})*(\boldsymbol{TEF})]}{1{,}000{,}000}$ or $\frac{[(\boldsymbol{TVMT})*(\boldsymbol{TDEF})]}{1{,}000{,}000}$

Bus $= \frac{[(\boldsymbol{BVMT})*(\boldsymbol{BEF})]}{1{,}000{,}000}$

Ferry $= \frac{[(\boldsymbol{FerryF})*(\boldsymbol{FEF})]}{1{,}000{,}000}$

Shuttle or Vanpool $= \frac{[(\boldsymbol{SVMT})*(\boldsymbol{SVEF})]}{1{,}000{,}000}$

Where:

TrainF = Estimated annual fuel required for train service based on project data
TEF = Train Emission Factor (in gCO2e per unit of fuel) from Table A-2
TVMT = Annual VMT required for train service based on project data
TDEF = Train Default Emission Factor (in gCO2e per mile) from Table A-2
BVMT = Annual VMT required for bus service based on project data
BEF = Bus Emission Factor (in gCO2e per mile)*
FerryF = Estimated annual fuel required for ferry service based on project data
FEF = Ferry Emission Factor (in gCO2e per unit of fuel) from Table A-3
SVVMT = Annual VMT required for the service based on project data
SVEF = Shuttle or Vanpool Emission Factor (in gCO2e per mile)*

*See Table A-1.

B. System and Efficiency Improvements that Result in Increased Ridership

$$GHG\ Emission\ Reductions = GHG\ Emissions\ of\ Displaced\ Autos$$

GHG Emissions of Displaced Autos

$$\boldsymbol{AutoVMT} = Annual\ Auto\ VMT\ Reduced\ in\ miles\ per\ year$$
$$= \ [(\boldsymbol{D}) * (\boldsymbol{R}) * (\boldsymbol{A}) * (\boldsymbol{L})]$$

Where:

D = Days of operation per year

R = Average unlinked daily ridership

A = Adjustment factor to account for transit dependency
Use: documented project specific data or system average developed from a recent, statistically valid survey or default
Default: 0.5 for local bus service or 0.83 for long distance commuter service

L = Length (miles) of average auto trip reduced.
Use: documented project specific data or system average developed from a recent, statistically valid survey or lookup by agency by mode from Table D-1. If no data exist by agency, use statewide average by mode from Table D-2.

$$\boldsymbol{GHG\ Emissions\ of\ Displaced\ Autos} = \frac{[(\boldsymbol{AutoVMT}) * (\boldsymbol{AVEF})]}{1{,}000{,}000}$$

Where:

AVEF = Auto Vehicle Emission Factor (in gCO2e per mile)*

* See Table A-1.

C. Cleaner Vehicles/Technology/Fuels

$$GHG\ Emission\ Reductions = GHG\ Emissions\ of\ Displaced\ Service\ Vehicle - GHG\ Emissions\ of\ New\ Service\ Vehicle$$

GHG Emissions of Displaced or New Service Vehicle

Train $= \frac{[(\boldsymbol{TrainF})*(\boldsymbol{TEF_{new}})]}{1{,}000{,}000}$ or $\frac{[(\boldsymbol{TVMT})*(\boldsymbol{TDEF})]}{1{,}000{,}000}$

Bus $= \frac{[(\boldsymbol{BVMT})*(\boldsymbol{BEF})]}{1{,}000{,}000}$

Ferry $= \frac{[(\boldsymbol{FerryF})*(\boldsymbol{FEF})]}{1{,}000{,}000}$ and $\frac{[(\boldsymbol{FerryF_d})*(\boldsymbol{FEF})]}{1{,}000{,}000}$

Shuttle or Vanpool $= \frac{[(\boldsymbol{SVMT})*(\boldsymbol{SVEF})]}{1{,}000{,}000}$

Where:

TrainF = Annual fuel consumption of the displaced train based on project data
TEF_{new} = New Train Emission Factor (in gCO2e per unit of fuel) from Table A-2
TVMT = Annual VMT of the displaced train based on project data
TDEF = Train Default Emission Factor (in gCO2e per mile) from Table A-2
BVMT = Annual VMT of the displaced bus based on project data
BEF = Bus Emission Factor (in gCO2e per mile)*
FerryF = Annual units of fuel estimated for the ferry based on project data
FEF = Ferry Emission Factor (in gCO2e per unit of fuel) from Table A-3
$FerryF_d$ = Annual fuel consumption of the displaced ferry based on project data
SVVMT = Annual VMT of the shuttle or vanpool displaced based on project data
SVEF = Shuttle or Vanpool Emission Factor (in gCO2e per mile)*

* See Table A-1.

D. Displaced Fuel

$$GHG\ Emission\ Reductions = GHG\ Emissions\ of\ Displaced\ Fuel^{2}$$

GHG Emissions of Displaced Fuel

$$\textbf{GHG of Displaced Fuel} = \frac{[(\boldsymbol{Fuel})*(\boldsymbol{FuelEF})]}{1{,}000{,}000}$$

Where:

Fuel = Estimated annual units of fuel displaced based on project data
Fuel EF = Fuel-Specific Carbon Content (in gCO2e per unit of fuel) from Table B-1

[2] The applicant must provide supporting documentation demonstrating how the annual fuel amounts were derived.

Project Type Total Emission Reductions

The total emission reductions for each project type and method is equal to the Total Emission Reductions for the Useful Life (UL):

$$\boldsymbol{Project\ Type\ Total\ Emission\ Reductions} = \left(\frac{(\boldsymbol{Yr1\ GHG\ Emission\ Reductions} + \boldsymbol{YrF\ GHG\ Emission\ Reductions})}{\mathbf{2}}\right) * \boldsymbol{UL}$$

Total Project GHG Emission Reductions

If the project consists of more than one project type, the Total Project GHG Emission Reductions is equal to the sum of the GHG reductions by project type:

$$\begin{aligned}&\boldsymbol{Total\ Project\ GHG\ Emission\ Reductions}\\ &= Project\ Type\ GHG\ Reductions\ (from\ New\ or\ Expanded\ Service)\\ &+ Project\ Type\ GHG\ Reductions (from\ System\ and\ Efficiency\ Improvements\ )\\ &+ Projct\ Type\ GHG\ Reductions\ (from\ Cleaner\ Vehicles/Technology/Fuels)\\ &+ Projct\ Type\ GHG\ Reductions\ (from\ Displaced\ Fuel)\end{aligned}$$

Auto, Bus, Van and Shuttle Emission Factor Lookup Tables

Table A-1 provides links to the relevant Lookup tables used in the calculator. A detailed methodology of how the emission factors were developed is provided in Appendix B.

Table A-1. Auto, Bus, Van, and Shuttle Emission Factor Tables

Emission Factor	Link to Lookup Tables
AVEF	http://www.arb.ca.gov/cc/capandtrade/auctionproceeds/ef_avef_final.pdf
BEF	http://www.arb.ca.gov/cc/capandtrade/auctionproceeds/ef_bus_final.pdf
SEF	http://www.arb.ca.gov/cc/capandtrade/auctionproceeds/ef_ldh_busshuttle_final.pdf

Train Emission Factor Lookup Table

Emissions for trains require project-specific information on the estimated quantity and type of fuel used annually, which are used with the appropriate carbon content factor (in gCO2e per unit of fuel) from Table B-1 to convert fuel to GHG emissions. Emission Factors are calculated using fuel type megajoule (MJ) per unit of fuel and the fuel type Energy Densities (grams of CO_2e per MJ). When converting from diesel fuel usage to other fuel types use the New Train Emission Factor (**TEF_{new}**). Alternatively, the applicant may use the ARB provided train default emission factors here to estimate GHG emission reductions, if fuel specific data is unknown or cannot be documented, of the proposed project.

TEF_{new} and ARB (**TDEF**) defaults were calculated using the diesel fuel usage of the baseline train as a basis for the emission factors. This method assumes that a new fuel type will have the same energy requirements as a diesel counterpart and allow all submitted applications to be compared on a level playing field.

Table A-2. Train Emission Factors

Train Fuel Type	TEF	TEF_{new} (Diesel Equivalent gCO2e)	TDEF (gCO_2e/mi)
CNG	78 gCO2e/scf	11,782	21,596
Diesel		13,818 gCO2e/gal	25,136
Electric (Heavy Rail)	379 gCO2e/KWh	3,047	5,592
Electric (Light Rail)		4,285	7,795
Electric (Trolley Bus, Cable Car, Street Car)		4,562	8,298
Hydrogen Fuel Cell	12,678 gCO2e/kg	7,477	13,602
Hydrogen Fuel Cell (SB 1505)	10,466 gCO2e/kg	6,173	11,229
LNG	6,824 gCO2e/gal	12,935	23,529
Renewable Diesel	4,510 gCO2e/gal	4,677	8,508

Ferry Emission Factor Lookup Table

Due to the high variability in ferries, standardized emission factors are not available for new/expanded ferry service. Emissions for ferries require project-specific information for the estimated quantity and type of fuel used annually, which are used with the appropriate carbon content factor from Table B-1 to convert fuel to GHG emissions. The same emission factor will be used for both Year 1 and Year F, according to fuel type, in Table A-3. Emission Factors are calculated using fuel type megajoule (MJ) per unit of fuel and the fuel type Energy Densities (grams of CO_2e per MJ).

Table A-3. Ferry Emission Factors

Fuel Type (units)	FEF (gCO_2e/unit of fuel)
CNG (scf)	78
Diesel (gal)	13,818
Electric/BEV or PHEV (KWh)	379
Hydrogen Fuel Cell (kg)	12,678
Hydrogen Fuel Cell (SB 1505) (kg)	10,466
LNG (gal)	6,824

Appendix B. Emission Factors

The following sections detail how the emission factors were developed.

Auto Vehicle Emission Factors

Passenger (auto) vehicle emission factors (**AVEF**) were derived using the following steps.

1. Emissions by county for each calendar year from 2016 through 2050 were downloaded from EMFAC 2014 with the following parameters:
    a. Annual Average
    b. EMFAC2011 vehicle categories LDA, LDT1, LDT2, and MDV
    c. Aggregated model year
    d. Aggregated speed
    e. Gasoline fuel

2. The auto fuel consumption rate (**AFCR**, in gallons of gasoline per mile) was calculated using the total gallons of gasoline used by each vehicle category divided by the total mileage by vehicle category by county and year, using the following equation:

$$AFCR = \frac{(Fuel\_Consumption_{LDA} + Fuel\_Consumption_{LDT1} + Fuel\_Consumption_{LDT2} + Fuel\_Consumption_{MDV}) * 1{,}000}{VMT_{LDA} + VMT_{LDT1} + VMT_{LDT2} + VMT_{MDV}}$$

    Where,
    Fuel_Consumption is the total fuel consumption for the vehicle type, in 1,000 gallons per day, from EMFAC 2014, and

    VMT is the total vehicle miles traveled for the vehicle type, in miles per day, from EMFAC 2014.

3. The auto vehicle emission factors (**AVEF**, in grams of CO_2e per mile) were calculated for each year and county by multiplying auto fuel consumption rate the by the WTW carbon content factor for gasoline, which is 11,460.09 g CO_2e per gallon (Table B-1), using the following equation:

$$AVEF = 11{,}460.09 * AFCR$$

Bus and Van/Shuttle Emission Factors

The bus and van/shuttle new service emission factors (NSEF) were derived using a similar method, as follows.

1. The statewide emissions each calendar year from 2016 through 2050 were downloaded from EMFAC 2014 with the following parameters:
    a. Annual Average
    b. EMFAC2011 vehicle categories UBUS for bus and LHD1 for Van/Shuttle
    c. All model years
    d. Aggregated speed
    e. Diesel fuel
2. The new service fuel consumption rate (**NSCR**, in gallons of diesel per mile) was calculated using the total gallons of diesel fuel used by each vehicle category and model year divided by the total mileage by vehicle category and model year, using the following equation:

$$NSCR_{diesel} = \frac{Fuel\_Consumption_{(UBUS\ \ \boldsymbol{OR}\ LDH1)}\ * 1{,}000}{VMT_{(UBUS\ \ \boldsymbol{OR}\ LDH1)}}$$

Where,
Fuel_Consumption is the total fuel consumption for the vehicle type, in 1,000 gallons per day, from EMFAC 2014, and

VMT is the total vehicle miles traveled for the vehicle type, in miles per day, from EMFAC 2014.

3. Diesel emission factors were developed using data as described in (a) below. Emission factors for other fuel types convert the diesel new service fuel consumption rate to the appropriate fuel type as described in (b).
    a. Diesel: the new service emission factor (**NSEF**, in grams of CO_2e per mile) for each calendar year and model year were obtained by multiplying the new service fuel consumption rate (**NSCR**, in gallons per mile) by the Well-to-Wheels carbon content factor for diesel (13,818.14 g CO_2e per gallon) using the following equation:

$$NSEF = 13{,}818.14 * NSCR$$

    b. Non-Diesel: For fuel types other than diesel, staff converted the diesel fuel consumption rate (**NSCR**) from Step 2 to the equivalent new service emission factor (**NSEF**, in grams of CO_2e per mile) using the following equation:

$$NSEF_{new\_fuel} = NSCR_{diesel} * ED_{diesel} * \left(\frac{1}{ED_{new\_fuel}}\right) * \left(\frac{1}{EER}\right) * CC_{new\_fuel}$$

Where,

$NSCR_{diesel}$ = New Service Consumption Rate for diesel, from Step 2 (gallons per mile)

ED_{diesel} = 134.47 MJ per gallon, from Table B-1

$ED_{new\ fuel}$ = Energy density of the new fuel type (MJ per unit of new fuel), from Table B-1

EER = Energy Economy Ratio (unitless), from Table B-1

CC_{new_fuel} = Carbon Content of the new fuel type (grams of CO_2e per unit of new fuel), from Table B-1

Table B-1. Fuel-Specific Factors

Fuels (units)	Energy Density	Carbon Content gCO_2e/unit*	EER Values Relative to Diesel
Diesel (gal)	134.47 (MJ/gal)	13,818.14 (gCO_2e/gal)	1.0
Gas (gal)	115.63 (MJ/gal)	11,460.09 (gCO_2e/gal)	0.9
CNG (scf)	0.98 (MJ/scf)	77.88 (gCO_2e/scf)	0.9
LNG (gal)	78.83 (MJ/gal)	6,824.31 (gCO_2e/gal)	0.9
Hydrogen (kg)	120.00 (MJ/kg)	12,678.00 (gCO_2e/kg)	1.9
Hydrogen SB 1505 compliant (kg)		10,466.4 (gCO_2e/kg)	
Electric (KWh)	3.6 (MJ/KWh)	378.58 (gCO_2e/KWh)	4.2 (Bus) 2.7 (Shuttle/Van) 4.6 (Heavy Rail) 3.3 (Light Rail)

*Calculated using fuel type megajoule (MJ) per unit of fuel from ARB Staff Report Table III-2. Energy Densities of LCFS Fuels and Blendstocks[3] and ARB CA-GREET fuel type grams of CO_2e per MJ.[4]

[3] Staff Report: Initial Statement of Reasons for Proposed Rulemaking, Proposed Re-Adoption of the Low Carbon Fuel Standard, December 2014

[4] Direct values (without energy efficiency ratio adjustments). Source: California Air Resources Board, CA-GREET 1.8b versus 2.0 CI Comparison Table, April 1, 2015

Train Emission Factors (TEF_{new}, TDF)

Train emission factors were derived using the following process.

1. A Train Consumption Rate (TCR, in gallons of diesel per mile) was calculated using the total gallons of diesel fuel used by 130 trains across the State in 2010 divided by the total mileage of those trains using the following equation:

$$TCR_{diesel} = \frac{Fuel\ Consumption}{VMT}$$

2. The diesel emission factor was developed using data as described in (a) below. Emission factors for other fuel types convert the diesel new service fuel consumption rate to the appropriate fuel type as described in (b).
    a. Diesel: the new train emission factor (**TDEF**, in grams of CO_2e per mile) was obtained by multiplying the train fuel consumption rate (**TCR**, in gallons per mile) by the WTW carbon content factor for diesel (13,818.14 g CO_2e per gallon) using the following equation:

$$TDEF = 13{,}818.14 * TCR$$

    b. Non-Diesel: For fuel types other than diesel, staff converted the diesel fuel consumption rate (**TCR**) from Step 2 to the equivalent new service emission factor (**TEF**, in grams of CO_2e per mile) using the following equation:

$$TEF_{new\_fuel} = TCR_{diesel} * ED_{diesel} * \left(\frac{1}{ED_{new\_fuel}}\right) * \left(\frac{1}{EER}\right) * CC_{new\_fuel}$$

Where:

TCR_{diesel} = Train Consumption Rate for diesel (gallons per mile)

ED_{diesel} = 134.47 MJ per gallon, from Table B-1

$ED_{new\ fuel}$ = Energy density of the new fuel type (MJ per unit of new fuel), from Table B-1

EER = Energy Economy Ratio (unitless), from Table B-1

CC_{new_fuel} = Carbon Content of the new fuel type (grams of CO_2e per unit of new fuel), from Table B-1

Appendix C. Example New/Expanded Service Project

The following hypothetical project is provided as an example of how to apply the quantification methodology. It is recommended that the applicant follow the steps outlined in the TIRCP quantification methodology while reviewing the project example.

The proposed project is requesting $1,000,000 in TIRCP funds and is not applying for any additional GGRF monies to expand the regional transit (RT) capacity by purchasing new railcars and extending the existing daily light rail service by 282.5 miles. The RT analysis estimated the project to increase daily ridership by 3,140. Survey data by RT estimated a length of the average auto trip reduced to be 5.6 miles. Where project specific data is not available, ARB defaults were used. The proposed project located in Sacramento County will be completed and in service beginning January 1, 2018. Railcars have an estimated useful life of 25 years.

Step 1: Identify the Project Type(s) and Method(s) Needed for the Proposed Project

Applicants determined the appropriate method for the proposed project type to be a New/Expanded Service project from Table 1. The inputs needed are determined by Table 3 and Step 2.A.

Project Type and Method	Method Section Reference
New/Expanded Service	
$GHG\ Emission\ Reductions = GHG\ Emissions\ of\ Displaced\ Autos - GHG\ Emissions\ of\ New/Expanded\ Service\ Vehicle$	Step 2.A

Steps 2. Determine the Calculator Inputs Needed

Project Details Input	
Project Type	New/Expanded Service
Transit Service Type	Train
Year 1(Yr1)	2018
Year F (YrF)	2043
Displaced Auto Inputs	
County	Sacramento
Yr 1 Days of Operation (D)	365 for daily services
Yr1 Average Daily Ridership (R)	3,140 from RT analysis
YrF D	365 for daily services
YrF R	3,140 from RT analysis
Adjustment factor for transit dependency (A)	0.5 from ARB default
Length of average auto trip reduced (L)	5.6 from Table D-1
New/Expanded Service Vehicle Inputs	
Fuel Type	Electric (Light Rail)
Annual Units of Fuel	
Engine Model Year (MY)	
Annual VMT	103,112.5= 365* 285.5 miles/day (from project data)

Step 3: Estimate GHG Emission Reductions Using the Calculator Tool

Once the applicant determines all of the required inputs from the respective table(s), the applicant enters the project information into the calculator to estimate GHG emission reductions starting with the Read Me Tab.

Read Me Tab

Project Name:	Light Rail Expansion
Contact Name:	Chris Young
Contact Phone Number:	916-555-1234
Contact Email:	Cyoung@transit.org
Date Completed:	2/5/2016

Inputs Tab

Project Inputs			
Project Type	Transit Service Type	Year 1 (Yr1)	Year F (YrF)
New/Expanded Service	Train	2018	2043

Displaced Autos Inputs						
County	Yr1 Days of Operation (D)	Yr 1 Average Daily Ridership (R)	YrF Days of Operation (D)	Yr F Average Daily Ridership (R)	Adjustment (A)	Length (L)
Sacramento	365	3,140	365	3,140	0.50	5.60

New/Expanded Service Vehicle Inputs			
Fuel Type	Annual Units of Fuel	Engine MY	Annual VMT
Electric (Light Rail)			103,113

Net GHG Benefits	Funds Requested	
Total GHG Emission Reductions (MTCO2e)	TIRCP Funds Requested ($)	Total GGRF Funds Requested ($)
12442.29	$ 1,000,000.00	$ 1,000,000.00

Submit Documentation

To complete the quantification process, the applicant must submit an electronic copy of the calculator (in .xlsm) and all of the required documentation as noted in Section C.

For this example New/Expanded Service project type, the Total GHG Emission Reductions (MTCO2e) is equal to the sum of GHGs of Displaced Autos minus the GHGs of New Service Vehicle. The applicant would report the Net GHG Benefits as **12,442.29 MTCO2e.**

Summary Tab

Results	GHG Emissions (MTCO2e)	Description
Net GHG Benefits	12,442.29	Total GHG Emissions (MTCO2e) from the proposed project.
TIRCP Funds Requested ($)	1,000,000.00	TIRCP Funds Requested for the proposed project.
Total GHG Emission Reductions /TIRCP Funds Requested ($)	0.0124	Emissions per TIRCP funding requested.
Total GGRF Funds Requested ($)	1,000,000.00	Total GGRF Funds Requested for the proposed project If you are applying, have applied, or are planning to apply for additional GGRF funds for the proposed project, enter the combined funding request for all GGRF programs. If you are applying only to TIRCP for GGRF funding, re-enter the TIRCP funds requested in the "Total GGRF Funds Requested ($)".
Total GHG Emission Reductions /Total GGRF Funds Requested ($)	0.0124	Emissions per total GGRF funding requested. This may be the same as the program-specific funding requested UNLESS the same project and phase will seek or has sought funding from other GGRF programs. Applicants must provide details in this case.

Appendix D. Length of Average Auto Trip Reduced Lookup Tables

Caltrans developed these recommended values for applicants to use for the length of the average auto trip reduced, by agency or statewide, by mode using data from the 2013 NTD. These values where calculated by dividing passenger miles traveled by unlinked passenger trips. For additional information on the tables please contact Caltrans at TIRCPcomments@dot.ca.gov.

Table D-1. Length of Average Auto Trip Reduced by Agency by Mode

NTD ID	Agency	Mode*	Miles/ Trip
9006	Santa Cruz Metropolitan Transit District	CB	31.7
9012	San Joaquin Regional Transit District	CB	46.0
9020	Santa Barbara Metropolitan Transit District	CB	40.3
9026	San Diego Metropolitan Transit System	CB	23.9
9031	Riverside Transit Agency	CB	13.2
9031	Riverside Transit Agency	CB	23.9
9036	Orange County Transportation Authority	CB	3.7
9036	Orange County Transportation Authority	CB	5.3
9041	Montebello Bus Lines	CB	10.4
9061	Yuba-Sutter Transit Authority	CB	41.0
9121	Antelope Valley Transit Authority	CB	63.3
9147	City of Los Angeles Department of Transportation	CB	16.7
9148	Victor Valley Transit Authority	CB	50.7
9149	City of Lompoc - Lompoc Transit	CB	51.7
9159	Western Contra Costa Transit Authority	CB	23.8
9164	Ventura Intercity Service Transit Authority	CB	11.5
9171	Santa Clarita Transit	CB	22.0
9196	Placer County Department of Public Works	CB	26.6
9196	Placer County Department of Public Works	CB	26.6
9205	City of Elk Grove	CB	20.0
9206	San Luis Obispo Regional Transit Authority	CB	24.5
9232	Solano County Transit	CB	8.8
9015	San Francisco Municipal Railway	CC	1.3
9030	North County Transit District	CR	27.5
9134	Peninsula Corridor Joint Powers Board dba: Caltrain	CR	21.8
9151	Southern California Regional Rail Authority dba: Metrolink	CR	34.6
9182	Altamont Corridor Express	CR	44.8
9016	Golden Gate Bridge, Highway and Transportation District	FB	11.0
9225	SF Bay Area Water Emergency Transportation Authority	FB	17.0
9003	San Francisco Bay Area Rapid Transit District	HR	13.0

NTD ID	Agency	Mode*	Miles/ Trip
9006	Santa Cruz Metropolitan Transit District	CB	31.7
9012	San Joaquin Regional Transit District	CB	46.0
9020	Santa Barbara Metropolitan Transit District	CB	40.3
9026	San Diego Metropolitan Transit System	CB	23.9
9031	Riverside Transit Agency	CB	13.2
9031	Riverside Transit Agency	CB	23.9
9036	Orange County Transportation Authority	CB	3.7
9036	Orange County Transportation Authority	CB	5.3
9041	Montebello Bus Lines	CB	10.4
9061	Yuba-Sutter Transit Authority	CB	41.0
9121	Antelope Valley Transit Authority	CB	63.3
9147	City of Los Angeles Department of Transportation	CB	16.7
9148	Victor Valley Transit Authority	CB	50.7
9149	City of Lompoc - Lompoc Transit	CB	51.7
9159	Western Contra Costa Transit Authority	CB	23.8
9164	Ventura Intercity Service Transit Authority	CB	11.5
9171	Santa Clarita Transit	CB	22.0
9196	Placer County Department of Public Works	CB	26.6
9196	Placer County Department of Public Works	CB	26.6
9205	City of Elk Grove	CB	20.0
9206	San Luis Obispo Regional Transit Authority	CB	24.5
9232	Solano County Transit	CB	8.8
9015	San Francisco Municipal Railway	CC	1.3
9030	North County Transit District	CR	27.5
9134	Peninsula Corridor Joint Powers Board dba: Caltrain	CR	21.8
9151	Southern California Regional Rail Authority dba: Metrolink	CR	34.6
9182	Altamont Corridor Express	CR	44.8
9154	LA County Metropolitan Transportation Authority dba: Metro	HR	4.8

*See Table D-2 for Mode type definition.

NTD ID	Agency	Mode*	Miles/ Trip
9013	Santa Clara Valley Transportation Authority	LR	5.4
9015	San Francisco Municipal Railway	LR	2.9
9019	Sacramento Regional Transit District	LR	5.6
9026	San Diego Metropolitan Transit System	LR	5.8
9154	LA County Metropolitan Transportation Authority dba: Metro	LR	6.4
9004	Golden Empire Transit District	MB	3.3
9006	Santa Cruz Metropolitan Transit District	MB	4.8
9007	Modesto Area Express	MB	3.2
9008	Santa Monica's Big Blue Bus	MB	3.9
9009	San Mateo County Transit District	MB	4.1
9009	San Mateo County Transit District	MB	7.1
9010	Torrance Transit System	MB	4.3
9010	Torrance Transit System	MB	12.3
9012	San Joaquin Regional Transit District	MB	3.4
9012	San Joaquin Regional Transit District	MB	4.3
9013	Santa Clara Valley Transportation Authority	MB	5.1
9013	Santa Clara Valley Transportation Authority	MB	3.9
9014	Alameda-Contra Costa Transit District	MB	3.7
9015	San Francisco Municipal Railway	MB	2.3
9016	Golden Gate Bridge, Highway and Transportation District	MB	11.0
9016	Golden Gate Bridge, Highway and Transportation District	MB	18.0
9017	City of Santa Rosa	MB	2.8
9017	City of Santa Rosa	MB	4.3
9019	Sacramento Regional Transit District	MB	3.6
9020	Santa Barbara Metropolitan Transit District	MB	4.3
9022	Norwalk Transit System	MB	3.6
9023	Long Beach Transit	MB	3.1
9026	San Diego Metropolitan Transit System	MB	3.7
9026	San Diego Metropolitan Transit System	MB	3.2
9027	Fresno Area Express	MB	2.5
9029	Omnitrans	MB	4.8
9029	Omnitrans	MB	3.9
9030	North County Transit District	MB	4.8
9031	Riverside Transit Agency	MB	6.2
9031	Riverside Transit Agency	MB	6.8
9035	Gold Coast Transit	MB	4.2
9036	Orange County Transportation Authority	MB	3.7
9036	Orange County Transportation Authority	MB	5.3
9039	Culver City Municipal Bus Lines	MB	3.4
9041	Montebello Bus Lines	MB	3.3

*See Table D-2 for Mode type definition.

NTD ID	Agency	Mode*	Miles/ Trip
9041	Montebello Bus Lines	MB	3.3
9042	City of Gardena Transportation Department	MB	3.9
9043	City of Commerce Municipal Buslines	MB	3.4
9061	Yuba-Sutter Transit Authority	MB	1.2
9062	Monterey-Salinas Transit	MB	5.3
9062	Monterey-Salinas Transit	MB	4.5
9078	Central Contra Costa Transit Authority	MB	4.8
9079	SunLine Transit Agency	MB	6.6
9087	Santa Maria Area Transit	MB	6.8
9089	Sonoma County Transit	MB	9.3
9089	Sonoma County Transit	MB	9.3
9090	Yolo County Transportation District	MB	11.0
9091	City of Visalia - Visalia City Coach	MB	4.6
9092	City of Fairfield - Fairfield and Suisun Transit	MB	7.2
9093	Redding Area Bus Authority	MB	6.1
9119	Laguna Beach Municipal Transit	MB	1.8
9121	Antelope Valley Transit Authority	MB	13.1
9134	Peninsula Corridor Joint Powers Board dba: Caltrain	MB	3.3
9142	Unitrans - City of Davis/ASUCD	MB	2.2
9144	Livermore / Amador Valley Transit Authority	MB	4.9
9146	Foothill Transit	MB	7.5
9147	City of Los Angeles Department of Transportation	MB	1.4
9148	Victor Valley Transit Authority	MB	6.0
9149	City of Lompoc - Lompoc Transit	MB	6.8
9154	LA County Metropolitan Transportation Authority dba: Metro	MB	4.1
9154	LA County Metropolitan Transportation Authority dba: Metro	MB	3.7
9156	City of San Luis Obispo	MB	2.8
9159	Western Contra Costa Transit Authority	MB	6.2
9162	The Eastern Contra Costa Transit Authority	MB	6.9
9166	LACMTA - Small Operators	MB	2.4
9171	Santa Clarita Transit	MB	4.1
9173	Merced County Transit	MB	1.9
9175	City of Lodi - Transit Division	MB	2.8
9193	Chula Vista Transit	MB	3.7
9196	Placer County Department of Public Works	MB	8.3
9196	Placer County Department of Public Works	MB	5.3
9200	Kings County Area Public Transit Agency	MB	5.2
9201	City of Turlock	MB	3.5

*See Table D-2 for Mode type definition.

NTD ID	Agency	Mode*	Miles/ Trip
9205	City of Elk Grove	MB	8.0
9206	San Luis Obispo Regional Transit Authority	MB	14.1
9208	Butte County Association of Governments	MB	6.3
9211	Anaheim Transportation Network	MB	2.1
9213	City of Petaluma	MB	3.0
9214	City of Redondo Beach - Beach Cities Transit	MB	4.5
9226	Imperial County Transportation Commission	MB	16.4
9232	Solano County Transit	MB	4.5
9244	City of Tulare	MB	5.2
9154	LA County Metropolitan Transportation Authority dba: Metro	RB	6.3
9015	San Francisco Municipal Railway	SR	1.5
9015	San Francisco Municipal Railway	TB	1.5
9036	Orange County Transportation Authority	VP	36.1
9095	San Diego Association of Governments	VP	47.1
9148	Victor Valley Transit Authority	VP	51.3
9154	LA County Metropolitan Transportation Authority dba: Metro	VP	45.0
9196	Placer County Department of Public Works	VP	40.2
9230	California Vanpool Authority	VP	39.3
9030	North County Transit District	YR	9.1

*See Table D-2 for Mode type definition

Table D-2. Length of Average Auto Trip Reduced Statewide by Mode

Mode Type		Miles/Trip
Commuter Bus	CB	26.6
Cable Car	CC	1.3
Commuter Rail	CR	32.2
Ferryboat	FB	14.0
Heavy Rail	HR	8.9
Light Rail	LR	5.2
Bus	MB	5.1
Bus Rapid Transit	RB	6.3
Streetcar Rail	SR	1.5
Trolley Bus	TB	1.5
Vanpool	VP	43.2
Hybrid Rail	YR	9.1