https://www.alamedactc.org/planning/sb743-vmt/

Alameda CTC VMT Reduction Calculator Tool—Design Document

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Introduction

This report documents the design of the Alameda CTC VMT Reduction Calculator Tool. The Microsoft Excel-based Tool produces estimates of the percent reduction in vehicle miles traveled (VMT) resulting from the application of mobility management strategies. The Tool is intended to act as a resource for evaluating and quantifying the impacts of mobility management strategies as part of the development review and transportation analysis process for development projects located in Alameda County. The Tool supports the goals of SB 743 (Steinberg, 2013) by providing jurisdictions and developers with a resource to quantify VMT reductions resulting from implementation of a variety of mitigation strategies at various scales. Use of this Tool is voluntary at the discretion of the lead agency. The tool is only applicable for projects within Alameda County.

This report describes the user inputs, constants and assumptions, formulas, and outputs for each strategy included in the Tool. Most of this information is available in the Tool itself, although this document provides some additional explanation of data sources and calculation methods.

The report is organized similarly to the Tool itself: the first section constitutes a User Guide, situating the Tool within a typical analytical workflow. The next four sections following the User Guide describe the Main page, FAQs page, Results page, and Conflict Info page. The remaining sections describe the 28 strategies included in the Tool, grouped in the following five categories:

- Employer Commute Programs
- Land Use Strategies
- Parking Management
- Neighborhood Enhancements
- Transit Strategies

User Guide

The Alameda CTC VMT Reduction Calculator Tool is designed to help analysts quantify the effectiveness of a given suite of VMT reduction strategies, based on substantial research evidence. As such, it forms an important part, but only one part, of an analytical pipeline related to SB 743's VMT impact analysis mandate. This User Guide situates the Tool within that pipeline, and provides tips on using the Tool as effectively as possible.

Before You Use the Tool

- Confirm whether the project is subject to VMT analysis. Some projects will be screened out of VMT analysis per local policy recommendations.
- Understand the project—its description, its components, and its location/context. While the Tool is intended to be easy to use, there is no substitute for a solid understanding of the project's elements and context.
- Calculate the project's VMT and VMT per capita/per service population prior to any reductions. The Tool reports VMT effects in terms of percentage reductions, so you will generally need to calculate the base number(s) onto which those reductions are applied.

Using the Tool

- Begin by identifying the project location in terms of Alameda CTC travel model Transportation Analysis Zones (TAZs). The Tool includes a link to Alameda County's online VMT Mapping Tool, a useful resource for identifying the project's TAZ.
    - Once you enter the TAZ number, the Tool will display the name of the jurisdiction containing that TAZ. This allows the analyst to quickly confirm they have selected the correct TAZ.
    - Because the research literature on VMT reduction strategies is based on studies in urban or suburban land use contexts (as opposed to rural areas), the Tool is not applicable in some very low-density parts of Alameda County. If your project is in one of these areas, the Tool will clearly indicate this fact. In that case, any quantification of VMT reductions would need to be done outside of this Tool and based on project- and context-specific evidence and calculations.
- The Tool is designed to be self-documenting and to include extensive guidance; it is therefore vital to read and consider the documentation and guidance in the Tool. In particular, analysts should carefully review each VMT reduction strategy's description to confirm whether the strategy is plausibly applicable to a given project.
    - Although most strategies affecting VMT at a neighborhood/city scale are too ambitious to be undertaken singlehandedly by all but the largest projects, many of these strategies (e.g., neighborhood traffic calming, bikeway network expansion, or transit frequency

improvements) can be accomplished by a larger program into which a given project makes a partial financial contribution. This use case is not explicitly handled in the Tool, but can be calculated by entering the total effect of the program and then prorating the resulting VMT reduction according to the project's share of total program costs.

- Refer to the hidden help texts located throughout the Tool (mouse over cells with a dashed border) for guidance on user inputs and other information about each strategy.
- Certain VMT reduction strategies conflict with one another. For example, a project cannot have both a mandatory AND a voluntary commute trip reduction program: such a program must be either mandatory or voluntary, not both.
  - If an analyst configures multiple conflicting strategies, the Tool will temporarily disable both conflicting strategies, excluding their effects from the aggregate effectiveness shown on the Results page until the conflict is resolved. Conflicting strategies are clearly labeled on the Results page as well as on the Conflict Info page, which is intended to help the analyst understand which strategies are in conflict.
  - To resolve a conflict, choose one conflicting strategy (typically the less effective one), navigate to that strategy's page, and check the "Exclude from Results" button.
- The Results page is designed to be ready to print as a durable report of the Tool's outputs.

After You Use the Tool

- Typically, the key question in a VMT impact analysis is "does the project's VMT, including the effect of VMT reduction strategies, constitute a significant environmental impact?" In order to answer this question, the analyst will need to apply the reductions calculated in the Tool to the baseline (pre-reduction) project VMT, then compare the result to the local jurisdiction's VMT impact significance thresholds.
- It is important to understand how the four different types of VMT reduction calculated in the Tool interact. See the "Results Page" section below for more information.

Main Page

ALAMEDA CTC VMT REDUCTION CALCULATOR TOOL

Users of the Tool should begin on the Main page. The Main page is organized around the following five boxes:

I. Overview

Describes the Tool and its purpose.

II. Instructions

Describes how to use the Tool in a series of six steps.

III. Legend

Describes the formatting for cells used in the VMT reduction calculations for each strategy.

IV. Project Information

The user can enter the following optional information:

- Project Name
- Project Address
- Project Type

The user must select the analysis location by indicating in which Alameda CTC travel model Transportation Analysis Zone (TAZ) the project is located. The Tool includes a link to Alameda County's online VMT Mapping Tool, a useful resource for identifying the project's TAZ.

V. Mobility Management Strategies

The user sees a list of the 28 strategies included in the Tool, shown below. Each strategy name is a hyperlink, and clicking on a name will take the user to that strategy. This section also contains a link to the Results page.

Most of the strategies in the first three groups reduce VMT at a project level, i.e., they reduce VMT associated with the specific project. Most strategies in the last two groups reduce VMT at a neighborhood/city level, i.e., their reductions apply to all VMT within the geographic area affected by the strategy. In practice, only medium to large projects, or citywide programs, will generally be able to employ these larger-scale strategies.

Employer Commute Program Strategies	
Strategies implemented by employers that encourage workers to commute by modes other than auto	
1A	Voluntary Employer Commute Program
1B	Mandatory Employer Commute Program
1C	Employer Carpool Program
1D1	Implement Subsidized or Discounted Transit Program (for Employees)
1D2	Implement Subsidized or Discounted Transit Program (for Residents)
1E	Employer Vanpool Program
1F	Employer Telework Program
Land Use Strategies	
Strategies that modify the location or characteristics of development projects to encourage non-auto travel modes	
2A	Transit Oriented Development
2B1	Increase Residential Density
2B2	Increase Employment Density
2C	Integrate Affordable and Below Market Rate Housing
Parking Management Strategies	
Strategies that discourage auto travel by modifying the price or supply of vehicle parking	
3A1	Price Workplace Parking
3A2	Unbundle Parking Costs from Property Cost
3B	Parking Cash Out
3C	Limit Parking Supply
3D	Provide Bike Parking
Neighborhood Enhancement Strategies	
Strategies that improve or encourage neighborhood-level bicycle, pedestrian, and other multimodal travel options	
4A	Street Connectivity Improvement
4B	Pedestrian Facility Improvement
4C	Bikeway Network Expansion
4D	Bike Facility Improvement
4E	Bikeshare
4F	Carshare
4G	Community-Based Travel Planning
4H	Provide Neighborhood Traffic Calming Measures
Transit Strategies	
Strategies that improve transit service and cause a mode shift from auto to transit	
5A	Transit Service Expansion
5B	Transit Frequency Improvements
5C	Transit-Supportive Treatments
5D	Transit Fare Reduction
5E	Microtransit or NEV Shuttle

FAQs Page

This page contains frequently asked questions and associated answers.

1. **What does this tool do?**
   The tool operates at two geographic scales: project/site-level and community/city-level. The tool user must provide simple input information about a strategy in order to produce a VMT reduction estimate. The tool is intended to act as a resource for evaluating and quantifying the impacts of mobility management strategies as part of the development review and transportation analysis process for certain development projects in Alameda County. The tool supports the goals of SB 743 (Steinberg, 2013) by providing jurisdictions and developers with a resource to quantify VMT reductions resulting from implementation of a variety of mitigation strategies.
2. **Why do the strategy inputs read "#N/A"? / Why is the strategy not calculating a reduction?**
   The most common reason for this is that the user has not selected a TAZ for analysis, per the main screen (step #2 of the instructions, and cell F51 in the "Main" tab). This error may also occur if the TAZ selected does not have a high enough intensity of land use for the tool to be appropriate.
3. **How do I enter strategy information?**
   Tool users enter information about a strategy of interest in the orange-colored cells found on each strategy page. Users cannot enter information in any other cells. Guidance on common sources for the information required for those cells is included as part of each measure's description.
4. **How do I see if the strategy reduces VMT?**
   Each strategy page has a row labeled "Change in VMT." A negative value in this row indicates a reduction in VMT; a positive value indicates an increase in VMT (denoted with a red outline of the cell). Most measures will never result in an increase in VMT. If a measure does not apply, or does not create a reduction, there will be a value of either "0%" or no value in the cell.
5. **What is the source for the VMT reduction strategies included in the tool?**
   The strategies are listed on the Main page of this tool. Generally, these strategies are modeled after those included in the 2010 CAPCOA Guide to Mitigating Greenhouse Gas Emissions. However, the tool does not include all strategies listed in CAPCOA; several have been removed as they are not particularly relevant to development or have limited supporting evidence for their methodologies. In addition, methodologies for individual measures have been updated based on sources detailed in each individual strategy tab.
6. **How do I select VMT reduction strategies?**
   From the Main page or the Results page, the user can click on a strategy hyperlink of interest. On the strategy page, entering input values in all the orange-colored cells will activate that strategy. If the user does not want the VMT reduction results of a given strategy to be included in the

summary results, either delete the strategy page inputs in the orange-colored cells or click "Exclude from results" on the strategy page.

7. **Where can I learn more about how the reductions are calculated?**
   Each strategy page lists the references used to develop the VMT reduction estimates. Users can also review the remainder of this Design Document to find out how each strategy's reductions are calculated.

8. **How is the total percent change in VMT adjusted when I select multiple strategies?**
   If only one strategy is selected, the user will see on the Results page (a) the percent change in VMT associated with that strategy, and (b) the total percent change in VMT (total) from all strategies. In this case, the values are the same. If more than one strategy is selected, the tool applies each reduction only to the remaining VMT after all previous reductions to adjust the sum of VMT reduction. This accounts for the diminished percent change in VMT that a strategy will have if other strategies are also selected. The total is calculated with the following formula:

   Total = {[100% - (Strategy A % change in VMT)] * [100% - (Strategy B % change in VMT)] * ... * [100% - (Strategy Z % change in VMT)]} - 100%

   In general, this process can be summarized through the following observation: two 50% reductions will not, when combined, result in a 100% reduction. Instead, they will result in a 75% reduction: the first reduces trips/VMT by 50%, and the second reduces by another 50%, for a total of 25% of the original total VMT. This reflects those strategies will only target individuals who have not yet "changed" their behavior.

9. **How are the mode share, trip length, and VMT per capita data derived?**
   The mode share, trip length, and VMT per capita data found in this tool reflect travel by residents of the greater Bay Area region only (the nine MTC member counties). The data are parsed by jurisdiction and by transportation analysis zone (TAZ), and are derived from year 2020 model estimates produced by the May 2019 version of the Alameda CTC Travel Demand Forecasting Model. The data do not reflect travel by visitors to the region. They also do not include travel made by heavy-duty trucks or travel for commercial purposes.

10. **Can I calculate the total percent change in VMT from multiple strategies if the scales of analysis from my chosen strategies are not the same?**
    Yes. The user may select any combination of strategies shown on the Main page. The Results page shows the type of VMT affected by each strategy and presents the total change for each type of VMT.

11. **Why are there four totals displayed on the Results page?**
    As discussed above in Question 8, the total percent change in VMT can be calculated when multiple strategies are selected. However, if the selected strategies reduce VMT from different types of trips (i.e., employee commute trips and all project-generated trips), it may not be valid to combine the total percent change in VMT. For example, limiting the parking supply at a commercial facility affects VMT from all project-generated trips, while an employee vanpool program only affects VMT from the facility's employee commute trips. Of the 15 project-level

strategies, nine reduce VMT from employee commute trips and six reduce VMT from all project-generated trips (including non-commute trips). The nine are summed to an Employee Commute Trips Total using multiplicative dampening (see Question 8), and the six are separately summed to a Project-Generated Trips Total in the same way. Similarly, of the 14 neighborhood/city-level strategies, 13 reduce VMT from all neighborhood/city trips and only one (4D Bike Facility Improvement) reduces VMT from trips on the roadway affected by a bikeway addition. While these totals cannot be combined within the tool, they may be separately applied to off-model VMT if the analyst is able to isolate VMT production by each of the individual sources. However, this is beyond the scope of this tool as of the most recent version.

12. **Can the tool be used to analyze strategies in rural / low-density areas?**
There is little empirical research to support the estimation of VMT reduction in rural areas. Because of the lack of relevant research, based on the project location, the tool cannot be applied to areas with densities below a certain level. Entering data for a project located in a very low-density area will result in a message that the site cannot be analyzed using this Tool. Additional analysis outside of the Tool will likely be required to assess the true VMT characteristics of sites in those areas, due to the low intensity of existing development making it more difficult to extrapolate travel patterns. Similar caution may be warranted for projects that substantially depart from the existing land use types in the project TAZ.

13. **How is the maximum VMT reduction calculated for each strategy?**
On each strategy page below the "Type of VMT affected," the "Max VMT reduction" is listed. Sometimes a strategy's maximum VMT reduction is dependent only on user inputs, other times it is capped at a certain percentage, and other times it is based on regional parameters (e.g., mode share) specific to each TAZ or city. Furthermore, the max VMT reduction can also be changed by optional user inputs that override default data. The max VMT reduction listed on each strategy page is meant to provide the user with a general estimate of the reduction potential for each strategy. The values listed were derived from the tool using dense, urban TAZs as the analysis location with all default data. The user may achieve a max VMT reduction that is different from the max VMT reduction listed based on the differences in regional parameters of the selected project site and any additional user overrides.

14. **There is text in a locked cell that is cut off, and I cannot adjust the cell margins to read the remainder of the text. How can I read the cell text?**
The margins of all cells have been adjusted so that at Excel's 100% zoom level all text is visible. Adjust your zoom level to 100% if a cell's text is cut off. This also applies to any text in comment bubbles. If you still cannot read the text, try adjusting your zoom level to other percentages.

15. **What does "percent of employees eligible" mean, as used in strategies 1A through 1D?**
This refers to the percent of employees able to participate in the strategy's program, if they desire. This will usually be 100%. Employees who might not be able to participate could include those who work nighttime hours when transit and rideshare services are not available, employees who are required to drive to work as part of their job duties, or contract employees who do not receive certain employer-sponsored benefits. This input does not refer to the percent of employees who actually participate in the program.

Results Page

This page lists all the strategies and displays the percentage reduction in VMT calculated for each strategy analyzed by the user. In the default state of the Tool, all strategies are "inactive," so no VMT reduction results are initially shown on this page. As the user "activates" an individual strategy by providing inputs, the tool calculates the percentage reduction in VMT for the strategy, displaying the results on the individual strategy page and the results summary page.

The bottom of this page displays the total percentage reduction in VMT for multiple strategies selected. The total VMT reduction formula applies multiplicative dampening so as not to double-count VMT impacts. For example, if one strategy reduces VMT by 10%, then only 90% of VMT remains to be affected by subsequent strategies. If a second strategy is applied that also reduces VMT by 10%, the combined resulting VMT would be 81% (10% reduction of 90% of VMT). Thus, the VMT reduction impact of both strategies is 19%, rather than 20% if the impacts were purely additive. The following is the formula used to calculate the total VMT reduction if multiple strategies are selected:

> **Total** = { [100% - (Strategy A % change in VMT)] * [100% - (Strategy B % change in VMT)] * ... * [100% - (Strategy Z % change in VMT)] } - 100%

The page shows four rows for total VMT reduction—one for strategies that affect employee commute trips, one for project strategies that affect all project-generated trips, one for strategies that reduce VMT from all neighborhood/city trips, and one for a strategy (4D Bike Facility Improvement) that reduces VMT from trips on the roadway affected by a bikeway addition. The results are reported in these four rows because it may not be valid to combine VMT reductions for the different types. For example, parking pricing at a commercial facility affects VMT from all project-generated trips, while an employee vanpool program only affects VMT from the facility's employee commute trips.

The four categories overlap, but generally in only one direction. Employee commute VMT will be affected by strategies that reduce employee commute trips and strategies that reduce all project-generated trips; but strategies that reduce employee commute trips have no effect on project-generated trips that are not employee commute trips. Likewise, all project-generated trips (including employee commute trips) are affected by strategies that reduce all neighborhood/city trips; but strategies that reduce project-generated trips are not considered to affect all neighborhood/city VMT.

Conflict Info Page

Certain VMT reduction strategies conflict with one another. For example, a project may not have both a mandatory AND a voluntary commute trip reduction program: such a program must be either mandatory or voluntary, not both.

If a conflict occurs, the VMT reductions associated with both conflicting strategies will be omitted from the results until the conflict is resolved. The Conflict Info page displays all active conflicts among strategies currently in use. To resolve the conflict(s), simply exclude one conflicting strategy's effect from the results, using the "Exclude from Results" checkbox on each strategy's worksheet.

Once the conflict(s) are resolved, the strategies' effects will be included in the Results page. For informational purposes, the VMT effects of excluded strategies are shown in light gray on the Results page, but are not included in the calculation of total reductions for each VMT category.

Employer Commute Program Strategies

Strategies implemented by employers that encourage workers to commute by modes other than autos.

1A. Voluntary Employer Commute Program

Description: This strategy will implement a voluntary commute trip reduction (CTR) program with employers. CTR programs discourage single-occupancy vehicle trips and encourage alternative modes of transportation such as carpooling, taking transit, walking, and biking, thereby reducing VMT and GHG emissions. Voluntary CTR programs do not include mandatory trip reduction requirements or monitoring and reporting. The CTR program must include all the following to apply the effectiveness reported by the literature:

- Carpooling encouragement.
- Ride-matching assistance.
- Preferential carpool parking.
- Flexible work schedules for carpools.
- Half-time transportation coordinator.
- Vanpool assistance.
- Bicycle end-trip facilities (parking, showers, and lockers).

Other elements may also be included as part of a voluntary CTR program, though they are not included in the VMT reduction estimation reported by the literature and thus are not incorporated in the estimated VMT reductions for this strategy. This program typically serves as a complement to the more effective workplace CTR strategies such as pricing parking (Strategy 3A1) or implementing employee parking "cash-out" (Strategy 3B).

Formula: % Change in VMT = % of employees eligible * % reduction in commute VMT

User Inputs:

- Is the program contractually required of the developer or property owner and accompanied by a regular performance monitoring and reporting program? [Yes/No].
    - If Yes, must use Strategy 1B
    - If No, use Strategy 1A
- Percent of employees eligible

- Refers to percent of employees that would be able to participate in the strategy's program, if they desired. This will usually be 100%. Employees who might not be able to participate could include those who work nighttime hours when transit and rideshare services are not available, or employees who are required to drive to work as part of their job duties. This input does not refer to the percent of employees who actually participate in the program.

Constants and Assumptions:

- Maximum percent reduction in commute VMT is 4%
- Strategy cannot be used in combination with 1B.
- Strategy encompasses strategies 1C, 1D1, and 1E and cannot be analyzed in combination with these strategies.

Alameda CTC Model Data:

- None

Sources:

- Boarnet, Marlon G., Hsin-Ping Hsu, and Susan Handy. 2014. "Impacts of Employer-Based Trip Reduction Programs and Vanpools on Passenger Vehicle Use and Greenhouse Gas Emissions: Policy Brief." www.arb.ca.gov/cc/sb375/policies/ebtr/ebtr_brief.pdf

1B. Mandatory Employer Commute Program

Description: This strategy will implement a mandatory commute trip reduction (CTR) program with employers. CTR programs discourage single-occupancy vehicle trips and encourage alternative modes of transportation such as carpooling, taking transit, walking, and biking, thereby reducing VMT and GHG emissions. Mandatory CTR programs include mandatory trip reduction requirements (including penalties for non-compliance) and regular monitoring and reporting.

The mandatory CTR program will include all other elements described for the voluntary program (Strategy 1A). This strategy is most effective when paired with a transportation demand management or CTR ordinance. This program typically serves as a complement to the more effective workplace CTR strategies, such as pricing parking (Strategy 3A1) or implementing employee parking "cash-out" (Strategy 3B).

Formula: % Change in VMT = (% of employees eligible * % reduction in vehicle mode share of employee commute trips * Adjustment from vehicle mode share to commute VMT)

User Inputs:

- Is the program contractually required of the developer or property owner and accompanied by a regular performance monitoring and reporting program? [Yes/No]

  - If Yes, use Strategy 1B
  - If No, must use Strategy 1A
- Percent of employees eligible
  - Refers to percent of employees that would be able to participate in the strategy's program, if they desired. This will usually be 100%. Employees who might not be able to participate could include those who work nighttime hours when transit and rideshare services are not available, or employees who are required to drive to work as part of their job duties. This input does not refer to the percent of employees who actually participate in the program.

Constants and Assumptions:

- Maximum percent reduction in vehicle mode share of employee commute trips is 26%
- Adjustment from vehicle mode share to commute VMT is 1
- Strategy cannot be used in combination with 1A.
- Strategy encompasses strategies 1C, 1D1, and 1E and cannot be analyzed in combination with these strategies.

Alameda CTC Model Data:

- None

Sources:

- Nelson/Nygaard Consulting Associates. 2015. Genentech—South San Francisco Campus TDM and Parking Report. June. Available : http://ci-ssfca.granicus.com/MetaViewer.php?view_id=2&clip_id=859&meta_id=62028. Accessed: January 2021.

1C. Employer Carpool Program

Description: This strategy will implement a ridesharing program and establish a permanent transportation management association with funding requirements for employers. Ridesharing encourages carpooled vehicle trips in place of single-occupied vehicle trips, thereby reducing the number of trips, VMT, and GHG emissions. When providing a ridesharing program, a best practice is to establish funding by a non-revocable funding mechanism. Ridesharing must be promoted through a multi-faceted approach, such as:

- Designating a certain percentage of parking spaces for ridesharing vehicles.
- Designating adequate passenger loading and unloading and waiting areas for ridesharing vehicles.
- Providing an app or website for coordinating rides.

Formula: % Change in VMT = % of employees eligible * % reduction in employee commute VMT

User Inputs:

- Percent of employees eligible
    - Refers to the percent of employees that would be able to participate in the strategy's program, if they desired. This will usually be 100%. Employees who might not be able to participate could include those who work nighttime hours when transit and rideshare services are not available, employees who are required to drive to work as part of their job duties, or contract employees who do not receive certain employer-sponsored benefits. This input does not refer to the percent of employees who actually participate in the program.

Constants and Assumptions:

- Maximum percent change in commute VMT:
    - Land use intensity too low for application of VMT tool: 0%
    - Low density suburb: -4%
    - Suburban center: -4%
    - Urban: -8%
- Strategy encompassed by strategies 1A and 1B and cannot be analyzed in combination with these strategies.

Alameda CTC Model Data:

- Place type of project/site, automatically generated based on the density and mode share of the selected TAZ.
    - Urban
    - Suburban center
    - Low density suburb

Sources:

- San Diego Association of Governments (SANDAG). 2019. Mobility Management VMT Reduction Calculator Tool—Design Document. June. Available: https://www.icommutesd.com/docs/default-source/planning/tool-design-document_final_7-17-19.pdf?sfvrsn=ec39eb3b_2. Accessed: January 2021.

1D1. Implement Subsidized or Discounted Transit Program (for Employees)

Description: This strategy will provide subsidized, discounted, or free transit passes for employees. Reducing the out-of-pocket cost for choosing transit improves the competitiveness of transit against driving, increasing the total number of transit trips and decreasing vehicle trips. This decrease in vehicle trips results in reduced VMT and thus a reduction in GHG emissions. When implementing transit discounts or subsidies, projects should adhere to the following guidance:

- Project should be located either within one mile of high-quality transit service (either rail, or bus with headways of no more than 15 minutes), one-half mile of local or less frequent transit service, or along a designated shuttle route providing last-mile connections to rail service. As an alternative to shuttle service, if bikeshare service (Strategy 4E) is available, the site may be located up to two miles from a high-quality transit service.
- If more than one transit agency serves the site, subsidies should be provided that can be applied to each of the services available. If subsidies are applied for only one service, all variable inputs below should also pertain only to the service which is subsidized.

Formula: % Change in VMT = ((Subsidy amount / Average transit fare without subsidy)* Elasticity of transit boardings with respect to transit fare price) * Percent of employees eligible for subsidy * Transit mode share of work trips * Percent of transit trips that would otherwise be made in a vehicle * Conversion factor of vehicle trips to VMT

User Inputs:

- Transit fare unit (drop-down selection)
  - $/trip
  - $/hour
  - $/day
  - $/month
  - $/year
- Average transit fare without subsidy
- Subsidy amount
- Percent of employees eligible for subsidy
  - Refers to percent of employees that would be able to participate in the strategy’s program, if they desired. This will usually be 100%. Employees who might not be able to participate could include those who work nighttime hours when transit and rideshare services are not available, or employees who are required to drive to work as part of their job duties. This input does not refer to the percent of employees who actually participate in the program.

- Transit mode share of work trips (optional)
  The user may override the above default existing transit mode share in this cell. Leave blank otherwise.

Constants and Assumptions:

- Elasticity of transit boardings with respect to transit fare price is -0.43
- Percent of transit trips that would otherwise be made in a vehicle is 50%
- Conversion factor of vehicle trips to VMT is 1
- Strategy encompassed by strategies 1A and 1B and cannot be analyzed in combination with these strategies.

Alameda CTC Model Data:

- Default transit mode share of work trips

Sources:

- Federal Highway Administration (FHWA). 2017. National Household Travel Survey—2017 Table Designer. Travel Day PMT by TRPTRANS by HH_CBSA, Workers by WRKTRANS by HH_CBSA. Available: https://nhts.ornl.gov/. Accessed: January 2021.
- Handy, L., Boarnet, S. 2013. Impacts of Transit Service Strategies on Passenger Vehicle Use and Greenhouse Gas Emissions. Available: http://www.arb.ca.gov/cc/sb375/policies/transitservice/transit_brief.pdf. Accessed: January 2021.
- Litman, T. 2020a. Transit Price Elasticities and Cross-elasticities. Victoria Transport Policy Institute. April. Available: https://www.vtpi.org/tranelas.pdf. Accessed: January 2021.
- Taylor, B., Miller, D., Iseki, H., & Fink, C. 2008. Nature and/or Nurture? Analyzing the Determinants of Transit Ridership Across US Urbanized Areas. Transportation Research Part A: Policy and Practice, 43(1), 60-77. Available: https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.367.5311&rep=rep1&type=pdf. Accessed: January 2021.

1D2. Implement Subsidized or Discounted Transit Program (for Residents)

Description: This strategy will provide subsidized, discounted, or free transit passes for residents. Reducing the out-of-pocket cost for choosing transit improves the competitiveness of transit against driving, increasing the total number of transit trips and decreasing vehicle trips. This decrease in vehicle trips results in reduced VMT and thus a reduction in GHG emissions. When implementing transit discounts or subsidies, projects should adhere to the following guidance:

- Project should be located either within one mile of high-quality transit service (either rail, or bus with headways of no more than 15 minutes), one-half mile of local or less frequent transit service, or along a designated shuttle route providing last-mile connections to rail service. As an alternative to shuttle service, if bikeshare service (Strategy 4E) is available, the site may be located up to two miles from a high-quality transit service.
- If more than one transit agency serves the site, subsidies should be provided that can be applied to each of the services available. If subsidies are applied for only one service, all variable inputs below should also pertain only to the service which is subsidized.

Note: please carefully specify the "Percent of project-generated VMT from residents" input, especially for projects with a high proportion of non-resident trips (e.g., schools, hotels, shopping centers). One way to estimate this value is to look at the trip generation calculations for the project and determine what proportion of the total trips comes from the residential portion of the project.

Formula:

% Change in VMT = ((Subsidy amount / Average transit fare without subsidy)* Elasticity of transit boardings with respect to transit fare price) * Percent of residents eligible for subsidy * Percent of project-generated VMT from residents * Transit mode share in neighborhood/city * Percent of transit trips that would otherwise be made in a vehicle * Conversion factor of vehicle trips to VMT

User Inputs:

- Transit fare unit (drop-down selection)
  - $/trip
  - $/hour
  - $/day
  - $/month
  - $/year
- Average transit fare without subsidy
- Subsidy amount
- Percent of employees eligible for subsidy
  - Refers to percent of employees that would be able to participate in the strategy's program, if they desired. This will usually be 100%. Employees who might not be able to participate could include those who work nighttime hours when transit and rideshare services are not available, or employees who are required to drive to work as part of their job duties. This input does not refer to the percent of employees who actually participate in the program.

- Percent of project-generated VMT from residents
  Please carefully specify this input, especially for projects with a high proportion of non-resident trips (e.g., schools, hotels, shopping centers).
- Transit mode share of work trips (optional)
  The user may override the above default existing transit mode share in this cell. Leave blank otherwise.

Constants and Assumptions:

- Elasticity of transit boardings with respect to transit fare price is -0.43
- Percent of transit trips that would otherwise be made in a vehicle is 50%
- Conversion factor of vehicle trips to VMT is 1
- Strategy encompassed by strategies 1A and 1B and cannot be analyzed in combination with these strategies.

Alameda CTC Model Data:

- Default transit mode share in neighborhood/city

Sources:

- Federal Highway Administration (FHWA). 2017. National Household Travel Survey—2017 Table Designer. Travel Day PMT by TRPTRANS by HH_CBSA, Workers by WRKTRANS by HH_CBSA. Available: https://nhts.ornl.gov/. Accessed: January 2021.
- Handy, L., Boarnet, S. 2013. Impacts of Transit Service Strategies on Passenger Vehicle Use and Greenhouse Gas Emissions. Available: http://www.arb.ca.gov/cc/sb375/policies/transitservice/transit_brief.pdf. Accessed: January 2021.
- Litman, T. 2020a. Transit Price Elasticities and Cross-elasticities. Victoria Transport Policy Institute. April. Available: https://www.vtpi.org/tranelas.pdf. Accessed: January 2021.
- Taylor, B., Miller, D., Iseki, H., & Fink, C. 2008. Nature and/or Nurture? Analyzing the Determinants of Transit Ridership Across US Urbanized Areas. Transportation Research Part A: Policy and Practice, 43(1), 60-77. Available: https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.367.5311&rep=rep1&type=pdf. Accessed: January 2021.

1E. Employer Vanpool Program

Description: This strategy will implement an employer-sponsored vanpool service. Vanpooling is a flexible form of public transportation that provides groups of 5 to 15 people with a cost-effective and convenient rideshare option for commuting. The mode shift from long-distance, single-occupied vehicles to shared vehicles reduces overall commute VMT, thereby reducing GHG emissions. When implementing a vanpool service, best practice is to subsidize the cost for employees that have a similar origin and destination and provide priority parking for employees that vanpool.

Formula:

% Change in VMT = ((((1- Vanpool participation rate)* Length of one-way vehicle commute trip in region + Vanpool participation rate *(Length of one-way vanpool commute trip / Average vanpool occupancy (including driver)))/((1- Vanpool participation rate)* Length of one-way vehicle commute trip in region + Vanpool participation rate * Length of one-way vanpool commute trip))-1)

If the user override of vanpool participation rate exceeds maximum of 15%, the default value will be used.

User Inputs:

- Does the employer sponsor a vanpool program? [Yes/No].
  - If No, strategy does not apply to project and no change in VMT.
- Percent of employees who participate in vanpool (optional)
  The user may override the above default vanpool participation rate in this cell. Leave blank otherwise. If the user override of vanpool participation rate exceeds maximum of 15%, the default value will be used.
- Length of one-way vehicle commute trip in region (optional)
  The user may override the above average auto commute trip length in this cell. Leave blank otherwise.
- Length of one-way vanpool commute trip (optional)
  The user may override the above default long (vanpool) commute trip length in this cell. Leave blank otherwise.

Constants and Assumptions:

- Default % of employees that participate in vanpool program is 2.7%
- Default average length of one-way vanpool commute trip is 42 miles
- Average vanpool occupancy (including driver) is 6.25
- If the user override of vanpool participation rate exceeds maximum of 15%, the default value will be used. This maximum is based on TCRP Report 95, Chapter 5 and ICF's experience implementing the 511NYRideshare program, the nation's largest regional TDM program.
- Strategy encompassed by strategies 1A and 1B and cannot be analyzed in combination with these strategies.

Alameda CTC Model Data:

- Default average length of one-way vehicle commute trip in region (miles)

Sources:

- Federal Highway Administration (FHWA). 2017. National Household Travel Survey—2017 Table Designer. Travel Day VT by HH_CBSA by TRPTRANS by TRIPPURP. Available: https://nhts.ornl.gov/. Accessed: January 2021.
- San Diego Association of Governments (SANDAG). 2019. Mobility Management VMT Reduction Calculator Tool—Design Document. June. Available: https://www.icommutesd.com/docs/default-source/planning/tool-design-document_final_7- 17-19.pdf?sfvrsn=ec39eb3b_2. Accessed: January 2021.

1F. Employer Telecommute Program

Description: A telework program enables employees to work from home or a remote location one or more days per week. Depending on the nature of the work, schedules can range from full-time, specific days of the week, or as needed. The VMT impacts of telework are similar to a flexible work schedule program, which enables employees to work long hours in exchange for one day off every week or two.

Formula: % Change in VMT = % of employees who participate * % change in commute VMT for 1% of employees telecommuting @ days/week

User Inputs:

- Percent of employees who participate
- Days per week the average employee telecommutes (drop-down)
  - 1
  - 2
  - 3

Constants and Assumptions:

- Percent change in commute VMT for 1% of employees telecommuting at X days/week:

# of days telecommuting	% change in commute VMT for 1% of employees telecommuting
1	-0.15%
2	-0.29%
3	-0.44%

Alameda CTC Model Data:

- None

Sources:

- Cambridge Systematics. 2009. "Moving Cooler: An Analysis of Transportation Strategies for Reducing Greenhouse Gas Emissions." Technical Appendices. Prepared for the Urban Land Institute. ww.reconnectingamerica.org/assets/Uploads/2009movingcoolerexecsumandappend.pdf
- California Air Pollution Control Officers Association. 2010. "Quantifying Greenhouse Gas Mitigation Measures." www.capcoa.org/wp-content/uploads/2010/11/CAPCOA-Quantification-Report-9-14-Final.pdf

Land Use Strategies

Strategies that modify the location or characteristics of development projects to encourage non-auto travel modes.

2A. Transit-Oriented Development

Description: This strategy would reduce project VMT in the study area relative to the same project sited in a non-transit-oriented development (TOD) location. TOD refers to projects built in compact, walkable areas that have easy access to public transit, ideally in a location with a mix of uses, including housing, retail offices, and community facilities. TODs are generally described as places within a 10-minute walk (0.5 mile) of a high-frequency rail transit station (either rail, or bus with headways of no more than 15 minutes). Project site residents, employees, and visitors would have easy access to high-quality public transit, thereby encouraging transit and reducing the number of single occupancy vehicle trips and associated GHG emissions. When building TOD, a best practice is to incorporate bike and pedestrian access to increase the likelihood of transit use.

Formula: % Change in VMT = (Transit mode share * Ratio of transit mode share for TOD area with strategy compared to existing transit mode share in surrounding city)/- Auto mode share)

User Inputs:

- Is the project within 0.5 mile of a rail transit station (e.g., SPRINTER, COASTER, Trolley)? [Yes/No].
  - Transit service must provide frequent and reliable service, connecting to regional destinations.
  - If No, strategy cannot be used
- Transit mode share in surrounding city (optional)
  The user may override the above default community transit mode share in this cell. Leave blank otherwise.
- Auto mode share in surrounding city (optional)
  The user may override the above default community auto mode share in this cell. Leave blank otherwise.

Constants and Assumptions:

- Ratio of transit mode share for TOD area with strategy compared to existing transit mode share in surrounding city is 4.9.

Alameda CTC Model Data:

- Default transit mode share in surrounding city

- Default auto mode share in surrounding city

Sources:

- Tal, G., et al. 2013. "Technical Background Document on the Impacts of Transit Access (Distance to Transit) Based on a Review of the Empirical Literature." www.arb.ca.gov/cc/sb375/policies/transitservice/transit_brief.pdf
- Federal Highway Administration. 2017a. National Household Travel Survey—2017 Table Designer. Travel Day PMT by TRPTRANS by HH_CBSA. Available: https://nhts.ornl.gov/. Accessed: January 2021.
- Federal Highway Administration. 2017b. National Household Travel Survey—2017 Table Designer. Average Vehicle Occupancy by HHSTFIPS. Available: https://nhts.ornl.gov/. Accessed: January 2021.
- Lund, H., Cervero, R., and Wilson, R. 2004. Travel Characteristics of Transit-Oriented Development in California. January. Available: https://community-wealth.org/sites/clone.communitywealth.org/files/downloads/report-lund-cerv-wil.pdf. Accessed: January 2021.

2B1. Increase Residential Density

Description: This strategy accounts for the VMT reduction achieved by a project that is designed with a higher density of dwelling units (du) compared to the average residential density in the United States. Increased densities affect the distance people travel and provide greater options for the mode of travel they choose. Increasing residential density results in shorter and fewer trips by single occupancy vehicles and thus a reduction in GHG emissions.

Projects with a residential density greater than 9.1 dwelling units per acre will see VMT reductions due to this strategy.

Formula: % Change in VMT = ((Residential density of project development (dwelling units per acre) - Residential density of typical development)/ Residential density of typical development)* Elasticity of VMT with respect to residential density

User Inputs:

- Residential density of project development (dwelling units per acre)
- Residential density of typical development (optional)
  The user may override the default residential density of typical development. Leave blank otherwise.

Constants and Assumptions:

- Residential density of typical development is 9.1 dwelling units per acre
- Elasticity of VMT with respect to residential density is -0.22

Alameda CTC Model Data:

- None

Sources:

- Ewing, R., Bartholomew, K., Winkelman, S., Walters, J., Chen, D. 2007. Growing Cooler: The Evidence on Urban Development and Climate Change. October. Available: https://www.nrdc.org/sites/default/files/cit_07092401a.pdf. Accessed: January 2021.
- Stevens, M. 2016. Does Compact Development Make People Drive Less? Journal of the American Planning Association 83:1(7–18), DOI: 10.1080/01944363.2016.1240044. November. Available: https://www.researchgate.net/publication/309890412_Does_Compact_Development_Make_People_Drive_Less. Accessed: January 2021.

2B2. Increase Employment Density

Description: This strategy accounts for the VMT reduction achieved by a project that is designed with a higher density of jobs compared to the average job density in the United States. Increased densities affect the distance people travel and provide greater options for the mode of travel they choose. Increasing job density results in shorter and fewer trips by single occupancy vehicles and thus a reduction in GHG emissions.

Formula: % Change in VMT = ((Job density of project development (jobs per acre) - Job density of typical development)/ Job density of typical development)* Elasticity of VMT with respect to Job density

User Inputs:

- Job density of project development (jobs per acre)
- Job density of a typical development (optional)
  The user may override the default job density of a typical development. Leave blank otherwise.

Constants and Assumptions:

- Job density of a typical development is 145.0 jobs per acre
- Elasticity of VMT with respect to job density is -0.07

Alameda CTC Model Data:

- None

Sources:

- Institute of Transportation Engineers (ITE). Trip Generation Manual. 10th Edition. Available: https://www.ite.org/technical-resources/topics/trip-and-parking-generation/trip-generation-10th-edition-formats/. Accessed: January 2021.
- Stevens, M. 2016. Does Compact Development Make People Drive Less? Journal of the American Planning Association 83:1(7–18), DOI: 10.1080/01944363.2016.1240044. November. Available: https://www.researchgate.net/publication/309890412_Does_Compact_Development_Make_People_Drive_Less. Accessed: January 2021.

2C. Integrate Affordable and Below Market Rate Housing

Description: Income has a statistically significant effect on the probability that a commuter will take transit or walk to work (1). Below market rate (BMR) housing provides greater opportunity for lower-income families to live closer to jobs centers and achieve jobs/housing match near transit. It also addresses to some degree the risk that new transit-oriented development would displace lower-income families. This strategy potentially encourages building a greater percentage of smaller units that allow a greater number of families to be accommodated on infill and transit-oriented development sites within a given building footprint and height limit. Lower-income families tend to have lower levels of auto ownership, allowing buildings to be designed with less parking which, in some cases, represents the difference between a project being economically viable or not. Residential development projects of five or more dwelling units will provide a deed-restricted low-income housing component on-site.

Formula: % Change in VMT = % of units in project that are deed-restricted BMR housing * Elasticity % BMR capped at 30%

User Inputs:

- % of units in project that are deed-restricted BMR housing

Constants and Assumptions:

- Elasticity is -4%

Alameda CTC Model Data:

- None

Sources:

- Bento, Antonio M., Maureen L. Cropper, Ahmed Mushfiq Mobarak, and Katja Vinha. 2005. “The Effects of Urban Spatial Structure on Travel Demand in the United States.” The Review of Economics and Statistics 87,3: 466-478.

- Nelson\Nygaard, 2005. Crediting Low-Traffic Developments (p.15). http://www.montgomeryplanning.org/transportation/documents/TripGenerationAnalysisUsingURBEMIS.pdf. Criterion Planner/Engineers and Fehr & Peers Associates (2001).
- Index 4D Method. A Quick-Response Method of Estimating Travel Impacts from Land- Use Changes. Technical Memorandum prepared for US EPA, October 2001.
- Holtzclaw, John; Clear, Robert; Dittmar, Hank; Goldstein, David; and Haas, Peter (2002), "Location Efficiency: Neighborhood and Socio-Economic Characteristics Determine Auto Ownership and Use—Studies in Chicago, Los Angeles and San Francisco", Transportation Planning and Technology, 25 (1): 1-27.

Parking Management Strategies

Strategies that discourage auto travel by modifying the price or supply of vehicle parking.

3A1. Price Workplace Parking

Description: This strategy will price on-site parking at workplaces. This may include the following: explicitly charging for parking for its employees, implementing above market rate pricing, validating parking only for invited guests, not providing employee parking and transportation allowances, and/or educating employees about available alternatives to driving. Because free employee parking is a common benefit, charging employees to park on-site increases the cost of choosing to drive to work. This is expected to reduce single-occupant vehicle commute trips, resulting in decreased VMT, thereby reducing associated GHG emissions.

When implementing workplace parking, best practice is to ensure that other transportation options are available, convenient, and have competitive travel times (i.e., transit service near the project site, shuttle service, or a complete active transportation network serving the site and surrounding community), and that there is no alternative free parking available nearby (such as on-street). This strategy is ineffective in environments that do not have other modes available. Though like Strategy 3B, Parking "Cash-Out," this strategy focuses on implementing market rate and above market rate pricing to provide a price signal for employees to consider other modes for their work commute. Strategy 3B requires employers to offer employee parking "cash-out."

Formula: % Change in VMT = ((Proposed parking price - Baseline parking price)/ Baseline parking price)* Elasticity of parking demand with respect to parking price * Share of employees paying for parking * Ratio of vehicle trip reduction to VMT

- % increase in parking price is capped at 50%

User Inputs:

- Parking price unit (drop-down)
  - $/hour
  - $/day
  - $/month
  - $/year
- Baseline parking price
- Proposed parking price
- Share of employees paying for parking

Constants and Assumptions:

- Elasticity of parking demand with respect to parking price is -0.4.
- Ratio of vehicle trip reduction to VMT is assumed to be 1

Alameda CTC Model Data:

- None

Sources:

- Lehner, S., Stefanie, P. 2019. The Price Elasticity of Parking: A Meta-analysis. Transportation Research Part A: Policy and Practice 121 2019. Available: http://sustainabletransportationsc.org/garage/pdf/parking_elasticity.pdf. Accessed: January 2021.

3A2. Unbundle Parking Costs from Property Cost

Description: This strategy will unbundle, or separate, a residential project's parking costs from property costs, requiring those who wish to purchase parking spaces to do so at an additional cost from the property cost. On the assumption that parking costs are passed through to the vehicle owners/drivers utilizing the parking spaces, this strategy results in decreased vehicle ownership and, therefore, a reduction in VMT and GHG emissions. Unbundling may not be available to all residential developments, depending on funding sources.

Note: please carefully specify the "Percent of project-generated VMT from residents" input, especially for projects with a high proportion of non-resident trips (e.g. schools, hotels, shopping centers). One way to estimate this value is to look at the trip generation calculations for the project and determine what proportion of the total trips comes from the residential portion of the project.

Formula: % Change in VMT = (Annual parking cost per space / Average annual vehicle cost) * Elasticity of vehicle ownership with respect to total vehicle cost * Adjustment factor from vehicle ownership to vehicle trips * Adjustment factor from vehicle trips to VMT * Percent of project-generated VMT from residents

User Inputs:

- Annual parking cost per space
    - Capped at $3,600 per year, or $300 per month
- Average annual vehicle cost (optional)
    - The user may override the default annual vehicle cost. Leave blank otherwise.
- Percent of project-generated VMT from residents

Constants and Assumptions:

- Average annual vehicle cost is $9,282
- Elasticity of vehicle ownership with respect to total vehicle cost is -0.4
- Adjustment factor from vehicle ownership to vehicle trips is 0.86
- Ratio of vehicle trip reduction to VMT is assumed to be 1

Alameda CTC Model Data:

- None

Sources:

- AAA. 2019. Your Driving Costs. September. Available: https://exchange.aaa.com/wpcontent/uploads/2019/09/AAA-Your-Driving-Costs-2019.pdf. Accessed: January 2021.
- California Department of Transportation (Caltrans). 2002. 2000–2001 California Statewide Household Travel Survey Final Report. Available: https://trid.trb.org/view.aspx?id=681358. Accessed: January 2021.
- Litman, T. 2020. Parking Requirement Impacts on Housing Affordability. June. Available: https://www.vtpi.org/park-hou.pdf. Accessed: January 2021.

3B. Parking Cash Out

Description: This strategy will require project employers to offer employee parking cash-out. Cash-out is when employers provide employees with a choice of forgoing their current subsidized/free parking for a cash payment equivalent that is equal to or greater than the cost of the parking space. This encourages employees to use other modes of travel instead of single occupancy vehicles. This mode shift results in people driving less and thereby reduces VMT and GHG emissions.

Formula: % Change in VMT = % of employees eligible * % reduction in commute VMT from implementation of strategy

User Inputs:

- Percent of employees eligible for this program

Constants and Assumptions:

- 12% reduction in commute VMT from implementation of strategy

Alameda CTC Model Data:

- None

Sources:

- Shoup, D. 2005. Parking Cash Out. Planners Advisory Service, American Planning Association. Available: http://shoup.bol.ucla.edu/ParkingCashOut.pdf. Accessed: January 2021.

3C. Limited Parking

Description: This strategy will reduce the total parking supply available at a residential project or site. Limiting the amount of parking available creates scarcity and adds additional time and inconvenience to trips made by private auto, thus disincentivizing driving as a mode of travel. Reducing the availability of parking results in a shift to other modes and decreased VMT and thus a reduction in GHG emissions. When limiting parking supply, a best practice is to do so at sites that are located near high-quality alternative modes of travel (such as a rail station, frequent bus line, or in a higher density area with multiple walkable locations nearby). Limiting parking supply may also allow for more active uses on any given lot, which may support Strategies 2B1 and 2B2 by allowing for higher density construction.

This strategy is ineffective in locations where unrestricted street parking or other off-site parking is available nearby and has adequate capacity to accommodate project-related vehicle parking demand. Evidence of the effects of reduced parking supply is strongest for residential developments.

Formula: % Change in VMT = -1 * ((Residential parking demand (# of spaces) - Project residential parking supply)/ Residential parking demand (# of spaces))* % of project VMT generated by residents * % of household VMT that is commute based * % reduction in commute mode share by driving among households in areas with scarce parking)

User Inputs:

- Residential parking demand (# of spaces)
- Project residential parking supply
- % of project VMT generated by residents

Constants and Assumptions:

- 37% of household VMT is commute-based
- Percentage of reduction in commute mode share by driving among households in areas with scarce parking is 37%

Alameda CTC Model Data:

- None

Sources:

- California Department of Transportation (Caltrans). 2012. California Household Travel Survey (CHTS). Available: https://www.nrel.gov/transportation/secure-transportation-data/tsdccalifornia-travel-survey.html. Accessed: January 2021.
- Chatman, D. 2013. "Does TOD need the T? On the importance of factors other than rail access." Journal of the American Planning Association 79, no. 1. Available: https://trid.trb.org/view/1243004 . Accessed: January 2021.

3D. Provide Bike Parking

Description: This strategy will install and maintain end-of-trip facilities for employee use. End-of-trip facilities include bike parking, bike lockers, showers, and personal lockers. The provision of secure bike parking and related facilities encourages commuting by bicycle, thereby reducing VMT and GHG emissions.

Formula: % Change in VMT = (One-way bicycle trip length (miles) *(Bicycle mode share for work trips - (Bike mode adjustment factor * Bicycle mode share for work trips)))/(One-way vehicle trip length in neighborhood/city (miles) * Vehicle mode share for work trips)

User Inputs:

- Would the project provide bike parking? [yes/no]
  - If Yes, VMT change will be calculated for strategy 3D
  - If No, no VMT change calculation will be performed
- Type of bike parking facility (drop-down)
  - Parking only
  - Parking with showers, bike lockers, and personal lockers
- Optional user inputs that may override the corresponding default values generated by Alameda CTC Model. Leave blank otherwise.
  - One-way bicycle trip length in neighborhood/city (miles)
  - One-way vehicle trip length in neighborhood/city (miles)
  - Bicycle mode share for work trips in region
  - Vehicle mode share for work trips in region

Constants and Assumptions:

- Bike mode adjustment factor is
  - 4.86 for bike parking with showers, bike lockers, and personal lockers
  - 1.78 for bike parking facility only

Alameda CTC Model Data:

- Default average one-way bicycle trip length in neighborhood/city (miles)
- Default average one-way vehicle trip length in neighborhood/city (miles)
- Default bicycle mode share for work trips in region
- Default vehicle mode share for work trips in region

Sources:

- Buehler, R. 2012. Determinants of bicycle commuting in the Washington, DC region: The role bicycle parking, cyclist showers, and free car parking at work. Transportation Research Part D, 17, 525– 531. Available: http://www.pedbikeinfo.org/cms/downloads/DeterminantsofBicycleCommuting.pdf. Accessed: January 2021.
- Federal Highway Administration (FHWA). 2017a. National Household Travel Survey—2017 Table Designer. Travel Day PT by TRPTRANS by HH_CBSA. Available: https://nhts.ornl.gov/. Accessed: January 2021.
- Federal Highway Administration (FHWA). 2017b. National Household Travel Survey—2017 Table Designer. Workers by WRKTRANS by HH_CBSA. Available: https://nhts.ornl.gov/. Accessed: January 2021.

Neighborhood Enhancement Strategies

Strategies that improve or encourage neighborhood-level bicycle, pedestrian, and other multimodal travel options.

4A. Street Connectivity Improvement

Description: This strategy accounts for the VMT reduction achieved by a project that is designed with a higher density of intersections compared to the average intersection density in the United States. Increased intersection density is a proxy for street connectivity improvements, which help to facilitate a greater number of shorter trips and thus a reduction in GHG emissions. Example projects that increase intersection density would be building a new street network in a subdivision or retrofitting an existing street network to improve connectivity (e.g., converting cul-de-sacs to grid streets).

Formula: % Change in VMT = ((Intersection density in project site with strategy (int/sq mi) - Intersection density (int/sq mi))/ Intersection density (int/sq mi))* Elasticity of VMT with respect to intersection density

User Inputs:

- Intersection density in project site with strategy (intersections per square mile)
- Average intersection density (intersections per square mile) (optional)
  The user may override the default average intersection density in this cell. Leave blank otherwise.

Constants and Assumptions:

- Elasticity of VMT with respect to intersection density is -0.14

Locally Specific Data:

- Default average intersection density (intersections per square mile)
  - Calculated based on EPA EnviroAtlas data

Sources:

- Fehr & Peers. 2009. Proposed Trip Generation, Distribution, and Transit Mode Split Forecasts for the Bayview Waterfront Project Transportation Study.
- Stevens, M. 2016. Does Compact Development Make People Drive Less? Journal of the American Planning Association 83:1(7–18), DOI: 10.1080/01944363.2016.1240044. November. Available:

https://www.researchgate.net/publication/309890412_Does_Compact_Development_Make_People_Drive_Less. Accessed: January 2021.

- (3) U.S. Environmental Protection Agency, 2021. EnviroAtlas: Estimated Intersection Density of Walkable Roads. Available: https://enviroatlas.epa.gov/enviroatlas/DataFactSheets/pdf/Supplemental/Estimatedintersectiondensityofwalkableroads.pdf. Accessed: April 2021.

4B. Pedestrian Facility Improvement

Description: This strategy will increase the sidewalk coverage to improve pedestrian access. Providing sidewalks and an enhanced pedestrian network encourages people to walk instead of drive. This mode shift results in a reduction in VMT and GHG emissions. When improving sidewalks, a best practice is to ensure they are contiguous and link externally with existing and planned pedestrian facilities. Barriers to pedestrian access and interconnectivity, such as walls, landscaping buffers, and slopes, should be minimized. The strategy is based on the share of vehicle trips which could easily shift to walking - on average, approximately 21.4 percent of vehicle trips are 1 mile or less.

Formula: % Change in VMT = (((Sidewalk length in study area with strategy (miles) / Existing street length in study area (miles)) -1 * (Existing sidewalk length in study area (miles) / Existing street length in study area (miles)))/(Existing sidewalk length in study area (miles) / Existing street length in study area (miles)))* Elasticity of VMT with respect to the ratio of sidewalks-to-streets

User Inputs:

- Existing sidewalk length in study area (miles)
  Measure the sidewalk on both sides of the street. For example, if one 0.5-mile-long street has full sidewalk coverage, the sidewalk length would be 1.0 mile. If there is only sidewalk on one side of the street, the sidewalk length would be 0.5 mile.
- Existing street length in study area (miles)
- Sidewalk length in study area with strategy (miles)

Constants and Assumptions:

- Street length is assumed to remain constant, since the strategy involves adding sidewalks to the existing street network, not modifying street networks. Assuming a constant street length simplifies the user inputs and prevents users from erroneously entering unreasonable values.
- Elasticity of VMT with respect to the ratio of sidewalks-to-streets is -0.05.
- VMT change capped at 3.4%, which is based on the following assumptions:
  - 21.4% of auto trips are short trips that could shift to walking (average 0.83 mile in length, per SANDAG)
    - Trips that shift to walking have an effective "vehicle trip length" of 0 miles

- 78.6% of auto trips are longer trips that cannot shift to walking (average 6.5 miles in length, per SANDAG)
- So maximum VMT change = (new VMT – old VMT) / old VMT = ((21.4% * 0 + 78.6% * 6.5) – (21.4% * 0.83 + 78.6% * 6.5)) / (21.4% * 0.83 + 78.6% * 6.5) = (-21.4% * 0.83) / (21.4% * 0.83 + 78.6% * 6.5) = -3.4%

Alameda CTC Model Data:

- None

Sources:

- Frank, L., Greenwald, M., Kavage, S. and Devlin, A. 2011. An Assessment of Urban Form and Pedestrian and Transit Improvements as an Integrated GHG Reduction Strategy. WSDOT Research Report WA-RD 765.1, Washington State Department of Transportation. April. Available: www.wsdot.wa.gov/research/reports/fullreports/765.1.pdf. Accessed: January 2021.
- Handy, Susan, Sciara, Gian-Claudia, and Boarnet, Marlon. 2014. Impacts of Pedestrian Strategies on Passenger Vehicle Use and Greenhouse Gas Emissions: Policy Brief. September. Available: https://ww2.arb.ca.gov/sites/default/files/2020-06/Impacts_of_Pedestrian_Strategies_on_Passenger_Vehicle_Use_and_Greenhouse_Gas_Emissions_Policy_Brief.pdf. Accessed: January 2021.
- Federal Highway Administration (FHWA). 2019. 2017 National Household Travel Survey Popular Vehicle Trip Statistics. Available: https://nhts.ornl.gov/vehicle-trips. Accessed: January 2021.

4C. Bikeway Network Expansion

Description: This strategy will increase the length of a city or neighborhood bikeway network. A bicycle network is an interconnected system of bike lanes, bike paths, and cycle tracks. Providing bicycle infrastructure with markings and signage helps to improve biking conditions (e.g., safety and convenience). In addition, expanded bikeway networks can increase access to and from transit hubs, thereby expanding the "catchment area" of the transit stop or station and increasing ridership. This encourages a mode shift from vehicles to bicycles, displacing VMT and thus reducing GHG emissions. When expanding a bicycle network, a best practice is to consider local or state bike lane width standards.

Formula: % Change in VMT = -1*((((Bikeway miles (only Class, I, II, and IV) in neighborhood/city with strategy - Existing bikeway miles (only Class I, II, and IV) in neighborhood/city)/ Existing bikeway miles (only Class I, II, and IV) in neighborhood/city)* Bicycle mode share * One-way bicycle trip length (miles) * Elasticity of bike commuters with respect to bikeway miles per 10,000 population)/(Vehicle mode share * One-way vehicle trip length in neighborhood/city (miles)))

- % change in bikeway miles is capped at 1000%.

User Inputs:

- Would the project expand a network of bikeways or add a single bikeway? (drop-down)
    - If Network of bikeways, use Strategy 4C
    - If Single bikeway, must use Strategy 4D
- Bicycle mode share in neighborhood/city (optional)
  The user may override the above default community bicycle mode share in this cell. Leave blank otherwise.
- Vehicle mode share in neighborhood/city (optional)
  The user may override the above default community SOV mode share in this cell. Leave blank otherwise.
- Are any of the current or proposed bikeways in the city/CPA classified as Class III? [Yes/No]
    - If Yes, class III bike lane miles should be left out of the bikeway mile user inputs.
      See Table 1 on page 5 of this Caltrans memorandum for information on bicycle facility types.
- Existing bikeway miles (only Class I, II, and IV) in neighborhood/city
    - Calculated as centerline miles of roadways containing bikeways.
    - For smaller analysis contexts, it may be easiest to show "bicycling" on Google Maps and measure the lengths of roadways containing bikeways. For larger contexts, contact the local jurisdiction's transportation planning staff, or contact Alameda County Public Works for projects in unincorporated areas.
- Bikeway miles (only Class, I, II, and IV) in neighborhood/city with strategy
    - Calculated as centerline miles of roadways containing bikeways.
    - % change in bikeway miles is capped at 1000%.
- One-way bicycle trip length in neighborhood/city (miles) (optional)
  The user may override the above average bicycle trip length in this cell. Leave blank otherwise.
- One-way vehicle trip length in neighborhood/city (miles) (optional)
  The user may override the above average auto trip length in this cell. Leave blank otherwise.

Constants and Assumptions:

- Elasticity of bike trips with respect to bikeway miles per 10,000 population is 0.25.
- The maximum percent increase in bike lane miles in the neighborhood/city is capped at 1000 percent. If there is no existing bike lane infrastructure in the neighborhood/city, the percent increase should be treated as 1000 percent.

Alameda CTC Model Data:

- Default bicycle mode share in neighborhood/city
- Default vehicle mode share in neighborhood/city
- Default average one-way bicycle trip length in neighborhood/city (miles)
- Default average one-way vehicle trip length in neighborhood/city (miles)

Sources:

- SANDAG. 2016. Activity Based Model. (v14.0.1, scenario ID 232)
- Pucher, J. and R. Buehler, 2011. "Analysis of Bicycling Trends and Policies in Large North American Cities: Lessons for New York." Report for U. S. Department of Transportation, Research and Innovative Technology Administration, Washington, D.C. and UTRC II New York.

4D. Bike Facility Improvement

Description: This strategy will construct or improve a single bicycle lane facility that connects to a larger existing bikeway network. Providing bicycle infrastructure helps to improve biking conditions within an area. This encourages a mode shift on the roadway parallel to the bicycle facility from vehicles to bicycles, displacing VMT and thus reducing GHG emissions. When constructing or improving a bicycle facility, a best practice is to consider local or state bike lane width standards.

Formula: % Change in VMT = - % of neighborhood/city VMT on parallel roadway *(((Annual days of use of new facility / Days per year)*(Active transportation adjustment factor + Credit for activity centers near project)* Growth factor adjustment for facility type * One-way bicycle trip length (miles))/ One-way vehicle trip length in neighborhood/city (miles))

User Inputs:

- Would the project expand a network of bikeways or add a single bikeway? (drop-down)
  - If Network of bikeways, must use Strategy 4C
  - If Single bikeway, use Strategy 4D
- One-way bicycle trip length in neighborhood/city (miles)
  The user may override the above average bicycle trip length in this cell. Leave blank otherwise.
- One-way vehicle trip length in neighborhood/city (miles)
  The user may override the above average auto trip length in this cell. Leave blank otherwise.
- Percentage of neighborhood/city VMT on parallel roadway
- Average daily traffic (vehicle trips per day)
  Roadways with AADT greater than 30,000 are not appropriate for bicycle facilities.
- One-way bicycle facility length (miles)

- Number of key destinations within 1/4 mile of bicycle facility
- Number of key destinations between 1/4 and 1/2 mile from bicycle facility
  Key destinations include banks, churches, hospitals, light rail stations (park & ride), office parks, post offices, public libraries, shopping areas or grocery stores, and universities or junior colleges.
- Bicycle facility type (drop-down)
  - New Class I bike path or Class IV bikeway
  - New Class II bike lane
  - Conversion from Class II to IV
    See Table 1 on page 5 of this Caltrans memorandum for information on bicycle facility types.

Constants and Assumptions:

- Adjustment factor of AADT for auto trips replaced by bike trips due to strategy:

Average Daily Traffic	Bike Project Length (miles)	Adjustment Factor
0–12,000	<= 1	0.0019
	> 1 and <= 2	0.0029
	> 2	0.0038
12,001–24,000	<= 1	0.0014
	> 1 and <= 2	0.002
	> 2	0.0027
24,001–30,000	<= 1	0.001
	> 1 and <= 2	0.0014
	> 2	0.0019

  - Estimated based on CARB (2005). Based on assumption that at all municipalities would be either cities with a population greater than or equal to 250,000 or a non-university town with a population less than 250,000.

- Credit for activity centers based on number and distance:

Number of Key Destinations	Credit within ½ Mile of Facility	Credit within ¼ mile of Facility
0–2	0.0000	0.000
3	0.0005	0.001
4 - 6	0.0010	0.002
≥ 7	0.0015	0.003

- Growth Factor Adjustment
  - 1.54 for new Class I bike path or class IV bikeway

  - 1.0 for new Class II bike lane
  - 0.54 for conversion from Class II to IV

- Existing Annual Average Daily Traffic on roadway parallel to bicycle project (two-way traffic volume in trips/day on road parallel to proposed bike lane) cannot exceed 30,000, per CARB (2005).
- Annual days of use of new facility are 200.
- Days per year are 365.

Alameda CTC Model Data:

- Average one-way bicycle trip length in neighborhood/city (miles)
- Average one-way vehicle trip length in neighborhood/city (miles)
- Is the jurisdiction a university town? (yes/no)
- Jurisdiction population >= 250k? (yes/no)

Sources:

- California Air Resources Board (CARB). 2020d. Quantification Methodology for the Strategic Growth Council's Affordable Housing and Sustainable Communities Program. September. Available: https://ww2.arb.ca.gov/sites/default/files/classic/cc/capandtrade/auctionproceeds/draft_sgc_ahsc_qm_091620.pdf. Accessed: January 2021.
- Federal Highway Administration (FHWA). 2017. National Household Travel Survey—2017 Table Designer. Travel Day PT by TRPTRANS by HH_CBSA. Available: https://nhts.ornl.gov/. Accessed: January 2021.

4E. Bikeshare

Description: This strategy will establish a bikeshare program. Bikeshare programs provide users with on-demand access to bikes for short-term rentals. This encourages a mode shift from vehicles to bicycles, displacing VMT and thus reducing GHG emissions. There are two primary types of pedal bikeshare programs: docked (station-based) and dockless (free-floating). When implementing a bikeshare program, a best practice is to discount bikeshare membership and dedicate bikeshare parking to encourage use of the service.

Formula: % Change in VMT = -1*(((% of residences in neighborhood/city with access to bikeshare system with strategy - % of residences in neighborhood/city with access to bikeshare system without strategy)* Daily bikeshare trips per person * Vehicle to bikeshare substitution rate * One-way bicycle trip length (miles))/(Daily vehicle trips per person * One-way vehicle trip length in neighborhood/city (miles)))

User Inputs:

- % of residences in neighborhood/city with access to bikeshare system without strategy
- % of residences in neighborhood/city with access to bikeshare system with strategy
- One-way vehicle trip length in neighborhood/city (miles) (optional)
  The user may override the above average auto trip length in this cell. Leave blank otherwise.
- One-way bicycle trip length in neighborhood/city (miles) (optional)
  The user may override the above average bicycle trip length in this cell. Leave blank otherwise.

Constants and Assumptions:

- Daily bikeshare trips per person is 0.021
- Daily vehicle trips per person is 2.7
- Vehicle to bikeshare substitution rate is 50

Alameda CTC Model Data:

- Default average one-way vehicle trip length in neighborhood/city (miles)
- Default average one-way bicycle trip length in neighborhood/city (miles)

Sources:

- California Air Resources Board (CARB). 2020a. Revisiting Average Trip Length Defaults and Adjustment Factors for Quantifying VMT Reductions from Car Share, Bike Share, and Scooter Share Services. May. Available: https://ww2.arb.ca.gov/sites/default/files/classic//cc/capandtrade/auctionproceeds/sharedmobility_technical_052920.pdf. Accessed: January 2021.
- Federal Highway Administration (FHWA). 2017. National Household Travel Survey—2017 Table Designer. Travel Day PT by TRPTRANS by HH_CBSA. Available: https://nhts.ornl.gov/. Accessed: January 2021.
- Federal Highway Administration (FHWA). 2018. Summary of Travel Trends 2017—National Household Travel Survey. July. Available: https://www.fhwa.dot.gov/policyinformation/documents/2017_nhts_summary_travel_trends.p df. Accessed: January 2021.
- Lazarus, J., Pourquier, J., Feng, F., Hammel, H., Shaheen, S. 2019. Bikesharing Evolution and Expansion: Understanding How Docked and Dockless Models Complement and Compete—A Case Study of San Francisco. Paper No. 19-02761. Annual Meeting of the Transportation Research Board: Washington, D.C. Available: https://trid.trb.org/view/1572878. Accessed: January 2021.
- Metropolitan Transportation Commission (MTC). 2017. Plan Bay Area 2040 Final Supplemental Report—Travel Modeling Report. July. Available: http://2040.planbayarea.org/files/2020-02/Travel_Modeling_PBA2040_Supplemental%20Report_7-2017.pdf. Accessed: January 2021.

4F. Carshare

Description: This strategy will increase carshare access in the user's neighborhood/city by deploying carshare vehicles. Carsharing offers people convenient access to a vehicle for personal or commuting purposes. This helps encourage transportation alternatives by reducing vehicle ownership, thereby avoiding VMT and associated GHG emissions. When implementing a carshare program, best practice is to discount carshare membership and provide priority parking for carshare vehicles to encourage use of the service.

Formula: % Change in VMT = -1 * (% adults in region with carshare access with strategy - % adults in region with existing carshare access)* % of adults with carshare access who become members * Percent VMT reduction by carshare members

User Inputs:

- % adults in region with existing carshare access
  Car share access defined as at least 1 car share pod within 1/2 mile of residence.
- % adults in region with carshare access with strategy

Constants and Assumptions:

- Percent of adults with carshare access who become members is 2%, per WSP (2019).
- Percent VMT reduction by carshare members is 32.9%

Alameda CTC Model Data:

- Average daily one-way auto trips per adult, by city/CPA.

Sources:

- Cervero, R., Golub, A., Nee, B. 2007. San Francisco City CarShare: Longer-Term Travel-Demand and Car Ownership Impacts. January. Available: https://iurd.berkeley.edu/wp/2006-07.pdf. Accessed: January 2021.
- Lovejoy, K., Handy, S., Boarnet, M. 2013. Impacts of Carsharing on Passenger Vehicle Use and Greenhouse Gas Emissions Policy Brief. October. Available: https://ww2.arb.ca.gov/sites/default/files/2020-06/Impacts_of_Carsharing_on_Passenger_Vehicle_Use_and_Greenhouse_Gas_Emissions_Policy_Brief.pdf. Accessed: January 2021.
- San Diego Association of Governments (SANDAG). 2017. San Diego Regional Transportation Study. Volume 1: Technical Report. Available: https://www.sandag.org/uploads/publicationid/publicationid_2145_23025.pdf. Accessed: January 2021.

4G. Community-Based Travel Planning

Description: This strategy will target residences in the neighborhood/city with community-based travel planning (CBTP). CBTP is a residential-based approach to outreach that provides households with customized information, incentives, and support to encourage the use of transportation alternatives in place of single occupancy vehicles, thereby reducing VMT and associated GHG emissions. CBTP involves teams of trained travel advisors visiting all households within a targeted geographic area, having tailored conversations about residents' travel needs, and educating residents about the various transportation options available to them. Due to the personalized outreach method, communities are typically targeted in phases.

Formula: % Change in VMT = -1 * (Households in neighborhood/city targeted with CBTP / Households in neighborhood/city)* % of targeted households that participate * % vehicle trip reduction by participating residences * Adjustment factor from vehicle trips to VMT

User Inputs:

- Households in neighborhood/city targeted with CBTP

Constants and Assumptions:

- Percent of targeted households that participate is 19%.
- Percent of vehicle trip reduction among participating residences is 12%.
- Adjustment factor from vehicle trips to VMT is 1

Alameda CTC Model Data:

- Number of households in neighborhood/city

Sources:

- Metropolitan Transportation Commission (MTC). 2021. Plan Bay Area 2050, Supplemental Report. (forthcoming)

4H. Provide Neighborhood Traffic Calming Measures

Description: Providing traffic calming measures encourages people to walk or bike instead of using a vehicle. This mode shift will result in a decrease in VMT. Project design will include pedestrian/bicycle safety and traffic calming measures in excess of jurisdiction requirements. Roadways will be designed to reduce motor vehicle speeds and encourage pedestrian and bicycle trips with traffic calming features. Traffic calming features may include marked crosswalks, count-down signal timers, curb extensions, speed tables, raised crosswalks, raised intersections, median islands, tight corner radii, roundabouts or mini-circles, on-street parking, planter strips with street trees, chicanes/chokers, and others.

Formula: % Change in VMT = % VMT Reduction based on matrix cross reference

User Inputs:

- Percentage of streets within project with traffic calming improvements (drop-down)
- Percentage of intersections within project with traffic calming improvements (drop-down)

Constants and Assumptions:

- The effectiveness of this measure depends on the interaction between the share of streets within the project area with traffic calming improvements and the share of intersections within the project area with traffic calming improvements. The effectiveness is looked up from a table referencing these two factors.

Alameda CTC Model Data:

- None

Sources:

- Cambridge Systematics. Moving Cooler: An Analysis of Transportation Strategies for Reducing Greenhouse Gas Emissions.(p. B-25) http://www.movingcooler.info/Library/Documents/Moving%20Cooler_Appendices_Complete_102209.pdf
- Sacramento Metropolitan Air Quality Management District (SMAQMD) Recommended Guidance for Land Use Emission Reductions. (p.13) http://www.airquality.org/ceqa/GuidanceLUEmissionReductions.pdf

Transit Strategies

Strategies that improve transit service and cause a mode shift from auto to transit.

5A. Transit Service Expansion

Description: This strategy will expand the local transit network by adding or modifying existing transit service to enhance the service near the project site. This will encourage the use of transit and therefore reduce VMT and associated GHG emissions.

There are two primary means of expanding the transit network: by increasing the frequency of service, thereby reducing average wait times and increasing convenience, or by expanding new service to cover areas previously outside the network's service area. This strategy is focused on providing additional transit network coverage, with no changes to transit frequency. Coverage can also be applied to extending hours of service. Strategy 5B is focused on increasing transit service frequency.

Formula: % Change in VMT = -1* % change in bus network coverage * Transit mode share * Elasticity of transit demand with respect to service miles * Statewide mode shift factor * Ratio of vehicle trip reduction to VMT

- % change in bus network coverage is capped at 100%.
- If the user override of existing transit mode share exceeds maximum of 25%, the default value will be used.

User Inputs:

- Total transit service miles in neighborhood/city before expansion
- Total transit service miles in neighborhood/city after expansion
- Transit mode share in neighborhood/city (optional)
    - The user may override the above default existing transit mode share in this cell. Leave blank otherwise.
    - If the user override of existing transit mode share exceeds maximum of 25%, the default value will be used.

Constants and Assumptions:

- Elasticity of transit ridership with respect to service coverage is 0.7.
- Statewide mode shift factor is 57.8%
- Ratio of vehicle trip reduction to VMT is 1
- Percent change in bus network coverage is capped at 100%.

- If the user override of existing transit mode share exceeds maximum of 25%, the default value will be used.

Alameda CTC Model Data:

- Default transit mode share in neighborhood/city

Sources:

- Handy, S., Lovejoy, K., Boarnet, M., Spears, S. 2013. Impacts of Transit Service Strategies on Passenger Vehicle Use and Greenhouse Gas Emissions. October. Available: https://ww2.arb.ca.gov/sites/default/files/2020-06/Impacts_of_Transit_Service_Strategies_on_Passenger_Vehicle_Use_and_Greenhouse_Gas_Emissions_Policy_Brief.pdf. Accessed: January 2021.
- Federal Highway Administration (FHWA). 2017. National Household Travel Survey—2017 Table Designer. Average Vehicle Occupancy by HHSTFIPS. Available: https://nhts.ornl.gov/. Accessed: January 2021.

5B. Transit Frequency Improvements

Description: This strategy will increase transit frequency on one or more transit lines serving the neighborhood/city. Increased transit frequency reduces waiting and overall travel times, which improves the user experience and increases the attractiveness of transit service. This results in a mode shift from single occupancy vehicles to transit, which reduces VMT and associated GHG emissions.

Formula: % Change in VMT = - Level of implementation *((% change in transit frequency (arrivals per hour) * Transit mode share * Elasticity of transit ridership with respect to frequency of service * Statewide mode shift factor)/ Vehicle mode share)

- The % change in transit frequency (arrivals per hour) is capped between -75% and 300% (4).
- If the user override of existing transit mode share exceeds maximum of 25%, the default value will be used.
- If the user override of existing auto mode share falls below minimum of 50%, the default value will be used.

User Inputs:

- Existing peak period headway (minutes)
  Headway is the amount of time that elapses between two buses servicing a given route and given line. Headway is the inverse of frequency (headway = 1/frequency), where frequency is the number of arrivals over a given time period (e.g., buses per hour).
- Peak period headway with strategy (minutes)

- Level of implementation
  The level of implementation refers to the number of transit routes receiving the frequency improvement as a fraction of the total transit routes in the neighborhood/city.
- Transit mode share in neighborhood/city (optional)
  - The user may override the above default existing transit mode share in this cell. Leave blank otherwise.
  - If the user override of existing transit mode share exceeds maximum of 25%, the default value will be used.
- Vehicle mode share in neighborhood/city (optional)
  - The user may override the above default SOV mode share in this cell. Leave blank otherwise.
  - If the user override of existing auto mode share falls below minimum of 50%, the default value will be used.

Constants and Assumptions:

- Elasticity of transit ridership with respect to frequency of service is 0.5.
- Statewide mode shift factor is 57.8%
- The percent change in transit frequency (arrivals per hour) is capped at a 300% increase or a 75% decrease.
- If the user override of existing transit mode share exceeds maximum of 25%, the default value will be used.
- If the user override of existing auto mode share falls below minimum of 50%, the default value will be used.

Alameda CTC Model Data:

- Default transit mode share in neighborhood/city
- Default vehicle mode share in neighborhood/city

Sources:

- Federal Highway Administration (FHWA). 2017a. National Household Travel Survey—2017 Table Designer. Travel Day PMT by TRPTRANS by HH_CBSA. Available: https://nhts.ornl.gov/. Accessed: January 2021.
- Federal Highway Administration (FHWA). 2017b. National Household Travel Survey—2017 Table Designer. Average Vehicle Occupancy by HHSTFIPS. Available: https://nhts.ornl.gov/. Accessed: January 2021.
- Handy, S., Lovejoy, K., Boarnet, M., Spears, S. 2013. Impacts of Transit Service Strategies on Passenger Vehicle Use and Greenhouse Gas Emissions. October. Available:

https://ww2.arb.ca.gov/sites/default/files/2020-06/Impacts_of_Transit_Service_Strategies_on_Passenger_Vehicle_Use_and_Greenhouse_Gas_Emissions_Policy_Brief.pdf. Accessed: January 2021.

- San Diego Association of Governments (SANDAG). 2019. Mobility Management VMT Reduction Calculator Tool—Design Document. June. Available: https://www.icommutesd.com/docs/default-source/planning/tool-design-document_final_7- 17-19.pdf?sfvrsn=ec39eb3b_2. Accessed: January 2021.

5C. Transit-Supportive Treatments

Description: This strategy will implement transit-supportive treatments on the transit routes serving the neighborhood/city. Transit-supportive treatments incorporate a mix of roadway infrastructure improvements and/or traffic signal modifications to improve transit travel times and reliability. This results in a mode shift from single occupancy vehicles to transit, which reduces VMT and the associated GHG emissions. Treatments can include transit signal priority, bus-only signal phases, queue jumps, curb extensions to speed passenger loading, and dedicated bus lanes.

Formula: % Change in VMT = -1*((% of neighborhood/city transit routes that receive treatments * Default % change in transit travel time due to treatments * Elasticity of transit ridership with respect to transit travel time * Transit mode share * Statewide mode shift factor)/ Vehicle mode share)

- If the user override of default % change in transit travel time due to treatments value falls below minimum of -20% or exceeds maximum of 0%, the default value will be used.
- If the user override of existing transit mode share exceeds maximum of 25%, the default value will be used.
- If the user override of existing auto mode share falls below minimum of 50%, the default value will be used.

User Inputs:

- % of neighborhood/city transit routes that receive treatments
- Percent change in transit travel time due to treatments (optional)
    - The user may override the above % change in transit travel time due to treatments in this cell. Leave blank otherwise.
    - If the user override of default % change in transit travel time due to treatments value falls below minimum of -20% or exceeds maximum of 0%, the default value will be used.
    - If the user enters a positive value, the default will be used.
- Transit mode share in neighborhood/city (optional)
    - The user may override the above default existing transit mode share in this cell. Leave blank otherwise.

  - If the user override of existing transit mode share exceeds maximum of 25%, the default value will be used.
- Vehicle mode share in neighborhood/city (optional)
  - The user may override the above default SOV mode share in this cell. Leave blank otherwise.
  - If the user override of existing auto mode share falls below minimum of 50%, the default value will be used.

Constants and Assumptions:

- Default percent change in transit travel time due to treatments is -10%.
- Elasticity of transit ridership with respect to transit travel time is -0.4.
- If the user override of default percent change in transit travel time due to treatments value falls below minimum of -20% or exceeds maximum of 0%, the default value will be used.
- If the user override of existing transit mode share exceeds maximum of 25%, the default value will be used.
- If the user override of existing auto mode share falls below minimum of 50%, the default value will be used.
- Statewide mode shift factor is 57.8%

Alameda CTC Model Data:

- Default transit mode share in neighborhood/city
- Default vehicle mode share in neighborhood/city

Sources:

- Federal Highway Administration (FHWA). 2017a. National Household Travel Survey—2017 Table Designer. Travel Day PMT by TRPTRANS by HH_CBSA. Available: https://nhts.ornl.gov/. Accessed: January 2021.
- Federal Highway Administration (FHWA). 2017b. National Household Travel Survey—2017 Table Designer. Average Vehicle Occupancy by HHSTFIPS. Available: https://nhts.ornl.gov/. Accessed: January 2021.
- San Diego Association of Governments (SANDAG). 2019. Mobility Management VMT Reduction Calculator Tool—Design Document. June. Available: https://www.icommutesd.com/docs/default-source/planning/tool-design-document_final_7-17-19.pdf?sfvrsn=ec39eb3b_2. Accessed: January 2021.
- Transportation Research Board (TRB). 2007. Transit Cooperative Research Program Report 118: Bus Rapid Transit Practitioner's Guide. Available: https://nacto.org/docs/usdg/tcrp118brt_practitioners_kittleson.pdf. Accessed: January 2021.

5D. Transit Fare Reduction

Description: This strategy will reduce transit fares on the transit lines serving the neighborhood/city. A reduction in transit fares creates incentives to shift travel to transit from single occupancy vehicles and other traveling modes, which reduces VMT and associated GHG emissions. Transit fare reductions can be implemented systemwide or in specific fare-free or reduced-fare zones.

This strategy differs from Strategy 1D1, which can be offered through employer-based benefits programs in which the employer fully or partially pays the employee's cost of transit.

Formula: % Change in VMT = -1 * (% change in transit fare * Percent of neighborhood/city transit routes that receive reduced fares * Elasticity of transit ridership with respect to transit fare * Transit mode share * Statewide mode shift factor)/ Vehicle mode share

- % change in transit fare is capped at 50%.
- If the user override of existing transit mode share exceeds maximum of 25%, the default value will be used.
- If the user override of existing auto mode share falls below minimum of 50%, the default value will be used.

User Inputs:

- Transit fare unit (drop-down)
    - $/trip
    - $/hour
    - $/day
    - $/month
    - $/year
- Existing regular transit fare
- Regular transit fare with project
- Percent of neighborhood/city transit routes that receive reduced fares
- Transit mode share in neighborhood/city (optional)
    - The user may override the above default existing transit mode share in this cell. Leave blank otherwise.
    - If the user override of existing transit mode share exceeds maximum of 25%, the default value will be used.
- Vehicle mode share in neighborhood/city (optional)
    - The user may override the above default SOV mode share in this cell. Leave blank otherwise.

  - If the user override of existing auto mode share falls below minimum of 50%, the default value will be used.

Constants and Assumptions:

- Elasticity of transit ridership with respect to transit fare is -0.3.
- Statewide mode shift factor is 57.8%
- If the user override of existing transit mode share exceeds maximum of 25%, the default value will be used.
- If the user override of existing auto mode share falls below minimum of 50%, the default value will be used.
- Percent change in transit fare is capped at 50%.

Alameda CTC Model Data:

- Default transit mode share in neighborhood/city
- Default vehicle mode share in neighborhood/city

Sources:

- Federal Highway Administration (FHWA). 2017a. National Household Travel Survey—2017 Table Designer. Travel Day PMT by TRPTRANS by HH_CBSA. Available: https://nhts.ornl.gov/. Accessed: January 2021.
- Federal Highway Administration (FHWA). 2017b. National Household Travel Survey—2017 Table Designer. Average Vehicle Occupancy by HHSTFIPS. Available: https://nhts.ornl.gov/. Accessed: January 2021.
- Handy, S., Lovejoy, K., Boarnet, M., Spears, S. 2013. Impacts of Transit Service Strategies on Passenger Vehicle Use and Greenhouse Gas Emissions. October. Available: https://ww2.arb.ca.gov/sites/default/files/2020-06/Impacts_of_Transit_Service_Strategies_on_Passenger_Vehicle_Use_and_Greenhouse_Gas_Emissions_Policy_Brief.pdf. Accessed: January 2021.
- San Diego Association of Governments (SANDAG). 2019. Mobility Management VMT Reduction Calculator Tool—Design Document. June. Available: https://www.icommutesd.com/docs/default-source/planning/tool-design-document_final_7- 17-19.pdf?sfvrsn=ec39eb3b_2. Accessed: January 2021.

5E. Microtransit or NEV Shuttle

Description: Microtransit services utilize real-time ride-hailing, mobile tracking and app-based payment to provide demand-based service to users. Microtransit services are flexible and can be designed to fulfill the mobility needs of a community. Neighborhood electric vehicles (NEVs) are a type of microtransit service that operate within a defined service area and fulfill trips that are short distance in nature, typically less than two miles long. NEVs help to facilitate connections to and from transit stations and provide users with an alternative to driving for short trips.

Formula: % Change in VMT = -1 * (% of neighborhood/city covered by new microtransit service * Microtransit share of all person trips * Auto trip substitution rate * Microtransit trip length (miles))/(One-way vehicle trip length in neighborhood/city (miles) * Vehicle mode share)

- If the user override of existing auto mode share value falls below minimum of 50%, the default value will be used.

User Inputs:

- % of neighborhood/city covered by new microtransit service
- One-way microtransit trip length (optional)
  The user may override the above average microtransit trip length in this cell. Leave blank otherwise.
- One-way vehicle trip length in neighborhood/city (miles) (optional)
  The user may override the above average auto trip length in this cell. Leave blank otherwise.
- Vehicle mode share in neighborhood/city (optional)
  - The user may override the above default SOV mode share in this cell. Leave blank otherwise.
  - If the user override of existing auto mode share value falls below minimum of 50%, the default value will be used.

Constants and Assumptions:

- Microtransit share of all person trips is 0.41%.
- Auto trip substitution rate is 0.33.
- Average length of one-way microtransit trip is 1 mile.
- If the user override of existing auto mode share value falls below minimum of 50%, the default value will be used.

Alameda CTC Model Data:

- Default average one-way vehicle trip length in neighborhood/city (miles)
- Default vehicle mode share in neighborhood/city

Sources:

- WSP. 2019. "Draft TDM Off-Model Methodology—March 2019 Revision." Memo to SANDAG.
- Alameda CTC Travel Demand Forecasting Model scenario run (May 2019 version; base year 2020).