Quantifying Reductions in Vehicle Miles Traveled from New Bike Paths, Lanes, and Cycle Tracks

Summary Report

California Climate Investments Quantification Methods Assessment
California Air Resources Board
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Background

Under California's Cap-and-Trade program, the State's portion of the proceeds from Cap-and-Trade auctions is deposited in the Greenhouse Gas Reduction Fund (GGRF). The Legislature and Governor enact budget appropriations from the GGRF for State agencies to invest in projects that help achieve the State's climate goals. These investments are collectively called California Climate Investments. Senate Bill (SB) 862 requires the California Air Resources Board (CARB) to develop guidance on reporting and quantification methods for all State agencies that receive appropriations from the GGRF. CARB may review and update quantification methodologies, as needed.

To date, multiple California Climate Investments programs have offered funding for new bicycle paths or lanes[1] (CARB, 2016, 2017, 2018, 2019). CARB developed quantification methodologies to provide project-level greenhouse gas (GHG) emission reduction and co-benefit estimates for administering agencies to use when selecting projects for funding. To measure GHG emission reductions from new bike paths and lanes, CARB relies on a method it published with the California Department of Transportation (Caltrans) in 2005 for evaluating motor vehicle fee registration projects and congestion mitigation and air quality improvement (CMAQ) projects (CARB, 2016, 2018, 2019; CARB & Caltrans, 2005).

This report summarizes outcomes from a literature review to determine whether and how the CMAQ methods could be modified to better reflect emerging data and methods for estimating reductions in vehicle miles traveled (VMT) from new bike facilities, the first step in estimating GHG emission reductions.[2] The report also proposes an alternative VMT reduction quantification method based on existing bicyclist counts along the project corridor.

The current VMT reduction estimation equation uses five inputs: (1) days per year of facility use, (2) average annual two-way daily vehicular traffic on a road parallel to the proposed facility, (3) an adjustment factor, (4) an activity center credit, and (5) bike trip length. Our report reviews only those inputs—or the components of inputs—whose values are clearly derived in the methodology documentation, specifically the facility use factor, bike trip length, and the mode share and facility-level bicycle ridership change values used to calculate the adjustment factors. The report also reviews the merits of correcting for bike trip type—utilitarian versus recreational. The report does not probe the activity center credit values because it is unclear how they were derived.

[1] The new bike paths and lanes category of projects includes "Bicycle paths (Class I), bicycle lanes (Class II), or separated bikeways (Class IV) that are targeted to reduce commute VMT and other auto travel," with emissions "reduced by replacing auto trips with bicycle trips" (CARB, 2016).
[2] The full list of literature reviewed is provided in the section I of the accompanying technical documentation.

Summary of Current Quantification Method

CARB's current method estimates VMT reductions from new Class I (bike path), II (bike lane) and IV (cycle track) bicycle facilities (CARB, 2016, 2018, 2019). CARB does not currently include Class III facilities (bicycle boulevards) in its VMT reduction quantification method, or distinguish Class IV facilities that replace auto travel lanes or parking from those that replace existing Class II bike lanes. CARB's current method estimates the annual VMT reductions from new bicycle facilities using Equation 1 (CARB, 2016 [B-1], 2018 [26], 2019 [16]):

Equation 1: Auto VMT Reductions (current method)

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

Where,

			Units
D	=	days of use per year (default is 200 days)	Days
ADT	=	annual average two-way daily vehicular traffic on parallel road (project-specific data, with a maximum of 30,000)	Trips/day
A	=	adjustment factor (table lookup value)	-
C	=	activity center credit (table lookup value)	-
L	=	bike trip length (1.8 miles/trip in one direction)	Miles/trip

The multi-component adjustment factor uses mode share and facility-level bicycle ridership change data and assumptions to estimate how much of the measured ADT would be converted to bicycle trips after bicycle facility installation. The adjustment factors "were derived from a limited set of bicycle commute mode split data for cities and university towns in the southern and western United States,"[3] then multiplied by 0.7 to "estimate potential auto travel diverted to bikes," and again by a 0.65 "growth factor" to "estimate the growth in bicycle trips from construction of the bike facility" (CARB & Caltrans, 2005 [31]). However, it is unclear from the method documentation what portion of the cited mode split data was used to calculate the adjustment factors, and how it was used to create different factors by ADT and bicycle facility length.

The activity center credit is an accessibility proxy that increases the adjustment factor for bike facilities that are closer to more "activity centers," like banks, churches, hospitals, light rail stations, office parks, post offices, public libraries, shopping areas, grocery stores, or schools and universities (CARB, 2016 [B-2], 2018 [28], 2019 [17]). It is unclear how the activity center credits were derived, as there is no documentation for this component of the method.

3 As compiled by the Federal Highway Administration in its 1992 National Bicycling and Walking Study.

Key Report Findings

The literature reviewed in the report indicates a need to update multiple factors in CARB's existing equation for estimating VMT reductions from new bicycle facilities. The report findings include:

- The 0.65 "growth rate" for cycling trips following new facility construction that the current quantification method uses may be low. Recent research indicates the growth rate may be closer to 1.0 for Class I bike paths, Class II bike lanes, and Class IV cycle tracks that do not replace existing Class II facilities. However, the growth rates may be lower for Class IV facilities that replace existing bike lanes (possibly closer to 0.6) and Class III bike boulevards (possibly closer to 0.3 or 0.4) (City of Toronto, 2001; Cohen et al., 2008; Dill et al., 2014; Fitzhugh et al., 2010; Goodno et al., 2013; Gudz et al., 2016; Matute et al., 2016; Monsere et al., 2014; Sallaberry, 2000).

- Methods exist for more accurately accounting for temporal variation in cycling levels than by assuming a new bicycle facility would be used a limited number of days per year (National Bicycle and Pedestrian Documentation Project, 2009; Nordback & Sellinger, 2014).

- The average bicycle trip length for all trips could be updated from the baseline 1.8 miles used in the current quantification method, based on more recent and/or California-specific data (Caltrans, 2013).

- Most of the cyclists riding on new facilities who did not take the same route prior to facility installation switch from other bicycle routes rather than from other travel modes. The available data indicate an overall stated substitution rate (from any non-cycling travel mode) of between 0.2 and 0.3, and an auto substitution rate of about 0.1, meaning that about 10 percent of the new bicycle trips replaced driving trips (Matute et al., 2016; Monsere et al., 2014; Thakuriah, Metaxatos, Lin, & Jensen, 2012).

- Nearly half of bicycle trips nationally are made for recreational purposes (Kuzmyak & Dill, 2012). The current quantification method does not fully exclude recreational trips from its VMT reduction calculus. And at least one recent study indicates that bike facilities do influence people's choice to bicycle instead of drive for recreational purposes (Matute et al., 2016). Nonetheless, if desired, decrementing the VMT reduction estimate by the percentage of recreational trips provides a more conservative estimate.

- A possible method is presented to project VMT reductions from new bicycle facilities based on existing bicycle counts, without using vehicular ADT. One reason to rely on bicycling count data rather than vehicular ADT is that using vehicular ADT assumes that higher auto volumes correlate to higher bicycling volumes, which is often not the case. Another reason is that pre-facility-installation bicycle counts appear to be a reasonably reliable predictor of post-installation counts (Matute et al., 2016). In addition, there is a growing body of literature on the auto substitution rate for cyclists using a new facility and route, as well as average bicycle trip lengths.

Table 1 summarizes the values used in the current quantification method that could be directly updated based on the literature reviewed in the report. The next section presents the alternative quantification method.

Table 1. Summary of Potential Updates to Current Quantification Method Values

Method Input	Current Value	Updated Value
Bicycle Trip Growth Rate	0.65	1.0
Bicycle Trip Length	1.8 miles	1.5 miles
Auto-Bike Substitution Rate	0.7	0.1[4]

Alternative Quantification Method

Estimating VMT reductions from new bicycle facilities without vehicular ADT begins with obtaining bike counts on the route for the proposed facility (or an adjacent route, if no road or path currently exists where the facility is proposed to run). The short-duration ridership counts must then be converted to average annual daily bike trips using a temporal and seasonal adjustment factor. Post-installation bike ridership can then be estimated from that initial adjusted count using a growth factor based on ridership studies. The growth factor can be adjusted based on facility type and length, although more facility-specific data is needed. Multiplying that new ridership estimate by an average trip length yields new bicycle miles traveled from adding a bike facility. Not all of those new bicycle trips replace vehicle trips, however. Further adjustment is needed, including an auto-bicycle substitution rate, a carpool factor (not every vehicle trip has just one occupant) and, to be conservative, a trip type factor (recreational bike trips may be less likely than utilitarian bike trips to replace auto trips).

Equation 2 is one potential bicycle-count-based method.

[4] This could be adjusted to correct for carpooling (not all bicyclists who would have made the same trip by car would have done it alone) by dividing the substitution rate (or total number of substituted trips) by the average vehicle occupancy rate (average number of people per auto) used by Caltrans (1.15) (Caltrans, 2016).

Equation 2: Auto VMT Reductions (alternative method)			
$Auto\ VMT\ Reduced = (D) * (BC) * (S) * (GF) * (AS) * (C) * (T) * (L)$			
Where,			Units
D	=	days of use per year (default is 365 days, since counts can be adjusted seasonally)	Days/year
BC	=	average hourly (or daily) bicycle count (counts taken on the street to be improved with the bike facility, or, in the case of a facility not on an existing street, a parallel street)	Trips/day
S	=	seasonal adjustment factor (adjusts bicycle count to annual average daily bicycle trips)	-
GF	=	growth factor (expected rate of increase in bicycle count, e.g. 1.0 for a 100% increase in trips on the route)	-
AS	=	automobile substitution rate (expected rate at which cyclists who did not bike on the same route prior to bicycle facility installation switched from driving, or being driven in, an automobile to cycling)	-
C	=	carpool factor (default is 1/1.15, to reflect the California average number of vehicle trips per person trips by personal auto)	-
T	=	trip type factor (optional inclusion for conservative estimates; default is 0.506)	-
L	=	bike trip length (default is 1.5 miles/trip in one direction)	Miles/trip

Values for the first two variables, *D* and *BC*, would be provided by the funding applicant. *D* would have a default of 365, but it could be changed based on local conditions and the type of seasonable adjustment factor used.

The seasonal adjustment factor, *S*, could use local data where available. But to ensure continuity in application across California, the National Bicycle and Pedestrian Documentation Project's adjustment factors can be used in the interim (National Bicycle and Pedestrian Documentation Project, 2009).

The growth factor, *GF*, could be approximated based on the findings from the count-based studies reviewed in the full report. As discussed, it appears from the literature that a uniform, facility-agnostic growth rate around 1.0 could be appropriate. The literature also indicates at least some correlation between facility length and ridership increases (at least for Class IV cycle tracks), but more research is needed to clarify the facility length-ridership relationship.

The auto substitution factor, *AS*, could be based on the available data discussed above, which indicate an auto substitution rate of about 0.1. However, the auto substitution factor should be adjusted to account for carpooling (not all bicyclists who would have made the same trip by car would have done it alone).

The carpool factor, *C*, corrects for that, by dividing the total number of substituted trips by the average vehicle occupancy rate (average number of people per auto) used by Caltrans (1.15) (Caltrans, 2016).

The (optional) trip type factor, *T*, is included to correct for the fact that bike trips that are purely for exercise, sport or recreation are not as likely to substitute for auto trips as utilitarian bike trips. The default value for *T* is based on the combined share (49.4%) of bicycle trips made for "vacation" (2.1%) or "other social or recreational" (47.3%) purposes, taken from the 2009 National Household Travel Survey (Kuzmyak & Dill, 2012). The default value is the percentage of all other (non-vacation, social or recreational) trips, calculated as 1-0.494 (=0.506). This approximation of commute and utilitarian trip share is likely conservative, however. Furthermore, the auto substitution factor already accounts for recreational ridership (Matute et al., 2016; Monsere et al., 2014; Thakuriah et al., 2012).

The trip length factor, *L*, is based on the average length of bicycle trips taken for any purpose, using the default 1.5-mile average from most recent California Household Travel Survey data.

Ease of Applying the Alternative Quantification Method

To gauge how easy it would be to use the alternative quantification method, jurisdictions' housing projects that received funding from the Affordable Housing and Sustainable Communities program or Active Transportation Program were surveyed about the type, timing and location of their bicycle and vehicular counts, and who conducted the counts. The bicycle and vehicular count information available online for the jurisdictions was also reviewed. The results, along with the insights from the case study presented in the technical documentation, indicate that the alternative quantification method would be at least as easy to use as the existing method, for at least two reasons.

First, once a funding applicant has the requisite hourly (or daily) bicycle count data or vehicular ADT, the alternative quantification method can be applied more quickly than the existing method. Default values are available for all other factors in the alternative method besides the bike count. The existing method, on the other hand, requires the potentially time-consuming identification and documentation of all the "activity centers" within ½-mile and ¼-mile buffers of the planned bicycle facility.

Second, in many jurisdictions it may be just as easy for a funding applicant to obtain the requisite hourly bicycle count data as the necessary vehicular ADT. Most of the jurisdictions for which information was obtained about their bike and auto traffic data collect bike counts at dozens of locations, most updated at least annually. Multiple jurisdictions also collect at least some bike count data using continuous counters, while multiple others are planning to either expand or initiate continuous bike count programs. And many of the surveyed jurisdictions have bike count data for nearly as many locations as automobile counts.

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