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CONSULTANTS

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SUBJECT: La Sierra and Victoria Vehicle Miles Traveled (VMT) Analysis

Matthew Esquivel,

*TJW Engineering, Inc. (*TJW*)* is pleased to submit this Vehicle Miles Traveled (VMT) Analysis for the proposed project located at the corner of La Sierra and Victoria in the City of Riverside. The purpose of this memorandum is to satisfy the requirements for disclosure of potential impacts and mitigation measures per the California Environmental Quality Act (CEQA). This analysis has been conducted using guidance from the *City of Riverside Traffic Impact Analysis Guidelines for Vehicle Miles Traveled and Level of Service Assessment (July 2020).*

PROJECT DESCRIPTION

The proposed project is located at the corner of La Sierra and Victoria in the City of Riverside. The proposed project includes 49 townhome dwelling units with access from La Sierra Avenue. The project site plan is attached for reference.

BACKGROUND

Senate Bill 743 (SB-743), which was codified in Public Resources Code section 21099, was signed by the Governor in 2013 and directed the Governor's OPR to identify alternative metrics for evaluating transportation impacts under CEQA. Based on this, delay-based analysis (level of service) has been replaced by VMT. Pursuant to Section 21099, the criteria for determining the significance of transportation impacts must "promote the reduction of greenhouse gas emissions, the development of multimodal transportation networks, and a diversity of land uses." Recently adopted changes to the CEQA Guidelines in response to Section 21099 include a new section (15064.3) that specifies that VMT is the most appropriate measure of transportation impacts. A separate Technical Advisory issued by OPR provides additional technical details on calculating VMT and assessing transportation impacts for various types of projects.

THRESHOLDS

The City guidelines outline two thresholds for determination of a significant impact. For residential projects, the following thresholds of significance are identified:

1. The baseline or cumulative project-generated VMT per capita exceeds 15% below the current jurisdictional baseline VMT per capita.
2. For projects inconsistent with the General Plan, the baseline or cumulative link-level boundary VMT per capita (City) increase under the plus project condition compared to the no project condition.

As the project is consistent with the General Plan, a link-level boundary VMT analysis is not applicable to this project. However, the project-generated VMT per capita was conducted following the City guidelines.

METHODOLOGY AND ANALYSIS

A VMT analysis was prepared using the City's guidelines for VMT analysis. The analysis was prepared using the Riverside County Travel Demand Model (RIVCOM).

The project is located within Traffic Analysis Zone (TAZ) 1956. The potential population generated by the project was calculated using a factor of 3.34 persons per household as noted in the County of Riverside General Plan, Appendix E – Socioeconomic Build-Out Assumptions and Methodology (2017).[1] Based on this data, the proposed residential project would have a population of 164 people (49 dwelling units x 3.34 persons per household). The existing base socioeconomic data moved from the project TAZ and added to adjacent TAZ's. The project TAZ was then populated with the project population.

VMT data for years between 2018 and 2045 can be extrapolated using linear interpolation between the 2018 and 2045 model outputs. The model was completed for base year 2018 and plan year 2045 without and with project conditions (total four model runs). Based on the residential land use and as per City guidelines, project VMT/resident was compared to the County's VMT/capita threshold for project opening year 2028.

[1] Lake Mathews/Woodcrest Plan Area was utilized due to the project's close proximity and similar characteristics to the Plan Area.

Table 1: VMT Analysis of Project Impact

	2018	2045	2028
Project VMT	2,494	2,513	2,498
Project Population	164	164	164
Project VMT/Resident	15.2	15.4	15.3
City of Riverside VMT	3,951,373	5,021,447	4,189,167
City Population	323,856	404,570	341,792
City VMT/Resident	12.2	12.4	12.3
City 15% Threshold	10.4	10.6	10.4
VMT Threshold	**Project VMT/Resident**	**% Above/Below Threshold**	**VMT Impact?**
10.4	15.3	46.15%	Yes

MITIGATION MEASURES

The City of Riverside outlines for residential projects an impact would occur for residential projects if the VMT per resident exceeds 15% below the citywide VMT per resident. In this case, the project exceeds the threshold by 4.9 VMT per resident (approximately 47% over the City threshold).

To mitigate the project VMT impacts and per the City guidelines, the *California Air Pollution Control Officers Association (CAPCOA) Handbook for Analyzing Greenhouse Gas Emission Reductions, Assessing Climate Vulnerabilities, and Advancing Health and Equality (December 2021)* was considered. The CAPCOA manual includes various measures to reduce VMT. Among the various measures identified, three (3) measures were deemed applicable to the proposed project.

Measure T-1: Increase Residential Density

This measure accounts for the VMT reduction achieved by a project that is designed with a higher density of dwelling units. The relevant pages from the CAPCOA manual are attached.

The VMT reduction resulting from a project that is designed with a higher density of dwelling units is calculated using the following equation: A=((B-C)/C)*D, where A is the percent reduction in VMT, B is the residential density of the project development, C is the residential density of a typical development, and D is the elasticity of VMT with respect to residential density (constant of -0.22). The project proposes a density of 4.94 dwelling units per acre and the general plan land use designation of 1-½ acre Single Dwelling is up to 2 dwelling units per acre. The resulting reduction in VMT is determined to exceed the CAPCOA greenhouse gas emissions maximum potential of 30%. Therefore, the T-1 mitigation is shown to result in a 30% VMT reduction, shown in Table 2.

Measure T-3: Provide Transit-Oriented Development

This measure accounts for VMT reduction in the study area relative to the same project sited in a non-transit oriented (TOD) development location. To qualify as a TOD, the proposed project must be a residential project near a high frequency transit station. The project falls within these parameters, as the project provides a 10-minute pedestrian friendly pathway to a high frequency transit station. The high frequency transit station is the nearby Metrolink station that provides access to Los Angeles and Orange County, two major employment centers.

The VMT reduction resulting from a project that qualifies as a TOD is calculated using the following equation: A=(B*C)/(-D), where A is the percent reduction in VMT, B and D are respectively the transit and vehicle mode share in the surrounding city as calculated by the National Household Travel Survey of the Federal Highway Administration (2017), and C is the ratio of transit mode share for TOD area with measure compared to existing transit mode share in the surrounding city (constant is 4.9). The resulting VMT reduction is determined to be 6.93%, shown in Table 2.

Measure T-4: Integrate Affordable and Below Market Rate Housing

This measure accounts for VMT reduction achieved with projects that provide affordable housing units. The relevant pages from the CAPCOA manual are attached.

The VMT reduction resulting from a project that is designed with affordable housing units is calculated using the following equation: A=B*C, where A is the percent reduction in VMT, B is the percent of affordable housing units, and C is the percent reduction in VMT for qualified units compared to market rate units (constant of -28.6%). The project proposes 3 out of 49 units at affordable and below market rate. The resulting reduction in VMT is determined to be 1.75%, shown in Table 2.

Measure T-15: Limited Residential Parking Supply

This measure addresses VMT reduction by limiting the amount of available parking, thus disincentivizing driving as a mode of transportation.

The VMT reduction resulting from a project that limits the amount of available parking spaces is calculated using the following equation: A=(-(B-C)/B)D*E*F, where A is the percent reduction in VMT, B is the residential parking demand (constant of 2.6 spaces/unit for single family homes, multiplied by the number of units proposed), C is the proposed number of parking spaces on the site (2 garage spaces per unit, plus 12 spaces along the project's private streets)[2], D is the percentage of project VMT generated by residents (100% for the proposed residential projects), E is the percent of household VMT that is commute based (constant of 37%), and F is the percent reduction in commute mode share by driving among households in areas with scarce parking (also constant of 37%). The resulting reduction in VMT is determined to be 1.93%, shown in Table 2.

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[2] Due to subpar street widths, the project will not be providing on-street parking throughout the community as is typical with residential developments. Therefore, the project would provide limited residential parking.

Measure T-18: Provide Pedestrian Network Improvement

This measure is described as increasing the sidewalk coverage to improve pedestrian access. The relevant pages from the CAPCOA manual are attached.

The VMT reduction resulting from construction of additional sidewalks is calculated using the following equation: A = ((C/B)-1) x D, where A is the percent reduction in VMT, B is the existing sidewalk length in the study area, C is the sidewalk length in the study area with measure, and D is the elasticity of household VMT with respect to the ratio of sidewalks-to-streets (constant of-.0.05). The study area used for this calculation is within the boundaries of TAZ 1956. There are approximately 1,288 linear feet of existing sidewalk along La Sierra Avenue between Cleveland Avenue and Victoria Avenue and the project would construct 2,295 linear feet within the project site. Exhibit 1 shows the location of these sidewalks. The resulting reduction in VMT comes out to be 8.9%, however, based on the CAPCOA manual, there's a maximum of a 6.4% reduction. Therefore, the project would result in a decrease in VMT of 6.40%, shown in Table 2.

Table 2: VMT Analysis with Mitigation

Project % Above City Threshold	46.15%
CAPCOA VMT Reductions	
T-1 – Increase Residential Density	-30.00%
T-3 – Provide Transit-Oriented Development	-6.93%
T-4 – Integrate Affordable Housing	-1.75%
T-15 – Limited Residential Parking Supply	-1.93%
T-18 – Pedestrian Network Improvement	-6.40%
Sub-Total	*-47.01%*
Project % Above/Below Threshold	**-0.85%**

POTENTIAL VMT REDUCING FEATURES

Additional improvements not covered in the CAPCOA Manual will encourage residents to utilize alternative means of transportation.

Currently, along the project's northern border, Victoria Boulevard provides eastbound access to passenger vehicles and trucks only. A current trail on this side of the street and east of the project ends just before the project site around Millsweet Place. The project proposes that the trail end be extended to the intersection of La Sierra Avenue and Victoria Boulevard. As the trail is shared by pedestrians and bicycles, this extension will expand the multi-modal network, thus encouraging residents to walk and/or bicycle instead of drive.

Another improvement involves the conversion of standard crosswalks to ladder crosswalks at the intersection of La Sierra Avenue and Victoria Boulevard. While the westbound leg of this intersection currently has a ladder crosswalk, the project proposes the standard crosswalks of the other three legs be painted with the ladder pattern. The higher visibility of ladder-style crosswalks versus the two parallel lines of a standard crosswalk leads to improved pedestrian safety, thus encouraging walking over driving.

CONCLUSION

The project VMT per resident was determined to be 15.3, which is 46.15% higher than the City threshold for residential projects. The project design elements include the following measures:

- Increase Residential Density
- Provide a Transit-Oriented Development
- Integrate Affordable Housing
- Limit the Parking Supply
- Pedestrian Network Improvements

These five measures result in a decrease in VMT of 47.01% which places the project under the City threshold by 0.85%. Additionally, improvements to the trail along the eastbound side of Victoria Avenue bordering the project site, as well as the crosswalk improvements at the intersection of La Sierra Avenue and Victoria Boulevard, encourage multi-modal transportation and has the potential to further reduce VMT.

It should be noted, at the time of this analysis, a VMT fee program and/or VMT mitigation program does not exist within the City. However, coordination with City staff has indicated a VMT Mitigation Bank Program is currently being established.

Please contact us at (949) 878-3509 if you have any questions regarding this analysis.

Sincerely,

Thomas Wheat, PE, TE
President

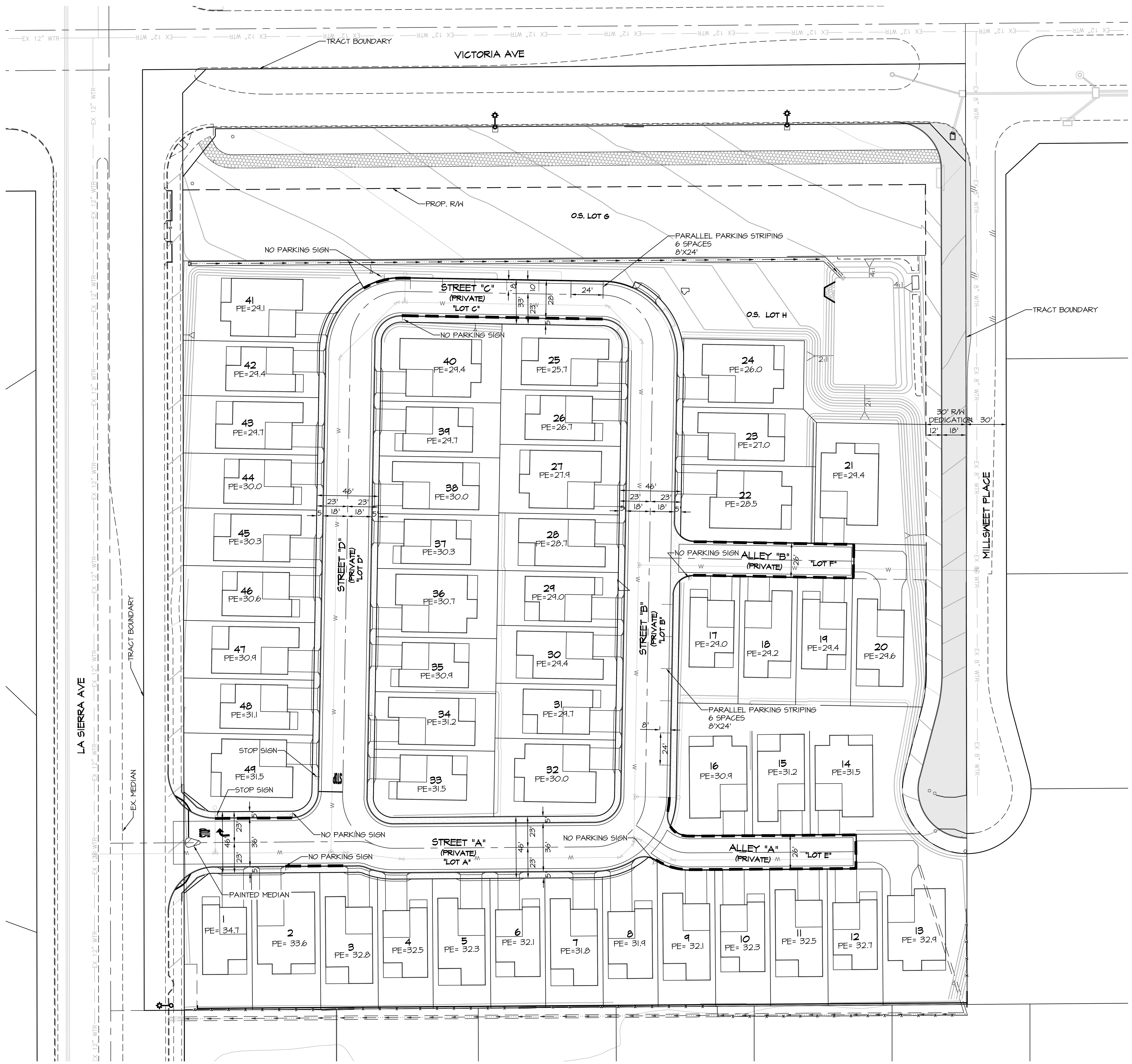
Registered Civil Engineer *#69467*
Registered Traffic Engineer *#2565*

David Chew, PTP
Transportation Planner

IN THE CITY OF RIVERSIDE, COUNTY OF RIVERSIDE, STATE OF CALIFORNIA

CONCEPTUAL SIGNING AND STRIPING

TENTATIVE TRACT NO. 38921



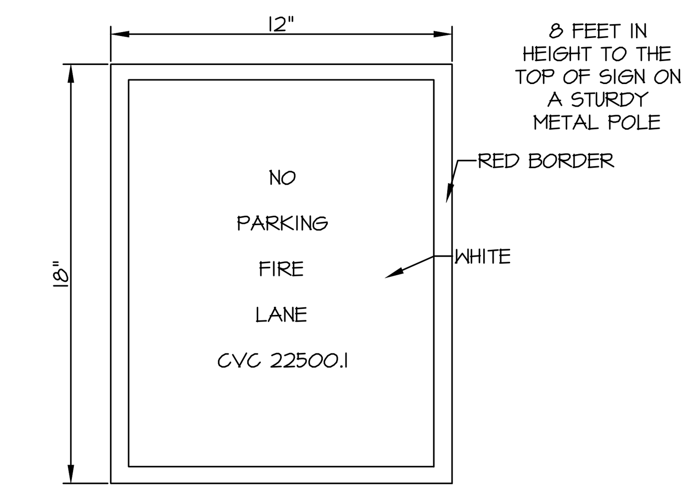
SCALE: 1" = 40'

OWNER

LA SIERRA VICTORIA DEVELOPMENT LLC
19215 WILD MUSTANG COURT
APPLE VALLEY, CA 92307

APPLICANT

WARMINGTON RESIDENTIAL
3090 PULLMAN ST
COSTA MESA, CA 92626
CONTACT: MATTHEW ESQUIVEL
EMAIL: MESQUIVEL@WARMINGTONGROUP.COM



"NO PARKING" SIGN DETAIL

STANDARD "NO PARKING" SIGN SIZE SHALL BE USED. SIGNS SHALL BE WHITE WITH RED LETTERING. "NO PARKING- FIRE LANE-CVC22500.2".

"NO PARKING" SIGNS TO BE PLACED AT ALL ALLEY ENTRANCES AS SHOWN HEREON.

LEGEND

- BOUNDARY
- RIGHT OF WAY
- CENTERLINE
- PROPERTY LINE
- EASEMENT
- PROP. CURB & GUTTER
- EX. CURB & GUTTER
- PROP. SIDEWALK
- EX. SIDEWALK
- UNDERGROUND STORAGE
- PROP. DOMESTIC WATER
- EX. DOMESTIC WATER
- PROP. RECYCLED WATER
- PROP. SEWER
- EX. SEWER
- PROP. STORM DRAIN
- EX. STORM DRAIN
- EX. MAJOR CONTOUR
- EX. MINOR CONTOUR
- 6' BLOCK WALL
- 6' STEEL TUBULAR FENCE
- 4' STEEL TUBULAR FENCE
- 6' VINYL FENCE
- RED PAINTED CURB

EX.	EXISTING
PROP.	PROPOSED
S/W	SIDEWALK
R/W	RIGHT OF WAY
R&R	REPLACE AND REPAIR
P/L	PROPERTY LINE
C&G	CURB & GUTTER
O.S.	OPEN SPACE
EVA	EMERGENCY VEHICLE ACCESS
SWR	SEWER
WTR	WATER
SD	STORM DRAIN
CB	CATCH BASIN
TBR	TO BE REMOVED
TYP.	TYPICAL

CONCEPTUAL SIGNING AND STRIPING
PREPARED DATE: JULY 11, 2024
PLANS PREPARED BY:

adkan ENGINEERS
Civil Engineering • Surveying • Planning
6879 Airport Drive, Riverside, CA 92504
Tel:(951) 688-0241 • Fax:(951) 688-0599

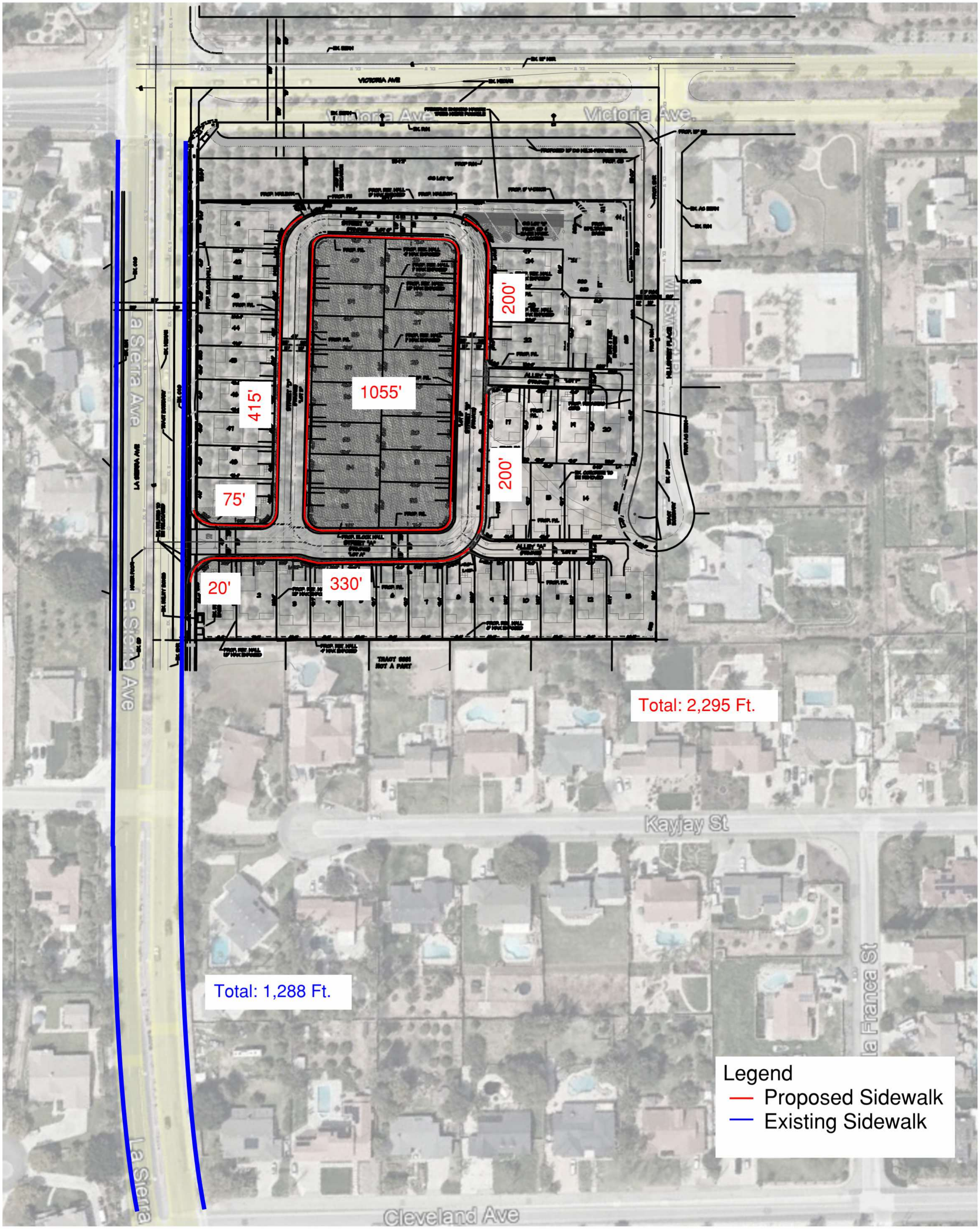


Exhibit 1: Proposed and Existing Pedestrian Sidewalk

La Sierra and Victoria VMT Analysis

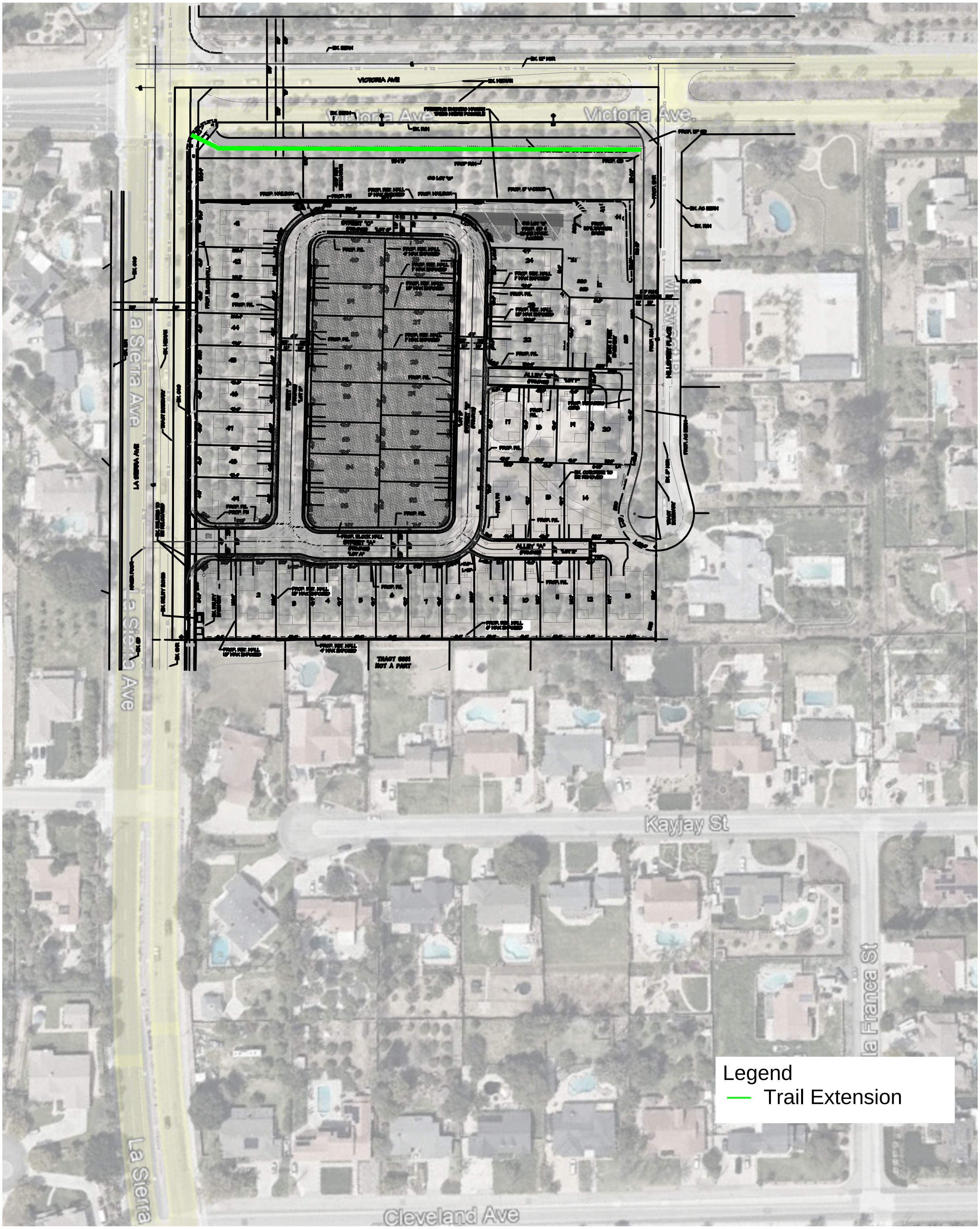


Exhibit 2: Trail Extension

La Sierra and Victoria VMT Analysis

TJW ENGINEERING, INC.

WRI-24-002

T-1. Increase Residential Density

GHG Mitigation Potential

30%

Up to 30.0% of GHG emissions from project VMT in the study area

Co-Benefits (icon key on pg. 34)

Climate Resilience

Increased density can put people closer to resources they may need to access during an extreme weather event. Increased density can also shorten commutes, decreasing the amount of time people are on the road and exposed to hazards such as extreme heat or flooding.

Health and Equity Considerations

Neighborhoods should include different types of housing to support a variety of household sizes, age ranges, and incomes.

Measure Description

This measure 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 U.S. 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. This measure is best quantified when applied to larger developments and developments where the density is somewhat similar to the surrounding area due to the underlying research being founded in data from the neighborhood level.

Subsector

Land Use

Locational Context

Urban, suburban

Scale of Application

Project/Site

Implementation Requirements

This measure is most accurately quantified when applied to larger developments and/or developments where the density is somewhat similar to the surrounding neighborhood.

Cost Considerations

Depending on the location, increasing residential density may increase housing and development costs. However, the costs of providing public services, such as health care, education, policing, and transit, are generally lower in more dense areas where things are closer together. Infrastructure that provides drinking water and electricity also operates more efficiently when the service and transmission area is reduced. Local governments may provide approval streamlining benefits or financial incentives for infill and high-density residential projects.

Expanded Mitigation Options

When paired with Measure T-2, *Increase Job Density*, the cumulative densification from these measures can result in a highly walkable and bikeable area, yielding increased co-benefits in VMT reductions, improved public health, and social equity.

GHG Reduction Formula

$$A = \frac{B - C}{C} \times D$$

GHG Calculation Variables

ID	Variable	Value	Unit	Source
Output				
A	Percent reduction in GHG emissions from project VMT in study area	0–30.0	%	calculated
User Inputs				
B	Residential density of project development	[ ]	du/acre	user input
Constants, Assumptions, and Available Defaults				
C	Residential density of typical development	9.1	du/acre	Ewing et al. 2007
D	Elasticity of VMT with respect to residential density	-0.22	unitless	Stevens 2016

Further explanation of key variables:

- (C) – The residential density of typical development is based on the blended average density of residential development in the U.S. forecasted for 2025. This estimate includes apartments, condominiums, and townhouses, as well as detached single-family housing on both small and large lots. An acre in this context is defined as an acre of developed land, not including streets, school sites, parks, and other undevelopable land. If reductions are being calculated from a specific baseline derived from a travel demand forecasting model, the residential density of the relevant transportation analysis zone should be used instead of the value for a typical development.
- (D) – A meta-regression analysis of five studies that controlled for self-selection found that a 0.22 percent decrease in VMT occurs for every 1 percent increase in residential density (Stevens 2016).

GHG Calculation Caps or Maximums

Measure Maximum

(A_{max}) The percent reduction in GHG emissions (A) is capped at 30 percent. The purpose for the 30 percent cap is to limit the influence of any single built environmental factor (such as density). Projects that implement multiple land use strategies (e.g., density, design, diversity) will show more of a reduction than relying on improvements from a single built environment factor.

Subsector Maximum

($\sum A_{max_{T\text{-}1\ through\ T\text{-}4}} \leq 65\%$) This measure is in the Land Use subsector. This subcategory includes Measures T-1 through T-4. The VMT reduction from the combined implementation of all measures within this subsector is capped at 65 percent.

Example GHG Reduction Quantification

The user reduces VMT by increasing the residential density of the project study area. In this example, the project's residential density would be 15 du per acre (B), which would reduce GHG emissions from project VMT by 14.2 percent.

$$A = \frac{15\ \frac{du}{ac} - 9.1\ \frac{du}{ac}}{9.1\ \frac{du}{ac}} \times -0.22 = -14.2\%$$

Quantified Co-Benefits

Improved Local Air Quality

The percent reduction in GHG emissions (A) would be the same as the percent reduction in NO_X, CO, NO_2, SO_2, and PM. Reductions in ROG emissions can be calculated by multiplying the percent reduction in GHG emissions (A) by an adjustment factor of 87 percent. See *Adjusting VMT Reductions to Emission Reductions* above for further discussion.

Energy and Fuel Savings

The percent reduction in vehicle fuel consumption would be the same as the percent reduction in GHG emissions (A).

VMT Reductions

The percent reduction in VMT would be the same as the percent reduction in GHG emissions (A).

Sources

- Ewing, R., K. Bartholomew, S. Winkelman, J. Walters, and D. Chen. 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.

T-3. Provide Transit-Oriented Development

GHG Mitigation Potential

31%

Up to 31.0% of GHG emissions from project VMT in study area

Co-Benefits (icon key on pg. 34)

Climate Resilience

Providing TOD puts a large number of people close to reliable public transportation, diversifying their transportation options during an extreme weather event.

Health and Equity Considerations

TOD may increase housing prices, leading to gentrification and displacement. Please refer to the *Accountability and Anti-Displacement and Housing* section in Chapter 5, *Measures for Advancing Health and Equity*, for potential strategies to minimize disruption to existing residents. TOD coupled with affordable housing options can help to support equity by helping to lower transportation costs for residents and increase active mobility.

Measure Description

This measure 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. Project site residents, employees, and visitors would have easy access to high-quality public transit, thereby encouraging transit ridership and reducing the number of single-occupancy vehicle trips and associated GHG emissions.

Subsector

Land Use

Locational Context

Urban and suburban. Rural only if adjacent to commuter rail station with convenient rail service to a major employment center.

Scale of Application

Project/Site

Implementation Requirements

To qualify as a TOD, the development must be a residential or office project that is within a 10-minute walk (0.5 mile) of a high frequency transit station (either rail, or bus rapid transit with headways less than 15 minutes). Ideally, the distance should be no more than 0.25 to 0.3 of a mile but could be up to 0.5 mile if the walking route to station can be accessed by pedestrian-friendly routes. Users should confirm “unmitigated” or “baseline” VMT does not already account for reductions from transit proximity.

Cost Considerations

TOD reduces car use and car ownership rates, providing cost savings to residents. It can also increase property values and public transit use rates, providing additional revenue to municipalities, as well as open new markets for business development. Increased transit use will likely necessitate increased spending on maintaining and improving public transit systems, the costs of which may be high.

Expanded Mitigation Options

When building TOD, a best practice is to incorporate bike and pedestrian access into the larger network to increase the likelihood of transit use.

GHG Reduction Formula

$$A = \frac{(B \times C)}{-D}$$

GHG Calculation Variables

ID	Variable	Value	Unit	Source
Output				
A	Percent reduction in GHG emissions from project VMT in study area	6.9–31.0	%	calculated
User Inputs				
	None			
Constants, Assumptions, and Available Defaults				
B	Transit mode share in surrounding city	Table T-3.1	%	FHWA 2017a
C	Ratio of transit mode share for TOD area with measure compared to existing transit mode share in surrounding city	4.9	unitless	Lund et al. 2004
D	Auto mode share in surrounding city	Table T-3.1	%	FHWA 2017b

Further explanation of key variables:

- (B and D) – Ideally, the user will calculate transit and auto mode share for a Project/Site at a scale no larger than a census tract. Ideally, variables B and D will reflect travel behavior in locations that are *not* already within 0.5 mile of a high-quality transit stop and may instead substitute data from nearby tracts further from transit if such locations exist. Potential data sources include the U.S. Census, California Household Travel Survey (preferred), or local survey efforts. If the user is not able to provide a project-specific value using one of these data sources, they have the option to input the mode share for one of the six most populated core-based statistical areas (CBSAs) in California, as presented in Table T-3.1 in Appendix C, *Emission Factors and Data Tables*. Transit mode share is likely to be smaller for areas not covered by the listed CBSAs, which represent the most transit-accessible areas of the state. Conversely, auto mode share is likely to be larger.
- (C) – A study of people living in TODs in California found that, on average, transit shares for TOD residents exceed the surrounding city by a factor of 4.9 (Lund et al. 2004).

GHG Calculation Caps or Maximums

Measure Maximum

($(B \times C)_{max}$) The transit mode share in the project study area with the measure is capped at 27 percent. This is based on the weighted average transit commute mode share of five surveyed sites in California where residents lived within 3 miles of rail stations (Lund et al. 2004). As transit mode share is typically higher for commute trips compared to all trips, 27 percent represents a reasonable upper bound for expected transit mode share in a TOD area. Projects in the CBSAs of San Francisco-Oakland-Hayward and San Jose-Sunnyvale-Santa Clara would have their transit mode share capped at 27 percent in the formula.

(A_{max}) For projects that use default CBSA data from Table T-3.1 in Appendix C, the maximum percent reduction in GHG emissions (A) is 31.0 percent. This is based on a project in the CBSA of San Francisco-Oakland-Hayward with a transit mode share that reaches the cap ($(B \times C)_{max}$). This maximum scenario is presented in the below example quantification.

Subsector Maximum

($\sum A_{max_{T\text{-}1 \text{ through } T\text{-}4}} \leq 65\%$) This measure is in the Land Use subsector. This subcategory includes Measures T-1 through T-4. The VMT reduction from the combined implementation of all measures within this subsector is capped at 65 percent.

Example GHG Reduction Quantification

The user reduces VMT by locating their project in a TOD location. Project site residents, employees, and visitors would have easy access to high-quality public transit, thereby encouraging transit use and reducing single occupancy vehicle travel. In this example, the project is within the San Jose-Sunnyvale-Santa Clara CBSA with an existing transit mode share (B) of 6.69 percent. Applying a 4.9 ratio of transit mode share for TOD area with the measure compared to existing transit mode share in the surrounding city yields 33 percent, which exceeds the 27 percent cap ($(B \times C)_{max}$). Therefore, 27 percent is used to define ($B \times C$). The existing vehicle mode share is 86.96 percent (D). The user would reduce GHG emissions from project study area VMT (as compared to the same project in a non-TOD location) by 31 percent.

$$A = \frac{27\%}{-86.96\%} = -31\%$$

Quantified Co-Benefits

Improved Local Air Quality

The percent reduction in GHG emissions (A) would be the same as the percent reduction in NO_X, CO, NO_2, SO_2, and PM. Reductions in ROG emissions can be calculated by multiplying the percent reduction in GHG emissions (A) by an adjustment factor of 87 percent. See *Adjusting VMT Reductions to Emission Reductions* above for further discussion.

Energy and Fuel Savings

The percent reduction in vehicle fuel consumption would be the same as the percent reduction in GHG emissions (A).

VMT Reductions

The percent reduction in VMT would be the same as the percent reduction in GHG emissions (A).

Sources

- 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., R. Cervero, and R. Wilson. 2004. *Travel Characteristics of Transit-Oriented Development in California*. January. Available: https://community-wealth.org/sites/clone.community-wealth.org/files/downloads/report-lund-cerv-wil.pdf. Accessed: January 2021.

T-4. Integrate Affordable and Below Market Rate Housing

GHG Mitigation Potential

28.6%

Up to 28.6% of GHG emissions from project/site multifamily residential VMT

Co-Benefits (icon key on pg. 34)

Climate Resilience

Increasing affordable housing creates the opportunity for a greater diversity of people to be closer to their desired destinations and the resources they may need to access during an extreme weather event. Close proximity to destinations allows for more opportunities to use active transportation and transit and to be less reliant on private vehicles. Alleviating the housing-cost burden also enables more people to remain housed, and increases people's capacity to respond to disruptions, including climate impacts.

Health and Equity Considerations

Neighborhoods should include different types of housing to support a variety of household sizes, age ranges, abilities, and incomes.

Measure Description

This measure requires below market rate (BMR) housing. BMR housing provides greater opportunity for lower income families to live closer to job centers and achieve a jobs/housing match near transit. It is also an important strategy to address the limited availability of affordable housing that might force residents to live far away from jobs or school, requiring longer commutes. The quantification method for this measure accounts for VMT reductions achieved for multifamily residential projects that are deed restricted or otherwise permanently dedicated as affordable housing.

Subsector

Land Use

Locational Context

Urban, suburban

Scale of Application

Project/Site

Implementation Requirements

Multifamily residential units must be permanently dedicated as affordable for lower income families. The California Department of Housing and Community Development (2021) defines lower-income as 80 percent of area median income or below, and affordable housing as costing 30 percent of gross household income or less.

Cost Considerations

Depending on the source of the affordable subsidy, BMR housing may have implications for development costs but would also have the benefit of reducing costs for public services, similar to Measure T-1, *Increase Residential Density*.

Expanded Mitigation Options

Pair with Measure T-1, *Increase Residential Density*, and Measure T-2, *Increase Job Density*, to achieve greater population and employment diversity.

GHG Reduction Formula

A = B × C

GHG Calculation Variables

ID	Variable	Value	Unit	Source
Output				
A	Percent reduction in GHG emissions from Project/Site VMT for multifamily residential developments	0–28.6	%	calculated
User Inputs				
B	Percent of multifamily units permanently dedicated as affordable	0–100	%	user input
Constants, Assumptions, and Available Defaults				
C	Percent reduction in VMT for qualified units compared to market rate units	-28.6	%	ITE 2021

Further explanation of key variables:

- (B) – This refers to percent of multifamily units in the project that are deed restricted or otherwise permanently dedicated as affordable.
- (C) – The 11th Edition of the *ITE Trip Generation Manual* (ITE 2021) contains daily vehicle trip rates for market rate multifamily housing that is low-rise and not close to transit (ITE code 221) as well as affordable multifamily housing (ITE code 223). While these rates do not account for trip length, they serve as a proxy for the expected difference in vehicle trip generation and VMT generation presuming similar trip lengths for both types of land use. If the user has information about trip length differences between market rate and affordable housing, then adjusting the percent reduction accordingly is recommended.

  Users should note that the ITE trip rate estimates are based on a small sample of studies for the affordable housing rate and that no stratification of affordable housing by number of stories was available. This is an important distinction since the multifamily low-rise vehicle trip rate applies to four or fewer stories. Therefore, this measure may not apply to affordable housing projects with more than four stories.

GHG Calculation Caps or Maximums

Measure Maximum

(A_{max}) The maximum GHG reduction from this measure is 28.6 percent. This maximum scenario is presented in the below example quantification.

Subsector Maximum

($\sum A_{max_{T\text{-}1 \text{ through } T\text{-}4}} \leq 65\%$) This measure is in the Land Use subsector. This subsector includes Measures T-1 through T-4. The VMT reduction from the combined implementation of all measures within this subsector is capped at 65 percent.

Example GHG Reduction Quantification

The user reduces project VMT by requiring a portion of the multifamily residential units to be permanently dedicated as affordable. In this example, the percent of units (B) is 100 percent, which would reduce GHG emissions from VMT by 28.6 percent.

$$A = \mathbf{100\%} \times -28.6\% = -28.6\%$$

Quantified Co-Benefits

Improved Local Air Quality

The percent reduction in GHG emissions (A) would be the same as the percent reduction in NO_X, CO, NO_2, SO_2, and PM. Reductions in ROG emissions can be calculated by multiplying the percent reduction in GHG emissions (A) by an adjustment factor of 87 percent. See *Adjusting VMT Reductions to Emission Reductions* above for further discussion.

Energy and Fuel Savings

The percent reduction in vehicle fuel consumption would be the same as the percent reduction in GHG emissions (A).

VMT Reductions

The percent reduction in VMT would be the same as the percent reduction in GHG emissions (A).

Sources

- California Department of Housing and Community Development. 2021. *Income Limits*. Available: https://www.hcd.ca.gov/grants-funding/income-limits/index.shtml#:~:text=%E2%80%9CAffordable%20housing%20cost%E2%80%9D%20for%20lower,of%20gross%20income%2C%20with%20variations. Accessed; November 2021.
- Institute of Transportation Engineers (ITE). 2021. *Trip Generation Manual*. 11th Edition. Available: https://www.ite.org/technical-resources/topics/trip-and-parking-generation/. Accessed; November 2021.

T-15. Limit Residential Parking Supply

GHG Mitigation Potential

13.7%

Up to 13.7% of GHG emissions from resident vehicles accessing the site

Co-Benefits (icon key on pg. 34)

Climate Resilience

Limiting residential parking supply could incentivize increased use of public transit and thus result in less traffic, potentially reducing congestion or delays on major roads during peak AM and PM traffic periods. When this reduction occurs during extreme weather events, it better allows emergency responders to access a hazard site. Evacuation plans and plans for transport to cooling/heating/clean air centers during power outages or unhealthy air quality events, however, would need to consider needs of households without access to private vehicles.

Health and Equity Considerations

Limiting parking supply can reduce the cost of housing development and, potentially, increase housing supply and decrease housing expenses. However, this may negatively impact residents that do not have a viable alternative to personal vehicle travel.

Measure Description

This measure 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 convenience of driving results in a shift to other modes and decreased VMT and thus a reduction in GHG emissions. Evidence of the effects of reduced parking supply is strongest for residential developments.

Subsector

Parking or Road Pricing/Management

Locational Context

Urban, suburban

Scale of Application

Project/Site

Implementation Requirements

This measure is ineffective in locations where unrestricted street parking or other offsite parking is available nearby and has adequate capacity to accommodate project-related vehicle parking demand.

Cost Considerations

Reducing residential parking supply, especially in high density residential areas, can have high-cost savings if it reduces the need for additional investment in parking infrastructure. Some of these savings may be offset by investments in alternative transport solutions, which will need to be robust to ensure that residents can effectively travel to work and all other destinations without a car.

Expanded Mitigation Options

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 Measures T-1 and T-2 by allowing for higher density construction.

GHG Reduction Formula

$$A = -\frac{B - C}{B} \times D \times E \times F$$

GHG Calculation Variables

ID	Variable	Value	Unit	Source
Output				
A	Percent reduction in GHG emissions from resident vehicles accessing the site	0–13.7	%	calculated
User Inputs				
B	Residential parking demand	[ ]	parking spaces	user input
C	Project residential parking supply	[ ]	parking spaces	user input
D	Percentage of project VMT generated by residents	[ ]	%	user input
Constants, Assumptions, and Available Defaults				
E	Percent of household VMT that is commute based	37	%	Caltrans 2012
F	Percent reduction in commute mode share by driving among households in areas with scarce parking	37	%	Chatman 2013

Further explanation of key variables:

- (B) – The user can calculate the parking demand in the *ITE Parking Generation Manual* based on the project building square footage or number of du. For residential projects, this demand varies based on the size of each unit, and ranges from 1.0 spaces/unit for one-bedroom apartments to 2.6 spaces/unit for single-family homes with 3+ bedrooms.
- (D) – Available research on changes in parking supply focuses on residential land uses. Therefore, reductions are applied only to the share of VMT generated by residents of a project. For most residential projects, this will be 100 percent; however, for mixed-use projects, the user will need to provide project-specific data.
- (E) – The percent of household VMT that is commute-based varies from location to location; the statewide average is 37 percent (Caltrans 2012). If the user can provide a project-specific value based on their project type and area, they should replace the default in the GHG reduction formula.
- (F) – A study found that among households with limited off-street parking (<1 space per adult), there was a 37 percent decrease in auto mode share for commute trips. The method above pro-rates this reduction based on how much the project's parking supply is reduced from demand rates calculated in the *ITE Parking Generation Manual* (ITE 2019). In addition, this reduction is applied to commute trips only due to the limitations of the research.

GHG Calculation Caps or Maximums

Measure Maximum

(A_{max}) The percent reduction in GHG emissions is capped at 13.7 percent. This occurs for projects that have no onsite parking (C), 100 percent of VMT arising from residential land use (D), and 37 percent of all VMT arising from commute trips (E). This maximum scenario is presented in the below example quantification.

(C>B) Parking supply is considered to be limited when demand (C) exceeds supply (B). If demand is equal to or less than supply, then implementation of this measure would not result in a GHG reduction.

Subsector Maximum

($\sum A_{max_{T\text{-}14 \text{ through } T\text{-}16}} \leq 35\%$) This measure is in the Parking or Road Pricing/Management subsector. This subcategory includes Measures T-14 through T-16. The VMT reduction from the combined implementation of all measures within this subsector is capped at 35 percent.

Example GHG Reduction Quantification

The user reduces VMT by reducing a project's parking supply. In this example, the parking demand per ITE is 100 parking spaces (B) and the project would not supply any parking spaces (C). The user would reduce GHG emissions from VMT by 13.7 percent.

$$A = -\frac{100 \text{ spaces} - 0 \text{ spaces}}{100 \text{ spaces}} \times 100\% \times 37\% \times 37\% = -13.7\%$$

Quantified Co-Benefits

Improved Local Air Quality

The percent reduction in GHG emissions (A) would be the same as the percent reduction in NO_X, CO, NO_2, SO_2, and PM. Reductions in ROG emissions can be calculated by multiplying the percent reduction in GHG emissions (A) by an adjustment factor of 87 percent. See *Adjusting VMT Reductions to Emission Reductions* above for further discussion.

Energy and Fuel Savings

The percent reduction in vehicle fuel consumption would be the same as the percent reduction in GHG emissions (A).

VMT Reductions

The percent reduction in VMT would be the same as the percent reduction in GHG emissions (A).

Sources

- California Department of Transportation (Caltrans). 2012. *California Household Travel Survey (CHTS)*. Available: https://www.nrel.gov/transportation/secure-transportation-data/tsdc-california-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(1). Available: https://trid.trb.org/view/1243004. Accessed: January 2021.
- Institute of Transportation Engineers (ITE). 2019. Parking Generation Manual. 5th Edition. February. Available: https://ecommerce.ite.org/IMIS/ItemDetail?iProductCode=PG5-ALL. Accessed: May 2021.

T-18. Provide Pedestrian Network Improvement

GHG Mitigation Potential

6.4%

Up to 6.4% of GHG emissions from vehicle travel in the plan/community

Co-Benefits (icon key on pg. 34)

Climate Resilience

Improving pedestrian networks increases accessibility of outdoor spaces, which can provide health benefits and thus improve community resilience. This can also improve connectivity between residents and resources that may be needed in an extreme weather event.

Health and Equity Considerations

Ensure that the improvements also include accessibility features to allow for people of all abilities to use the network safely and conveniently. Ensure that sidewalks connect to nearby community assets, such as schools, retail, and healthcare.

Measure Description

This measure 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.

Subsector

Neighborhood Design

Locational Context

Urban, suburban, rural

Scale of Application

Plan/Community

Implementation Requirements

The GHG reduction of this measure is based on the VMT reduction associated with expansion of sidewalk coverage expansion, which includes not only building of new sidewalks but also improving degraded or substandard sidewalk (e.g., damaged from street tree roots). However, pedestrian network enhancements with non-quantifiable GHG reductions are encouraged to be implemented, as discussed under *Expanded Mitigation Options*.

Cost Considerations

Depending on the improvement, capital and infrastructure costs may be high. However, improvements to the pedestrian network will increase pedestrian activity, which can increase businesses patronage and provide a local economic benefit. The local municipality may achieve cost savings through a reduction of cars on the road leading to lower infrastructure and roadway maintenance costs.

Expanded Mitigation Options

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, slopes, and unprotected crossings should be minimized. Other best practice features could include high-visibility crosswalks, pedestrian hybrid beacons, and other pedestrian signals, mid-block crossing walks, pedestrian refuge islands, speed tables, bulb-outs (curb extensions), curb ramps, signage, pavement markings, pedestrian-only connections and districts, landscaping, and other improvements to pedestrian safety (see Measure T-35, *Provide Traffic Calming Measures*).

GHG Reduction Formula

$$A = \left(\frac{C}{B} - 1\right) \times D$$

GHG Calculation Variables

ID	Variable	Value	Unit	Source
Output				
A	Percent reduction in GHG emissions from household vehicle travel in plan/community	0–6.4	%	calculated
User Inputs				
B	Existing sidewalk length in study area	[ ]	miles	user input
C	Sidewalk length in study area with measure	[ ]	miles	user input
Constants, Assumptions, and Available Defaults				
D	Elasticity of household VMT with respect to the ratio of sidewalks-to-streets	-0.05	unitless	Frank et al. 2011

Further explanation of key variables:

- (B and C) – Sidewalk length should be measured 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. The recommended study area is 0.6 mile around the pedestrian network improvement. This represents a 6- to 10-minute walking time.
- (D) – A study found that a 0.05 percent decrease in household vehicle travel occurs for every 1 percent increase in the sidewalk-to-street ratio (Frank et al. 2011; Handy et al. 2014).

GHG Calculation Caps or Maximums

Measure Maximum

(A_{max}) The percent reduction in GHG emissions (A) is capped at 3.4 percent, which is based on the following assumptions:

- 35.2 percent of vehicle trips are short trips (2 mile or less, average of 1.29 miles) and thus could easily shift to walking (FHWA 2019).
- 64.8 percent of vehicle trips are longer trips that are unlikely to shift to walking (2 miles or more, average of 10.93 miles) (FHWA 2019).
- So $A_{max} = \frac{35.2\% \times 1.29 \text{ miles}}{64.8\% \times 10.93 \text{ miles}} = 6.4\%$

Subsector Maximum

($\sum A_{max_{T\text{-}18 \text{ through } T\text{-}22\text{-}C}} \leq 10\%$) This measure is in the Neighborhood Design subsector. This subcategory includes Measures T-18 through T-22-C. The VMT reduction from the combined implementation of all measures within this subsector is capped at 10 percent.

Example GHG Reduction Quantification

The user reduces household VMT by improving the pedestrian network in the study area. In this example, the existing sidewalk length (B) is 9 miles, and the sidewalk length with the measure (C) would be 10 miles. With these conditions, the user would reduce GHG emissions from household VMT within the study area by 0.6 percent.

$$A = \left(\frac{10 \text{ miles}}{9 \text{ miles}} - 1\right) \times -0.05 = -0.6\%$$

Quantified Co-Benefits

Improved Local Air Quality

The percent reduction in GHG emissions (A) would be the same as the percent reduction in NO_X, CO, NO_2, SO_2, and PM. Reductions in ROG emissions can be calculated by multiplying the percent reduction in GHG emissions (A) by an adjustment factor of 87 percent. See *Adjusting VMT Reductions to Emission Reductions* above for further discussion.

Energy and Fuel Savings

The percent reduction in vehicle fuel consumption would be the same as the percent reduction in GHG emissions (A).

VMT Reductions

The percent reduction in household VMT would be the same as the percent reduction in GHG emissions (A).

Improved Public Health

Users are directed to the Integrated Transport and Health Impact Model (ITHIM) (CARB et al. 2020). The ITHIM can quantify the annual change in health outcomes associated with active transportation, including deaths, years of life lost, years of living with disability, and incidence of community and individual disease.

Sources

- California Air Resources Board (CARB), California Department of Public Health (CDPH), and Nicholas Linesch Legacy Fund. 2020. Integrated Transport and Health Impact Model. Available: https://skylab.cdph.ca.gov/HealthyMobilityOptionTool-ITHIM/#Home. Accessed: September 17, 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.

- Frank, L., M. Greenwald, S. Kavage, and A. Devlin. 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, S., S. Glan-Claudia, and M. Boarnet. 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.