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Exploring the Equity Effects of VMT Mitigation Measures

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16. Abstract

In 2018, pursuant to Senate Bill (SB) 743 (2013), the Governor's Office of Planning and Research (OPR) and the California Natural Resources Agency promulgated regulations and technical guidance that eliminated automobile level of service (LOS) as a transportation impact metric for land development projects under the California Environmental Quality Act (CEQA), and replaced it with Vehicle Miles Traveled (VMT). The authors investigated the equity effects of VMT mitigation measures and developed a framework for evaluating those effects at the project level. The authors then applied the framework to two highway expansion case studies in California. They found that most VMT mitigation would be implemented at least partially within the project impact areas, as well as some disadvantaged communities, but would generally benefit communities outside of the project area, too. Most of the proposed mitigation measures would not displace existing residences or businesses or pose a significant risk of gentrification. Many of the measures showed substantial potential to improve accessibility to jobs, though less potential to improve accessibility to grocery stores. Community engagement and empowerment was harder to gauge. Overall, the five-part framework can provide a first-cut assessment of the equity effects of VMT mitigation measures during the environmental review phase of VMT-generating projects, like roadway expansions.

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Exploring the Equity Effects of VMT Mitigation Measures

A National Center for Sustainable Transportation Research Report

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Executive Summary

In 2013, then-Governor Jerry Brown signed Senate Bill (SB 743) into law. Pursuant to that direction, the Governor's Office of Planning and Research (OPR) and the California Natural Resources Agency promulgated regulations and technical guidance that eliminated automobile level of service (LOS)—a measure of automobile delay—as a transportation impact metric for land development projects under the California Environmental Quality Act (CEQA), and replaced it with Vehicle Miles Traveled (VMT)—a measure of the amount of vehicular travel. Actual implementation of the LOS-to-VMT shift was left up to lead agencies—the agencies with primary approval authority over a given project. For land development projects, lead agencies (usually cities or counties) were required to start using a VMT-based metric by July 1, 2020. For transportation projects, the regulations give lead agencies discretion to choose between LOS and a VMT-based metric. In September 2020, Caltrans decided that VMT was the best measure of transportation-related environmental impacts under CEQA.

Using LOS as the guiding metric for transportation impacts prioritizes vehicular flows and speed.[1] That, in turn, incentivized projects that could theoretically help increase vehicular flows and speed (like roadway expansions), which increasing the cost of projects that could exacerbate congestion (like infill development in urban areas, where roadways are typically more congested at baseline) (Volker et al., 2019a, b). The overall effect was to make the built environment more auto-centric. As a result, many planners and policymakers viewed VMT as a more appropriate metric for achieving sustainability goals, like reduced greenhouse gas (GHG) emissions, improved public health and safety, and more streamlined infill development amidst California's ongoing housing crisis (Volker et al., 2019b).

Despite the potential environmental benefits of VMT reduction, VMT mitigation strategies raise critical equity concerns. Disadvantaged communities—often low-income, communities of color, or those located in areas with limited access to transportation options—are frequently disproportionately affected by transportation projects. These communities may face negative impacts from increased pollution, displacement, or

[1] LOS is generally assessed using six letter grades, from A (free flow) to F, which denote different levels of vehicular delay for intersections and different combinations of automobile speed, density, and capacity for roadway sections.

reduced access to economic opportunities due to transportation infrastructure development.

This report explores the equity effects of VMT mitigation measures and develops a framework for evaluating those effects at the project level. We start with a broad review of the literature review, in which we examine the dimensions of transportation disadvantage generally, the relationship between VMT and transportation equity and justice, the equity effects of VMT mitigation measures, and the performance metrics used to evaluate VMT-related equity effects. We then discuss the key takeaways from a workshop we convened with experts in transportation equity and analysis. We then draw from both the literature review and workshop to develop a framework for evaluating the equity impacts of VMT mitigation measures at the project level. Finally, we apply our framework to two highway expansion case studies in California: the Yolo 80 Corridor Improvements Project and the I-5 Managed Lanes Project.

We found a rich body of literature around transportation equity generally, the dimensions of disadvantage, and the equity impacts of VMT-generating projects. However, the literature on the equity effects of VMT mitigation measures is much sparser. We found few to no empirical studies on the equity effects of most mitigation measures we explore in this report. Similarly, very few of the studies, reports, or standards we reviewed explored metrics for assessing the equity effects of measures to mitigate vehicle miles traveled (VMT). As a result, to develop our framework for evaluating those effects at the project level, we also reviewed more general recommendations for equity-related key performance indicators (KPIs), like the US Department of Transportation's former Justice40 KPI recommendations and drew inspiration from a workshop we convened. Our equity assessment framework for evaluating the equity effects of VMT mitigation measures includes five metrics: disadvantaged community, displacement and gentrification, accessibility, community approval and engagement, and geographical and spatial equity.

We applied our framework to two highway expansion case studies in California and found mixed results. Most of the proposed VMT mitigation measures would be at least partially implemented in disadvantaged communities, but they would also apply in or affect other communities, too. Most of the proposed mitigation measures would not displace existing residences or businesses or pose a significant risk of gentrification. In general, measures showed substantial potential to improve accessibility to jobs, though less potential to improve accessibility to grocery stores. Community engagement and empowerment was harder to gauge, in part because it was often unclear whether the engagement related to VMT mitigation measures specifically, but both projects included substantial community engagement overall. Regarding geographical and spatial equity, we found that most mitigation measures would be implemented at least partially in the same communities as would be affected by the primary project. However, the measures would generally benefit communities outside of the project area, too.

Introduction

Overview

The urgency of addressing climate change has made VMT reduction a central focus of California's transportation policy. The transportation sector is a major contributor to the state's GHG emissions, accounting for approximately 40% of the total emissions. As part of its commitment to reducing these emissions, the state has set ambitious targets for VMT reduction, which are seen as crucial for achieving the broader goal of carbon neutrality by 2045. The state enacted Senate Bill (SB) 743 in 2013 to help achieve those VMT reductions. SB 743 and its implementing regulations fundamentally changed the way that transportation-related environmental impacts are analyzed under the California Environmental Quality Act (CEQA), which is California's foundational environmental review law.

CEQA imposes a tiered system of environmental review for non-exempt projects that require discretionary approvals, which include most larger land development projects and many transportation-related infrastructure projects. Once the lead permitting agency determines that a project is subject to CEQA, it prepares an "initial study" to determine whether the project would have potentially "significant" and unmitigable environmental impacts, including transportation system impacts (14 California Code of Regulations [CEQA Guidelines] Section 15063; CEQA Guidelines, Appendix G). The lead agency must prepare a full environmental impact report (EIR) when there is substantial evidence that the project may have a significant impact on the physical environment, i.e., that the impact would exceed the threshold of significance. The agency must mitigate or avoid that impact if feasible (California Public Resources Code [PRC] Section 21002.1).

Prior to SB 743, transportation-related environmental impacts were primarily evaluated in CEQA analyses based on congestion-relief metrics, particularly the Level of Service (LOS) standard, which prioritizes vehicular mobility by measuring the flow and delay of traffic. This approach often led to the expansion of road capacity as a means of alleviating congestion, which, in turn, often caused increased VMT and exacerbated environmental and public health issues.

SB 743 and its implementing regulations replaced LOS with VMT as the primary metric for evaluating the environmental impacts of land use projects under the California Environmental Quality Act (CEQA), effective July 1, 2020 (CEQA Guidelines Section 15064.3). For transportation projects, the regulations give lead agencies "discretion to determine the appropriate measure of transportation impact," which left the door open for the continued use of LOS for analyzing the transportation-related impacts of transportation projects (CEQA Guidelines Section 15064.3). However, Caltrans effectively shut that door with its September 2020 Transportation Analysis Framework, in which it "concurs that VMT is the most appropriate measure of transportation impacts under CEQA" (p. 1).

The policy shift from LOS to VMT is motivated by the state's climate goals, particularly the reduction of greenhouse gas (GHG) emissions, and aligns with California's broader environmental agenda, which emphasizes sustainability and equity. By focusing on the total distance driven by vehicles, the VMT metric shifts attention away from mere traffic efficiency toward a broader consideration of environmental and social impacts, including equity outcomes.

Despite the potential environmental benefits of VMT reduction, these measures also raise critical equity concerns. Disadvantaged communities—often low-income, communities of color, or those located in areas with limited access to transportation options—are frequently disproportionately affected by transportation projects. These communities may face negative impacts from increased pollution, displacement, or reduced access to economic opportunities due to transportation infrastructure development. This report explores the equity effects of VMT mitigation measures and develops a framework for evaluating those effects at the project level.

Objectives

The overarching goal of this project is to examine the equity implications of VMT mitigation measures in California. More specifically, this report aims to achieve the following objectives.

Examine the dimensions of transportation disadvantage generally, and the more specific relationship between VMT and transportation equity and justice. Transportation disadvantage refers to experiencing a disproportionate lack of transportation benefits or a disproportionate share of its burdens, which often manifests in reduced access to mobility options, longer travel times, higher costs, and increased exposure to negative environmental and health outcomes. This report examines the various dimensions of transportation disadvantage, including accessibility, mobility, and exposure to environmental hazards. It also explores the social and economic factors that contribute to transportation disadvantages, such as race, income, disability, and geographic location. This report also explores the specific relationship between VMT and transportation equity and justice, which is complex and multifaceted. For example, VMT is often disproportionately generated by higher-income populations who can afford to live in suburban areas and commute longer distances to urban employment centers. Conversely, lower-income populations, particularly those living in urban cores, tend to generate less VMT, but bear a disproportionate share of the environmental and health burdens associated with high VMT, such as air pollution and traffic-related injuries. Meanwhile, VMT reduction measures can either alleviate or exacerbate these inequities.

Evaluate VMT mitigation measures. There are countless strategies to reduce VMT, including improvements to public transportation, land use planning that encourages higher density and mixed-use development, active transportation infrastructure, and pricing mechanisms such as congestion pricing and parking management. This report explores the potential equity implications of these strategies. For example, public transportation investments can improve mobility for disadvantaged populations but may also lead to gentrification and displacement if not paired with affordable housing policies. Similarly, pricing mechanisms like congestion tolls can reduce VMT but may disproportionately burden low-income drivers with fewer transportation alternatives.

Develop a framework for evaluating the equity effects of VMT mitigation measures at the project level. To ensure that VMT mitigation measures are equitable, their effects could be evaluated at the project level during the environmental impact review process. This report develops a framework for evaluating the equity impacts of VMT mitigation measures at the project level, and then applies it to two highway expansion case studies in California: the Yolo 80 Corridor Improvements Project and the I-5 Managed Lanes Project.

Structure of the Report

Following this introductory chapter, we review the literature. In that second chapter, we discuss how transportation equity has been defined and framed, explore the dimensions of transportation disadvantage generally, review the literature on the sociodemographics of VMT generation, review the literature on the equity impacts of VMT and VMT-generating projects, review the literature on the equity effects of VMT mitigation measures, and review the performance metrics used to evaluate VMT-related equity effects. In the third chapter, we summarize the key takeaways from a workshop we convened with experts in transportation equity and analysis. In the fourth chapter, we develop a framework for evaluating the equity impacts of VMT mitigation measures at the project level. In the fifth chapter, we apply our framework to two highway expansion case studies in California: the Yolo 80 Corridor Improvements Project and the I-5 Managed Lanes Project. In the sixth and final chapter, we summarize the key takeaways from the report.

Literature Review

We focus our literature review in the following three areas:

- The relationship between VMT and transportation equity and justice, including the dimensions of transportation disadvantage more generally;
- The types, efficacy, and equity implications of VMT mitigation measures; and,
- Performance measures related to equity, VMT, and State Highway System (SHS) projects.

The rest of the literature review proceeds as follows. We expand on our literature review methods in the first section. In the second through fifth sections, we explore various aspects of the relationship between VMT and transportation equity and justice. Specifically, in the second section, we discuss how transportation equity is defined and framed. In the third section, we explore the dimensions of transportation disadvantage. In the fourth section, we examine the sociodemographics of VMT generation. In the fifth section, we review the literature on the equity effects of VMT and VMT-generating projects. Following that, in the sixth section, we review the literature on the equity effects of VMT mitigation measures. In the seventh and final section, we explore the kinds of performance metrics that have been used to evaluate VMT-related equity effects.

Literature Review Methods

We searched Google Scholar in the fall of 2023 to identify relevant literature regarding the relationship between VMT and transportation equity and justice, the types, efficacy, and equity implications of VMT mitigation measures, and performance measures related to the equity impacts of roadway capacity expansions and associated VMT mitigation measures. In general, across all topics, we focused our literature review on academic journal articles, but included some “gray” literature such as reports from academic institutions, government agencies, or consultants.

To review the relationship between VMT and transportation equity and justice, including the dimensions of transportation disadvantage, we used the following search terms: “relationship” AND “VMT” AND (“transportation equity” OR “transportation justice”).

To find relevant studies on the equity impacts of induced travel or increased VMT on an expanded freeway, we used the following search terms: (“induced travel” OR “induced demand”) AND (“equity” OR “environmental justice” OR “social justice” OR “community impacts”).

To find relevant studies on the impacts of roadway capacity expansion, focusing on the near-term effects caused by construction (e.g., displacement), we used the following search terms: ("highway" OR "roadway" OR "freeway") AND ("expansion" OR "construction") AND ("equity" OR "environmental justice" OR "social justice").

To find relevant studies on the equity impacts of VMT mitigation measures, starting with the following search terms: ("VMT mitigation" OR "vehicle miles traveled" OR "VMT reduction" OR "LOS" OR "Level of service") AND ("equity" OR "environmental justice" OR "social justice"). In order to gain a richer understanding of the types and efficacy of VMT mitigation measures, we relied heavily on Handy et al.'s (2024) report. We also searched for review articles on the six categories of VMT mitigation measures identified by Handy et al. (2024): public transportation, active transportation, road management (i.e., roadway pricing and road diets), transportation demand management, land use, and parking management, we searched for review articles about each of those individual topics.

To find relevant literature on performance measures related to the equity impacts of roadway capacity expansions and associated VMT mitigation measures, we took a three-pronged approach. We first reviewed the literature identified in the searches described above. We also searched Google Scholar using the following search terms targeted at VMT-related scenario analyses that could include equity components: "scenario analysis" AND ("VMT mitigation" OR "VMT equity"). Finally, we canvassed the experts we convened for the workshop.

Definition and Framing of Transportation Equity

Transportation equity is concerned with the distribution of transportation benefits and burdens. While there is no singular definition of the concept, the consensus in the literature suggests that equity can be framed by answering the following three questions: (1) What is being distributed? (2) What is a fair distribution, and on what moral principles is fairness determined? (3) Among whom is the distribution measured? (Karner et al., 2020; Martens, 2017; Pereira et al., 2017; Pereira & Karner, 2021). Transportation equity is a component of the broader concept of mobility justice, which describes the conditions needed for freedom of movement facilitated by and beyond the transportation system, such as through empowering communities in decision making, valuing local knowledge in the design and execution of plans and projects, and ensuring access to high-quality education that eventually leads to informed participation (Bierbaum et al., 2021; Sheller, 2018).

The objects of distribution—that is, the benefits and burdens of transportation—can be analyzed through the dimensions of resources, opportunities and risks, outcomes, and well-being (Martens et al., 2019). From a transportation agency perspective, resource distribution has traditionally been focused on providing mobility; for example, road infrastructure and transit service. However, because transportation is a means to an end rather than the end itself, equity scholars consider destination accessibility as the primary benefit of transportation (Martens et al., 2012; Pereira et al., 2017). The burdens of transportation are numerous: cost, noise, pollution, and inactivity all contribute negatively to health and economic outcomes and are more likely to be shouldered by people of color, low-income individuals, and other marginalized populations (Schweitzer & Valenzuela, 2004).

How fairness is defined in equity debates should be deliberated among a broad group of stakeholders and in the context of a particular plan or project. The approaches for doing so range from agency-led to community-led, all of which have different implicit standards by which results are considered equitable (Karner et al., 2020). A variety of fairness standards have been used or proposed in the academic literature and in practice (Krapp et al., 2021; Lewis et al., 2021; Pereira et al., 2017). While equity as defined in the federal environmental justice standards prior to 2025 (i.e., no disproportionate burdens between "minority" and non-minority populations) is most commonly employed in practice, a capabilities approach, which accounts for the particular circumstances that people must overcome to ensure access to what they need, is a more comprehensive perspective on equity (Pereira et al., 2017).

The third framing question of transportation equity asks among whom the distribution of transportation benefits and burdens are assessed. The populations of concern for which to measure equity can be defined in multiple ways. Typically, these are defined in terms of transportation disadvantaged populations, as we detail below.

Dimensions of Disadvantage

To understand the equity implications of VMT mitigation measures, it is important to lay out the various dimensions of transportation disadvantage. Martens et al. (2019) list the following dimensions of transportation disadvantage: mobility/accessibility, traffic-related pollution, traffic safety, health (Martens et al., 2019). Within each of these dimensions, the possible equity metrics are further categorized into resources, opportunities, outcomes, and well-being. Beyond the physical disadvantages, Luz and Portugal (2020) propose a framework for transport-related social exclusion in which they define the dimensions as physical exclusion, geographical exclusion, exclusion from facilities, economic exclusion, time-based exclusion, exclusion based on perception, space exclusion, and social position-based exclusion (Luz & Portugal, 2020).

Public agencies, universities, and non-profit organizations use a variety of metrics and methods to classify transportation disadvantage (McGinnis & Barajas, 2024). Table 1, extracted from McGinnis and Barajas' 2024 report "Evaluating Transportation Equity Data Dashboards," shows the various methods used to determine disadvantaged communities for the 12 online transportation equity tools that were evaluated in the study. Many use relative or comparative thresholds to determine disadvantage while others use single indicators or a combination of methods. One example of the studied tools is the United States Department of Transportation (USDOT) Equitable Transportation Communities (ETC) Explorer, which was an online tool that was designed to complement the Biden White House's Justice40 initiative that aimed to deliver 40% of benefits related to sustainability projects to disadvantaged communities (USDOT, 2023b). The USDOT ETC includes the following dimensions of what they define as transportation “insecurity”: transportation access, transportation cost burden, transportation safety, and social exclusion. Within the transportation access sub-component, the metrics the tool considers include percent of households with no car, average commute time to work, frequency of transit services per square mile, jobs within a 45-minute drive, and estimated average walk time to points of interest. Within the transportation cost sub-component, the metrics they consider include calculated average annual cost of transportation as a percent of household income, cost of gas, cost of transit, time value of money, time to work, median income, vehicle miles traveled, vehicle finance charges, cost of maintenance, and insurance costs. Within the transportation safety sub-component, the metric they consider is traffic fatalities per 100,000 people.

Several of the California-specific tools listed in Table 1 use CalEnviroScreen 4.0, which uses the definition of disadvantaged communities as outlined in SB 535, which identifies communities where targeted investment from the state’s cap-and-trade program should be directed. CalEnviroScreen 4.0 uses 20 indicators based on pollution burden and population characteristics to create a “CES score” for each census tract in the state. The pollution burden includes exposures and environmental effects as components and the population characteristics include sensitive populations and socioeconomic factors as components (Office of Environmental Health Hazard Assessment, n.d.).

Table 1. Methods of determining disadvantage (McGinnis, C. & Barajas, J.M., 2024).

	Single Indicators			Indices			Thresholds		
Tool	**Title VI**	**EJ**	**Indigenous Land**	**Age**	**Disability Status**	**Percentile Ranked**	**Composite**	**Relative/ Comparative**	**Absolute**
Climate and Economic Justice Screening Tool								X	
USDOT ETC Explorer						X		X	
Screening Tool for Equity Analysis of Projects (STEAP)	X	X						X	
Housing and Transportation Affordability Index								X	
Caltrans Transportation Equity Index (EQI)							X		
Transportation Disparities Mapping Tool			X				X	X	
IDOT Community Impact Assessment Screener								X	
FDOT Environmental Screening Tool			X					X	
Active Transportation Database			X				X	X	
TransitCenter Equity Dashboard									X
Caltrans Smart Mobility Calculator			X				X	X	

Who Generates VMT, How Much, and Why?

This section summarizes the literature's findings about the contributors to VMT, both by population characteristics and by built environment characteristics.

Population Characteristics

Table 2 summarizes the findings regarding the effects of various population characteristics on VMT. Multiple studies indicate that VMT positively correlates with income (Alexander et al., 2021; Emrath & Lui, 2008; Heyer et al., 2020) and being white (Emrath & Lui, 2008; Woldeamanuel & Kent, 2014). More broadly, Alexander et al. (2021) found that disadvantaged communities, as defined by SB 535, had significantly lower VMT than advantaged communities. Disadvantaged communities were also found to have lower scores on their measure of the microscale built environment features, which they refer to as the State Of Place index. The disadvantaged communities were also, on average, less sprawled with higher access to public transit, had a higher percentage of zero vehicle households, and had significantly lower median incomes. They found that sprawled areas with a lower State of Place Index, particularly those inhabited by higher-income households, exhibited the highest levels of VMT.

Akar and Guldmann (2012) and Cook et al. (2015) also examined the geographic correlates of VMT and similarly found lower VMT levels in denser areas. More specifically, Cook et al. (2015) found that residents of the core regions of major metropolitan areas in California tend to have lower levels of VMT, while suburban residents tend to have higher levels of VMT, particularly in southern California. Rural areas showed more variability, with some of the highest VMT found in isolated desert areas in southeastern California and mountainous regions along the Nevada border. The Central Valley also exhibited higher VMT compared to other parts of the state. Fuel consumption followed a similar pattern, with urban areas having lower consumption and suburban and rural areas having higher consumption. Areas north and east of Los Angeles had high fuel consumption due to high VMT despite better fuel economy, while northern California areas had higher consumption due to poor fuel economy. Desert and mountain regions generally have high fuel consumption due to both high VMT and low fuel economy.

Table 2. Effects of population characteristics on VMT.

Population /Characteristic	Change in VMT	Outcomes	Geography	Data source/ Unit of analysis	Reference(s)
Black population per capita	Lower VMT	Disparities in access (hypothesized)	California	2009 NHTS/ household	(Woldeamanuel & Kent, 2014)
Highly educated, suburban	Increase in VMT	More job opportunities, higher wages?	California	2014–2018 American Community Survey (ACS)/ Census tract	(Heyer et al., 2020)
Larger households, contain more workers, higher incomes, home-owners, single-family homes, younger, less well-educated, headed by someone who is male, White, or Hispanic	Greater fuel consumption (proxy for increased VMT)	Greater transportation cost burden	U.S.	2001 NHTS/ household	(Emrath, P. & Lui, F., 2008)
Higher number of vehicles, workers, adults, and children	Increase in per capita VMT	Farther commutes/ higher transportation cost burden?	U.S.	2009 NHTS/ household	(Akar & Guldmann, 2012)
Suburban populations and rural populations	Higher VMT per capita than state average	Farther commutes/ higher transportation cost burden?	California	Private dataset (2000)/ vehicle	(Cook et al., 2015)
Disadvantaged Communities	Lower VMT	Less access to opportunities and options for mode choice	California	CNT's H+T Index and CalEnviroScreen 3.0/ census tract	(S. E. Alexander et al., 2021)

Built Environment Characteristics

The previous section discussed how population characteristics correlated with VMT. The built environment also has a well-documented effect on travel behavior (Ewing & Cervero, 2010; Heres-Del-Valle & Niemeier, 2011). For example, Stevens (2017) conducted a meta-regression analysis using the available empirical literature on the VMT effects of 10 built environment measures. He found that seven measures—distance to downtown, household/population density, job accessibility by auto, intersection/street density, job density, percent of four-way intersections, and distance to the nearest transit stop—were negatively correlated with VMT. The other three measures—land use mix, job accessibility by transit, and jobs-housing balance—had inconclusive or non-statistically significant correlations with VMT. More recently, Handy et al. (2024) assessed the empirical evidence of the effects on VMT of 42 measures that could potentially reduce VMT, including multiple measures related to the built environment. With respect to land use measures, they found strong evidence that residential density reduces VMT, an inconclusive effect of employment density on VMT, strong evidence that land use mix reduces VMT, and moderate evidence that jobs/housing balance reduces VMT.

Transportation infrastructure also affects VMT. For example, Handy et al. (2024) found through their review of the empirical literature that numerous measures related to public transportation and active travel—like transit service frequency, transit stop amenities, bicycle facilities, pedestrian facilities, and bike share and scooter share—can reduce VMT. On the other hand, a vast body of empirical research demonstrates that expanding roadway supply increases VMT. This is the “induced travel” effect—a net increase in VMT across the roadway network due to an increase in roadway capacity. Volker and Handy (2022) recently reviewed the empirical literature on induced travel (Volker & Handy, 2022). The studies they reviewed consistently found an induced travel effect from roadway capacity expansions, even after controlling for a wide variety of other factors affecting VMT and attempting to correct for the endogeneity of roadway capacity. They found short-run elasticities ranging from 0.07-0.76 in the US and 0.07-0.99 across all studies. Longer-run elasticity estimates ranged from 0.26-1.06 in the US and 0.26-1.34 across all studies. Volker and Handy (2022) also examined the difference in elasticity by roadway type, using the Federal Highway Administration’s classification scheme. They found a longer-run induced travel elasticity of close to 1.0 for expansions of the top four largest-capacity roadway types (interstate highways, freeways and other expressways, major arterials, and minor arterials), albeit with a relatively greater elasticity for expansions of interstate highways. They also found that the elasticity of VMT with respect to roadway capacity is likely lower (though not zero) for local roads than for higher road classifications.

What Are the Equity Effects of VMT and VMT-Generating Projects?

VMT is continuing to increase statewide (Caltrans, n.d.), corresponding to an increase in emissions, and therefore contributing to poor air quality which disproportionately burdens low-income communities (Bell & Ebisu, 2012; Rowangould, 2013). Four case studies for Pasadena, Pacoima, Sacramento, and San Jose revealed that highways were mainly placed through communities of color (Loukaitou-Sideris, A. et al., 2023). Even today, people of color are still living in neighborhoods that are closer to the highway (Mahajan, 2023; Manville & Goldman, 2017). Therefore, higher VMT from projects along existing highways will have greater impacts on disadvantaged communities on balance, including vehicular air pollution (Houston et al., 2004; Rowangould, 2013), noise, economic decline, and other negative externalities (see Loukaitou-Sideris et al. [2023] for a summary and related studies). Congestion mitigation has fewer advantages for lower-income groups because low-income workers and travelers travel less by car at peak times due to scheduling and trip distances are often shorter so the benefits of flow improvements are limited (Lachapelle & Boisjoly, 2022). There are some cases in which highway planning could provide benefits to the community through increased accessibility and efficient travel time to nearby areas; however, this would only apply to the portion of the community not impacted by the vacating of land for construction of the highways (Davis & Jha, 2011).

What Are the Equity Implications of VMT Mitigation Strategies?

In reviewing the equity impacts of VMT mitigation measures, we focus primarily on the 42 measures that were evaluated in a concurrent UC Davis project conducted for Caltrans – Methods for Assessing the Effectiveness of Potential Vehicle-Miles-Traveled (VMT) Mitigation Measures (Handy et al., 2024). The purpose of that project was to assist Caltrans in the development and refinement of their "Mitigation Playbook" designed to address induced VMT resulting from highway projects. Handy et al. (2024) organized the 42 measures they evaluated into six categories: public transportation, land use, active transportation, road management, transportation demand management, and parking management. We use those same six categories to organize our review of the equity impacts of VMT mitigation measures, though we focus our review on the 13 measures within those categories for which we found relevant empirical studies, rather than all 42 measures examined by Handy et al. (2024). We also add a seventh category of measures not evaluated by Handy et al. (2024) —VMT fees, which includes in-lieu fees, VMT mitigation exchanges, and VMT mitigation banks, three approaches to VMT mitigation that could become increasingly common, particularly in areas with limited options for implementing actual VMT-reducing projects or policies (Alexander et al., 2021; Fehr & Peers, 2020). Table 3 provides a summary of the mitigation measures we reviewed and their potential equity impacts or outcomes.

Table 3. Mitigation measures and equity impacts/outcomes.

Category	Mitigation Measure	Equity Impacts/Outcomes	Reference(s)
Public Transportation	Improved transit service	Low-income drivers are more likely to become transit riders if transit improves	(Yousefzadeh Barri et al., 2021)
	TNC/transit partnership	Mobility on Demand services may not be equitably distributed among disadvantaged communities who do not have smartphones or bank accounts	(Brown et al., 2021)
	Fares	Low-income transit riders pay 29% more per mile than the higher-income transit riders with flat fare structures.	(Brown, 2018)
	Park-and-ride lots	Can have multiple benefits for regional mobility including: expanding reach of fixed-route transit, improving accessibility to employment, reducing VMT, serving low-income and limited mobility residential regions where it is more affordable to pay to park and commute than move near walkable transit	(Niles & Pogodzinski, 2021)
	Microtransit	Low-income communities have continued to call attention to barriers associated with smartphones, banks, and credit needed to utilize microtransit services	(Karner & Levine, 2021)
Land Use	Transit-oriented development	Affordable housing strategies can be applied to mitigate gentrification concerns	(Alexander et al., 2021; Stone, 2020)
		Low-income communities often overlooked for small improvements that encourage walking/transit use (built environment features such as paths, streetlights, benches)	(Alexander et al., 2021)
		Investment can displace long-term residents	(Chapple & Loukaitou-Sideris., 2019)
	Employment infill/density	Can reduce disparity in locations of housing and employment referred to as “spatial mismatch.” Car ownership programs demonstrate positive effects in reducing transportation challenges and increasing access to jobs	(Fan, 2012)
	Mixed-use development	Mixed-use developments with diverse on-site activities, good transit access, and walkability reduce traffic impacts compared to conventional suburban developments	(Ewing & Cervero, 2010)

Category	Mitigation Measure	Equity Impacts/Outcomes	Reference(s)
Active Transportation	Bicycling/E-bikes	Benefits and burdens of bicycling may not be equitably distributed among populations due to higher crash risk and concentrations of criteria pollutants in disadvantaged neighborhoods	(Braun et al., 2021)
Road Management	Congestion Pricing	Pricing may disproportionately burden low-income populations. However, free roads generate no revenue that can be invested in low-income communities, while road pricing could.	(Levinson, 2010; Manville & Goldman, 2017)
Transportation Demand Management	Car sharing programs	Early findings from EV car sharing program in San Joaquin valley indicate success in providing transportation to low-income rural populations	(Rodier et al., 2021)
Parking Management	Parking pricing	Can include dynamic parking pricing, off-street parking pricing/policies. More analysis may be needed to understand how parking usage relates to income level	(Shaheen et al., 2019; Spears et al., 2014)
Fees	Impact Fee VMT Exchange VMT Bank	Recommendation that these be managed at a regional level, but include local input in order to avoid conflicts between jurisdictions. Another recommendation to develop equity framework to inform the selection of mitigation measures. Suggested similar approach to California's Greenhouse Gas Reduction Fund requirements for benefiting disadvantaged communities and giving weight to prioritize mitigation projects that will also benefit disadvantaged communities	(Alexander et al., 2021; Elkind et al., 2018)

Public Transportation

Transit service improvements

Public transit service improvements to reduce VMT could include any of the following: improved headways or frequency, first-last mile connectivity, transit service coverage, transit-supportive roadway design, and transit reliability. An overall equity concern with public transportation investments is that most existing transit networks are located in urban core areas where poverty is decreasing overall. As a result, public transit investments in existing systems—which tend to constitute the majority of public transit investments (Heyer et al., 2020)—and transit-oriented infill developments are often located in areas where the population of disadvantaged residents is declining. That being said, a recent study of Toronto area residents found that low-income drivers are more likely than higher-income groups to become transit riders if transit improves (Yousefzadeh Barri et al., 2021).

Transportation Network Company/Transit Partnerships

A study in Los Angeles aimed to understand if people use ride-hailing services to get to and from transit stops using data from a LA Metro Mobility on Demand (MOD) pilot program (Brown et al., 2021). The study found that while the pilot program was widely used, the users were more likely to be white, own smartphones, and have bank accounts. Therefore, the benefits of this program were not equitably distributed, as disadvantaged groups were less likely to use the service and benefit from the increased access to transit stops.

Transit Fares

Free or reduced-fare transit passes have potential to increase transit ridership, increase mobility of disadvantaged groups, and provide youth with opportunities to get to school and after-school activities (Saphores et al., 2020). A study of 59 California transit agencies found that the most common programs implemented were for students and the elderly, with only 13 programs for low-income groups and 11 employer-based programs (Saphores et al., 2020). One study suggested that free transit to schools in Los Angeles would decrease unexcused absences by 1 to 5% (Reed et al., 2021). Although free-transit can help encourage ridership, fare programs alone are not a solution. When a free bus service was offered for youth in Malaysia, ridership did not increase due to the service being unreliable (Reed et al., 2021). Supplemental programs are needed to successfully implement free or reduced-fare transit passes. A 2020 study found that student programs funded by student fees and employee programs funded by employers did not have a negative impact on ridership or agency fund recovery ratios which indicates free or reduced-fare transit pass programs where large groups of potential transit riders pay a fee to a transit agency while a subset of group uses the transit service can be beneficial to both riders and agencies (Saphores et al., 2020). A study in Los Angeles using the California Household Travel Survey to investigate how equitable the current flat fare structure of LA Metro compared to variable fare structures found that low-income transit riders pay 29% more per mile than the higher-income transit riders (Brown, 2018). The same study found that any type of fare variation improves equity compared to the flat fare option. King and Taylor (2022) noted the same concern in their synthesis of the research on transit service and pricing. Deductions on flat fares for low-income riders can be helpful. However, these reductions are still inequitable due to the differences in distances traveled by each income group (Brown, 2018).

Park-and-Ride Lots

Park-and-Ride lots can have multiple benefits for regional mobility—including expanding the reach of fixed-route transit and making employment opportunities more accessible, reducing VMT by limiting driving into city center transit destinations, serving low-income and limited-mobility residential regions where it is more affordable to pay to park and commute than move near walkable transit—and they can be combined with Transit-Oriented Development to separate commuter vehicles from pedestrians and bicycles (Niles & Pogodzinski, 2021). Studies of transit stops in San Jose, Seattle, and Los Angeles revealed that the presence of 100 parking spaces in an existing Park-and-Ride lot had a stronger positive impact on ridership than the existence of 100 housing units (Niles & Pogodzinski, 2021).

Microtransit

Microtransit is an emerging on-demand transportation mode that offers shared rides through flexible routing and scheduling, potentially filling gaps in traditional transit services. Public transportation agencies in the US are exploring microtransit to enhance transit systems and accommodate rider needs. One study used a large-scale survey to explore the factors that influence the use of the Sacramento Regional Transit (SacRT) SmaRT Ride (SR) microtransit service in Sacramento, California (Xing et al., 2022). The study found that that age and education were negatively associated with the choice of SR, while physical conditions, attitudes toward microtransit, perceived time savings, and social support also affected SR use.

Microtransit solutions have the ability to reduce gaps in service, an example being Pickup, which offered door-to-door service as a complement to public transportation in a residential area. Houston METRO also created Community Connector in northwest Houston to serve a community impacted from a network redesign which complemented the fixed-route service and helped residents connect to transit in areas that did not have sufficient pedestrian infrastructure. Although these solutions can be helpful, low-income communities have continued to call attention to barriers associated with smartphones, banks, and credit needed to utilize the services (Karner & Levine, 2021).

Land Use

Transit-Oriented Development

Transit-oriented development (TOD) creates more dense, mixed-use development near transit in order to support sustainable communities. TOD focuses on developing around transit that can increase ridership, which can in turn decrease VMT. Researchers found that people living in TOD areas in Washington, D.C., reduced their VMT by 38% and Baltimore TOD residents reduced their VMT by 21% (Nasri & Zhang, 2014). The main concern surrounding TOD is transit-induced gentrification—the process whereby investment or development in a neighborhood increases property values and rents, which then causes displacement of current residents and businesses, an increase in the proportion of high-income households, and a reduction in the proportion of non-White residents. Gentrification can be difficult to measure and different indicators and studies can produce conflicting results. For example, one study found that, on average, median income household income, housing prices, and rent values increased more rapidly in transit neighborhoods than non-transit neighborhoods, and that 12% of transit neighborhoods in the Bay Area and 8% of transit neighborhoods in Los Angeles experienced residential gentrification (Chapple & Loukaitou-Sideris, 2019). Another study of three TOD projects in Sacramento found only mixed and "medium" evidence of gentrification (DeLeon et al., 2024). Meanwhile, multiple studies have found that TOD does not, on average, increase displacement of existing residents beyond existing residential turnover rates (Asquith et al., 2019; Chapple et al., 2017; Chapple & Zuk, 2020; Chatman et al., 2019; Mast, 2019; Phillips et al., 2021). Another study examined the total housing plus transportation costs of living in TODs and found that low-income households benefit income-wise from living in TODs because while the housing costs might increase, the transportation costs decrease (Renne et al., 2016).

A few anti-displacement strategies include the creation of affordable housing, preservation of already existing affordable housing, renter protections, and neighborhood stabilization. There are two main focuses when it comes to neighborhood stabilization and they include people-focused strategies and strategies focused on place and housing units (Chapple & Loukaitou-Sideris, 2019). People-focused strategies may include rental/foreclosure assistance, right to return policies, relocation benefits, or tenant counseling. Strategies focused on place and housing units might include condominium conversion restrictions, rent regulation, no-net-loss or one-for one replacement, and community land trusts.

Employment infill/density and mixed-use development

Improving access to jobs may help reduce VMT. One study examined the impact of workplace employment density on commute mode choice and VMT for personal commercial activities, finding that higher workplace density correlates with reduced automobile commuting and personal commercial VMT (Chatman, 2003). The results suggested that prioritizing employment density in land use planning could be more effective in reducing VMT than current practices, although further research is warranted on related factors such as parking costs and transit service. The disparity in locations of housing and employment has been referred to as "spatial mismatch." A review article that evaluated the successes and failures of spatial mismatch mitigation strategies, categorized them into four groups, including land use, economic development, housing, and transportation (Fan, 2012). While empirical evidence on most strategies remains inconsistent, car ownership programs consistently demonstrate positive effects in reducing transportation challenges and increasing access to jobs. Improving the balance of housing and jobs has the potential to decrease VMT, and a jobs/housing balance is important to ensure employment accessibility in efforts to reduce car dependency. However, who benefits from an increase in employment density depends on the kinds of jobs attracted to the area. There is also the risk that employment densification could displace existing residents in the area.

Active Transportation

Bicycling facilities and e-bikes

While cycling generally promotes public health, this may be counterbalanced by spatial variation in the risks of cycling. A study in Los Angeles County aimed to understand the health risks of cycling through an equity lens. They considered both crash risk and PM2.5 concentrations spatially for various sociodemographic groups. They found that the health risks are disproportionately high for disadvantaged neighborhoods. They also found that the benefits of cycling still outweigh the risks in these areas (Braun et al., 2021). However, the benefits and burdens of cycling are not equitably distributed among the communities in LA County.

E-bikes power and speed allow for quicker travel times from farther distances. This can be especially helpful when traveling from distant neighborhoods into the Central Business District (CBD) or other important destinations. A study focusing on the effect of including e-bikes for Indego, a bikeshare program, found that e-bikes increased the overall usage of Indego especially in disadvantaged areas which signifies integrating e-bikes promotes bikesharing usage in disadvantaged communities (Caspi, 2022). The same study also found that the average e-bike trip length and time was higher than in disadvantaged communities which means people in disadvantaged areas use e-bikes to reach further destinations.

Road Management

Road pricing strategies to reduce congestion or VMT can include area-wide pricing, cordon pricing, and facility-specific pricing. Pricing strategies can, in theory, reduce VMT and congestion, but only if the prices are high enough. Those strategies could thus theoretically benefit those people of color and lower-income households living close to the tolled area or facility. However, the empirical evidence indicates that pricing strategies tend to disproportionately benefit higher-income people (Levinson, 2010). Manville and Goldman (2018) found that people living in “freeway dominated” Census block groups drive less, are less likely to commute by personal auto, and are much less likely to own vehicles than people living in Census blocks without freeways. They also found using the Census’ Integrated Public Use Microdata Sample survey data that commuters in poverty are both less likely to drive than non-poor commuters and less likely to drive during the morning peak period, which is when the primary automobility benefits from pricing programs would theoretically be realized, in the absence of significant induced VMT (Manville & Goldman, 2018). This indicates that the primary putative benefits of pricing strategies flow disproportionately to higher-income people. Congestion mitigation has fewer advantages for lower-income groups because lower-income workers and travelers travel less by car at peak times due to scheduling and trip distances are often shorter so the benefits of flow improvements are limited (Lachapelle & Boisjoly, 2022).

In the same way that lower-income people are less likely to benefit from pricing-based congestion mitigation, they are also less likely to be burdened by any tolls imposed (Manville & Goldman, 2018). Pricing strategies remain nominally regressive—they are relatively more expensive at the margins for lower-income drivers. But pricing is less likely to affect lower-income than higher-income drivers because tolls are usually imposed—or are at least more expensive—at peak commute hours when lower-income drivers are less likely to drive.

Furthermore, tolling revenues can be used to help offset the residual burden imposed on lower-income drivers, such as by subsidizing non-auto travel modes or providing a mode-agnostic transportation credit to lower-income households that could even be used to pay for roadway tolls, such as suggested by Manville et al. (2022). However, tolling revenues are usually used first and foremost to cover the construction and/or operation costs of the tolled facilities, which can leave little left over for public transit subsidies or other purposes, as Lee (2023) recently detailed through interviews with multiple policy actors.

On a broader level, tolling is a less regressive way of funding transportation infrastructure than some other funding mechanisms when considering the effects on all lower-income residents in a region, rather than just lower-income drivers. For example, Schweitzer and Taylor (2008) compared the cost burdens on lower-income residents of a tolled road in Orange County (State Route 91) and the county's local option transportation sales tax. The found that, on average, lower-income residents pay more out-of-pocket with a sales tax.

Transportation Demand Management

Car-sharing programs

One study reviewed existing literature on the climate benefits and necessity of carsharing services in underserved areas, while also examining the evolution of carsharing in the U.S., including non-profit and for-profit models, as well as recent government-funded initiatives (Rodier. et al., 2021). The findings emphasize the potential of electric car sharing to reduce emissions and improve equity, but also highlight challenges such as the concentration of for-profit services in affluent urban areas and the limited success of electric carsharing due to infrastructure challenges. Lessons learned underscore the importance of rigorous evaluation, sustainable funding mechanisms, and the potential of non-profit models to expand service beyond commercial boundaries and improve accessibility in marginalized communities. However, there remains a need for further research and financial support to fully realize the benefits of electric car sharing programs.

Another report listed early findings from an electric vehicle (EV) carsharing pilot called Míocar that was launched in rural disadvantaged communities in California's San Joaquin Valley in August 2019 (Rodier et al., 2021). The report notes that in rural areas, providing cost-effective transit service is a challenge due to longer travel distances, lower population densities, and limited transit options compared to urban areas, and many residents rely on personal cars for essential needs such as work, healthcare, and education. However, maintaining a car can consume a significant portion of the household budget, especially for low-income families. To address these challenges and reduce greenhouse gas emissions, Míocar aimed to offer affordable mobility options and reduce emissions by placing round-trip EV car sharing hubs in affordable housing complexes. This report summarizes data collected during the 10-month operational ramp-up of the Míocar service, providing insights into member characteristics, vehicle use patterns, and the impact of the service on travel behavior. Initial findings suggest that Míocar attracts members with lower incomes who rely on the service for essential trips, with many reporting that without Míocar, they would not have been able to reach their destinations. The pilot also sparks interest in electric vehicles among users, despite low rates of EV ownership in the region. Finally, the report notes that evaluation is needed to understand the long-term viability and potential benefits of rural EV car sharing programs (Rodier et al., 2021).

Parking Management

Charging for parking can be nominally seen as a regressive tax, in that it is relatively more expensive at the margins for lower-income drivers. But the aggregate effect can be much different. For one, lower-income commuters are less likely to drive to work than higher-income commuters (Manville & Goldman, 2018), and they are also less likely to own vehicles in general (Currans et al., 2023). This indicates that lower-income households are less likely to be affected by parking pricing in general. However, that does not change the fact that charging for parking burdens lower-income drivers more than higher-income drivers at the margins.

Lower-income drivers might also be relatively more affected by pricing street parking. Chatman and Manville (2018) examined the effects of SFpark on lower-income drivers and found that lower-income people are overrepresented among street parkers. Using race and ethnicity as a proxy, they found that Black and Hispanic drivers were overrepresented at meters by about double their population share. However, they did not find evidence that the pricing scheme displaced lower-income drivers (e.g., forced them to park further away, which can trigger safety concerns in higher-crime areas). They concluded that higher prices made lower-income drivers less likely to use street parking, but also less sensitive to prices if they did park on the street, possibly because their trips were less discretionary than those of higher-income street parkers.

While parking pricing programs can disproportionately burden lower-income drivers at the margins, they can also be used to promote transportation equity by compensating those who are most overburdened or subsidizing non-auto travel modes. For example, parking cash-out programs in California must subsidize alternatives to parking (like transit, bicycling, and walking) as much as they subsidize parking (Shoup, 1997). Beyond the workplace context, local governments can use revenue from metering on-street parking to fund alternative transportation modes. San Francisco, for example, uses its parking meter revenue to subsidize public transit (Pierce & Shoup, 2013).

Fees

Though various fees such as VMT impact fees, exchanges, and banks were not included in the initial list of categories from the concurrent UC Davis project (Methods for Assessing the Effectiveness of Potential Vehicle-Miles-Traveled (VMT) Mitigation Measures), they were mentioned in a few reports that were found in the process of this literature review. Therefore, we include them in our findings for discussion purposes. A study mentioned in previous sections that used a mixed methods approach to understand the best practices for off-site environmental mitigation strategies used the example of wetland impacts to understand the types of mitigation strategies that are used (Alexander et al., 2021). They found that wetland impact mitigation strategies include the following three mechanisms: permittee-responsible mitigation, mitigation banks, and in-lieu fee mitigation. Permittee-responsible mitigation requires the contractor to restore, establish, enhance, or preserve aquatic resources. However, the other two mitigation strategies could be more applicable to VMT. Mitigation banks and in-lieu fee agreements refer to the use of a credit system to compensate for expected impacts and funding public agencies and non-profit organizations who are involved with mitigation strategies, respectively. Another report lists a third mitigation strategy as “exchange” rather than a “bank,” in which a contractor could agree to implement a predetermined VMT reduction project or propose a new project (Fehr & Peers, 2020). Another report that discusses the pros and cons of VMT banks and exchanges provides a few equity considerations (Elkind et al., 2018). The report emphasizes the need for equitable distribution of impacts and mitigation, suggesting approaches similar to California's Greenhouse Gas Reduction Fund, which requires that a percentage of funds be directed towards benefiting disadvantaged communities. It proposes using CalEnviroScreen data to identify vulnerable communities and suggests incentivizing mitigation projects in those areas. Additionally, it recommends giving weight to prioritizing mitigation projects that will benefit disadvantaged areas.

Overall, Alexander et al. (2021) recommend that these fees be managed at a regional level, but include local input in order to avoid conflicts between jurisdictions. They also recommend developing an equity framework to inform the selection of mitigation measures. To ensure an equitable distribution of impacts and mitigation, the Elkind et al. (2018) suggest a similar approach to that used for California’s Greenhouse Gas Reduction Fund’s requirements for benefiting disadvantaged communities—giving weight to prioritize mitigation projects that will also benefit disadvantaged communities.

Performance Measures Related to Equity, VMT, and State Highway System Projects

Current Metrics

Traditionally, the transportation industry has relied solely on measures of congestion such as LOS and volume to capacity (V/C) ratios to inform both travel time and congestion mitigation benefits of programmed projects. With the passage of SB 743, California is in the process of transitioning to the use of VMT to replace LOS under CEQA analysis. However, many jurisdictions within California are continuing to use LOS for other analyses outside of CEQA (Volker et al., 2023). When LOS is used as the reference unit for mobility, it values decreased vehicle delay and evaluates investments based on which option can increase vehicle travel at least cost. The improvement of LOS and reduction of congestion is widely used across the U.S to demonstrate environmental benefits of various transportation projects (Volker et al., 2019a).

For example, a case study of three highway expansion projects in California found that congestion/LOS was the primary performance measure and motivation in all three cases (Lee, 2023). Another study based in Tampa, Florida, found that a planned freeway expansion slightly lowered the daily NOx emissions. However, during peak periods the expansion was found to increase emissions and pollutant concentrations. The study also noted that further analysis would need to be done to understand equity impacts. However, under the planned expansion scenario, the study found disproportionately high exposures to people living in poverty and to Tampa's Black community and disproportionately low exposures for high-income and white people (Kocak et al., 2021).

Additional performance measures that can be used for SHS projects are listed in the Transportation Performance Management (TPM) Implementation Plan that was developed by the USDOT and Federal Highway Administration (FHWA) (USDOT & FHWA, n.d.). The metrics listed in this plan focus on meeting Federal performance management requirements as aligned with the Moving Ahead for Progress in the 21st Century (MAP-21) and Fixing America's Surface Transportation (FAST) Acts. Under the MAP-21 and FAST Acts, Congress directed FHWA to develop performance measures to support six out of the seven goals established in the two acts. The performance measures listed within the TPM Implementation Plan apply to seven different categories including safety, pavement condition, bridge condition, performance of the National Highway System (system performance), freight movement, traffic congestion, and on-road mobile source emissions. System performance measures include percent of person-miles traveled on the interstate that are reliable as a measure of interstate travel time reliability and percent of person-miles traveled on the non-Interstate NHS that are reliable as a measure of non-Interstate travel time reliability. Performance measures for traffic congestion include annual hours of peak hour excessive delay per capita and percent of non-single occupancy vehicle travel.

Issues with current metrics

Under the umbrella of induced travel, debates persist regarding the effectiveness of highway expansions in providing long-term congestion relief among state actors (Lee, 2023), despite substantial evidence that, on average, highway expansions produce commensurate increases in VMT (Volker & Handy, 2022). Concerns over displacement further complicate highway expansion justifications, with divergent beliefs among policy actors regarding environmental justice and equity outcomes (Lee, 2023). While some argue that highway expansion reduces congestion and improves transportation equity by shortening commutes for low-income individuals, others view it as perpetuating environmental racism and housing segregation. Moreover, Lee (2023) found that the programming of five major metropolitan regions in California primarily fund autocentric infrastructure, therefore finding that state goals to reduce greenhouse gas emissions often clash with locally funded highway expansions.

Roles of scenario analysis and planning for transport equity concerns

Our literature review revealed that there was almost no academic literature that directly employed scenario analysis or planning approaches to understand their predicted scenario outcomes or forecast on equity in VMT mitigation, although there were a few studies that attempted to theorize these effects as a part of discourse analyses. A report by Caltrans (2021) on transportation-related equity indicators identified five critical elements of the equity analyses—population variables, spatial or geographic-based variables, numerical thresholds, analysis level, and geographic unit of analysis—which can also be used as equity assessment measures in scenario analysis (Caltrans, 2021). Nevertheless, there has been very little research on how project-specific scenario analysis—particularly scenarios for State Highway System expansion projects—can be evaluated in terms of equity or what specific indicators planners should use as equity assessment measures in scenario analysis for SHS expansion projects or VMT mitigation measures. As a result, to develop our project-level equity evaluation framework, we also reviewed more general recommendations for equity-related key performance indicators (KPIs), like the US Department of Transportation's former Justice40 KPI recommendations (USDOT, 2023b) and drew inspiration from the workshop we convened.

Workshop with Practitioners

A workshop with transportation practitioners was held on August 28, 2024, with a focus on gathering input that could be used in the scenario analysis as well as holding broader discussions around equity and VMT mitigation measures. Attendees included transportation professionals from Caltrans, a large metropolitan planning organization in California, and a large environmental advocacy organization. The workshop consisted of a focus-group style discussion around two central themes: (1) the challenges and opportunities that government agencies face when addressing equity regarding transportation projects, and (2) options for equity performance metrics and their use at the project level.

Transportation Equity in General: Challenges and Opportunities

The first theme focused more broadly on transportation equity and the challenges that transportation agencies face when addressing equity concerns in the planning, programming, and delivery of roadway expansions, including issues related to induced travel and VMT mitigation. During discussions on this theme, we also asked the attendees what potential opportunities or solutions exist to improve equity outcome regarding roadway capacity expansions.

Challenges

A broad challenge that came up was the assumption made by agencies that roadway capacity expansion projects are inevitable. Additionally, in terms of equity, there is often an assumption that these projects will have negative impacts, rather than considering how they could potentially benefit historically marginalized communities. Attendees noted that state agencies and MPOs should prioritize projects that reduce VMT from the outset, such as investing in rail, transit, biking, walking, and electrifying the transportation system to minimize pollution and environmental impacts. The discussion also highlighted the historical challenges associated with roadway expansion projects, as many highways were originally sited in ways that disproportionately affected low-income communities of color. As a result of this, historically marginalized communities often continue to bear the brunt of the negative impacts of current roadway capacity expansion projects.

No standard way of defining or measuring equity

Equity is still an emerging topic within transportation agencies and there are differences between how the various agencies define and measure equity. Additionally, modeling the effects of an expansion project within the broader transportation system is difficult and the effects may not be captured effectively. Communicating impacts between different agencies that have different modeling systems is a challenge when assessing impacts to communities on a project level.

Key performance indicator (KPI) and data gaps

Choosing appropriate KPIs for equity creates additional challenges as transportation is often shaped by the personal experiences and mobility needs of individual travelers. While impacts are typically assessed at the community level, this approach does not always capture the effects on individuals. Though the industry is moving toward better alignment on KPIs for equity, there is still a challenge with lack of data and choosing KPIs that assess real impacts on people.

Timing for both assessing equity impacts and for equitable engagement

A challenge around public engagement that was discussed is that it is often very limited or non-existent in the planning phase of roadway expansion projects.

Additionally, the length of projects was mentioned as a challenge, as projects may range from five to ten or more years from project initiation to completion. This long duration of projects creates a challenge for both equitable engagement timing as well as planning out mitigation strategies. In addition to this, being able to accurately disclose a mitigation measure within CEQA documents adds complexity due to the long-term planning nature.

Costs associated with VMT mitigation

VMT mitigation adds to the total expense of projects, potentially decreasing the overall number of projects that can be completed. One attendee mentioned that transportation demand management (TDM) strategies seemed to be the most cost-effective mitigation measure to include, while sidewalk improvements or cycling infrastructure tend to be more costly.

Lack of funding and resources for equity assessments

Within the planning phase, there are limited resources for preparing documents regarding expected equity impacts. In the delivery phase, agencies are still navigating how to gather information about what the equity impacts are and what analyses to perform to assess these impacts. Additionally, they face the challenge of understanding how to address equity through VMT mitigation strategies.

Governance

Another challenge that was discussed was that VMT-reducing projects may fall outside or be perceived as falling outside of Caltrans' purview, creating a challenge of governance. For example, housing or transit projects may be seen as part of the scope of other agencies. Additionally, the various transportation agencies have different core objectives. To combine these core objectives with the focus on VMT mitigation, while also considering equity, adds additional complexities.

Opportunities/Solutions

KPIs/Equity Assessment

One suggestion around equity assessment was the possibility of assessing impacts more programmatically or on a statewide scale. Through a combination of various planning documents, highway capacity expansion projects and their expected induced VMT could be calculated using the NCST induced VMT calculator in order to get a sense of the overall induced VMT in the state as well as associated locations. In combination with geographic filters designating equity priority communities, induced VMT and equity impacts could be evaluated.

It was then suggested that this could have potential for a baseline approach, as equity assessments need to address the unique needs of the specific communities that will be impacted. All communities are different, but if there was a baseline or standard starting point for equity analyses to understand impacts or even potential benefits, it could help with alignment on the topic.

Timing for engagement

The next discussion focused on the timing of public engagement in terms of when would be most effective to get input that could be translated into what gets built. One suggestion was made that engagement regarding mitigation measures would make more sense closer to the end of the project, considering the long duration of the planning phase for roadway projects. Another suggestion was that engagement would be useful during at least two different points of a project—during the planning phase as well as one or two years before construction. Engagement during the planning phase is very important when considering the general scope of the project and outlining potential mitigation measures. Engagement one or two years before construction is also important as communities—and the project—can change significantly over the course of five to twelve years (a common range of project planning timelines).

Strategies for equitable engagement

The group then discussed effective ways to conduct constructive outreach that can reach the communities that would be affected by expansion projects and get more individual feedback—meet people where they are—versus looking at broad aggregate indicators.

One suggestion for equitable public engagement was made around choosing the location for public meetings. In an example project mentioned by one of the participants, locations for public meetings were selected based on an origin destination (OD) analysis and correlation to locations of disadvantaged communities based on the OD analysis. Additionally for that same project, they are planning to translate their project fact sheets so they are available in multiple languages.

Community engagement over a longer time period was another suggestion for equitable engagement. An example was given of a project that hired a consultant who specifically worked to engage community members that would remain in correspondence about the project over a longer time period. This could help build relationships with community members who are willing to be involved. Additionally, partnerships with community-based organizations (CBOs) who have insight about how to better reach and serve certain communities can aid in more equitable public engagement. CBOs can also help to translate technical documents to be more digestible to the community. However, it is also important to ensure a representative sample of CBOs.

A final suggestion was made that creativity around engagement tools can be helpful. One project used a mapping tool in which people could add a pin and note where problems are located, and other people could "like" the pins. This offered an opportunity for the community to participate outside of in-person meetings.

Performance Metrics for Equity

The second discussion themes focused on performance metrics for equity, principally at the project level. This discussion focused on how priority populations are determined for equity-enhancing projects, how equity is evaluated at the project level for roadway capacity expansions and their associated VMT mitigation measures, and what opportunities there are to use the Caltrans Equity Index (EQI) tool and other equity tools. We also discussed what equity impacts and measurement methods are most important to the attendees and their associated agencies, which projects should be included in our case studies focused on VMT mitigation, and which equity metrics they recommended to be included in our case study analyses.

Overall, there was a consensus that there is no established or widely accepted method for assessing equity at the project level. Additionally, the Caltrans EQI is relatively new, and many employees are still unfamiliar with it, emphasizing the need for education and training on the tool.

One suggestion for determining priority populations or disadvantaged communities referenced the earlier discussion on conducting OD analyses and overlaying maps of disadvantaged communities. Additionally, new tools like Streetlight data were mentioned as valuable resources for understanding how people in disadvantaged communities travel, including where residents work and the modes they use. For example, Streetlight uses cellphone data to assess travel patterns. Using location-based data or other sources to analyze travel patterns, in combination with tools like the Caltrans EQI, could provide valuable insights into community needs and help assess accessibility or identify inequities. This approach can also evaluate how a project could affect those inequities. However, implementing these types of analyses would require additional time and resources.

The attendees also discussed challenges around measuring VMT reductions, especially for communities that may not produce significant VMT, but still experience the externalities of it. The discussion also highlighted the need to balance reducing VMT with addressing the inequities caused by transportation infrastructure, including how to support non-driving populations and ensure more equitable distribution of transportation resources.

Attendees suggested several options to consider for the case study analyses, including a safety comparison of the modal options, cost comparison of modal options, access to affordable housing within a reasonable-distance active transportation route to their jobs, schools, healthcare facilities, and grocery stores. Another suggestion was to consider impacts to pedestrian and cyclist safety as a metric. Many drivers may use parallel routes to roadway capacity expansion projects to avoid congestion which may have negative impacts on adjacent disadvantaged communities as well as pedestrians and cyclists. Additionally, the six equity metrics included in the "mobility wallet" report (Romero, 2024) were discussed: demographics of current carpoolers, transit mobility, affordability, environmental exposure and resilience, public participation, and pedestrian and cyclist safety.

Overall, the discussion emphasized the importance of tailoring solutions to the specific travel patterns and unique needs of individual communities, rather than applying a one-size-fits-all approach to VMT mitigation measures.

Framework for Evaluating the Equity Effects of VMT Mitigation Measures

Operationalizing Equity Metrics in Response to the Implementation of VMT Mitigation Measures

From the context of this project, operationalizing the equity metrics in response to VMT mitigation measures can be defined as the process of defining, measuring, and applying equity-focused indicators to assess and address the distributional impacts of strategies aimed at reducing VMT (Mineta Transportation Institute, 2024). Specifically, it involves establishing concrete metrics to analyze how VMT mitigation measures affect different population groups, particularly those historically disadvantaged or vulnerable to negative externalities of highway expansions (e.g., additional exposure to the burdens of increased vehicular traffic, such as air pollution, crashes, and noise).

Very few studies, reports, or standards we reviewed explored metrics for assessing the equity effects of measures to mitigate vehicle miles traveled (VMT), specifically. As a result, we reviewed more general recommendations for equity-related key performance indicators (KPIs), like the US Department of Transportation's former Justice40 KPI recommendations (U.S. Department of Transportation, 2023). We also reviewed recent evaluations of community impact assessment procedures and equity impact assessment tools (Barajas et al., 2022; McGinnis & Barajas, 2024; Nguyen & Barajas, 2023). In addition, we drew inspiration from the workshop we convened. While there are many ways to operationalize equity impact metrics, we focus on simple methods that could be implemented relatively easily during or in conjunction with project-level environmental impact analysis. These metrics are summarized in Table 4, which identifies five categories of metrics, describes the specific metrics we propose using for each category, and identifies data sources and tools to use for each metric. Note that several federal datasets that were available prior to 2025 have either been archived or are presently unavailable.

Table 4. Equity metrics used with respect to VMT mitigation measures.

Equity Metrics	Description	Overarching Question(s) to Ask for Evaluation of the EIR Documents	Equity Analysis Tools
Disadvantaged Community	Area-based definition of disadvantaged populations. Measured in a variety of ways, often using socioeconomic characteristics, environmental justice burdens, transportation burdens, and other indicators of vulnerability. Different indicators may highlight different aspects of disadvantage.	• Will the VMT mitigation measure be implemented in a disadvantaged community?	• Caltrans EQI • CEJST Tool (archived) • USDOT ETC Explorer (archived) • CalEnviroScreen 4.0 • CDC Social Vulnerability Index
Displacement/ Gentrification	Area-based index of the susceptibility of a neighborhood to gentrification, residential displacement, and business displacement. It may be a leading indicator (a neighborhood is susceptible to gentrification or displacement from broader forces) or a lagging indicator (a project would cause a change in the gentrification or displacement susceptibility).	• Longer-term residential gentrification: Would the VMT mitigation measure be implemented in an area with a high risk of gentrification? • Residential displacement near the VMT mitigation measure sites: Would the VMT mitigation measure cause physical displacement of existing businesses, e.g., via redevelopment, buyout, or eminent domain? If so, (1) how many housing units would be displaced? And (2) how many residents would be displaced? • Business displacement near the VMT mitigation measure sites: Would the VMT mitigation measure cause physical displacement of existing businesses, e.g., via redevelopment, buyout, or eminent domain? If so, (1) how many businesses would be displaced? And (2) what kinds of businesses would be displaced?	• Urban displacement project – CA map

Equity Metrics	Description	Overarching Question(s) to Ask for Evaluation of the EIR Documents	Equity Analysis Tools
Access	Access measures the potential for interaction. Measures should include access to key destinations, such as jobs, and important non-employment sites, like grocery stores. It may also include the ability to access transportation options.	• Would the VMT mitigation measure increase accessibility to jobs? • Would the VMT mitigation measure increase accessibility to grocery stores (one example of basic services)?	• Conveyal Analysis
Community Approval/ Engagement	Assesses the degree to which affected communities are involved in planning the mitigation measures along a continuum from information sharing to community ownership.	• How has the VMT mitigation measure been received by community members in the area where the measure would be located? • What is the level of engagement and/or empowerment with the community for examining scenarios and evaluating their equity outcomes in transportation projects affected?	• Quantitative metrics of outreach and engagement (number and locations of meetings held, comments received, groups engaged) • Qualitative metrics of outreach and engagement (assessment of comments received, assessment of community engagement along empowerment models [e.g., Spectrum of Community Engagement, Arnstein's ladder of citizen participation])

Equity Metrics	Description	Overarching Question(s) to Ask for Evaluation of the EIR Documents	Equity Analysis Tools
Geographical and Spatial Equity	Geographic equity gauges how the benefits and burdens of transportation projects are distributed geographically, without necessarily considering community characteristics. Spatial equity considers community characteristics in the geographic distribution of projects.	• Would the VMT mitigation measure be implemented in the same community as the primary project? • If not, using the CalEnviroScreen Indicator Maps or an equivalent tool: (1) Would the VMT mitigation measure be implemented in an area with higher, lower, or equal poverty levels as the site of the primary project? (2) Would the VMT mitigation measure be implemented in an area with higher, lower, or equal ozone levels as the site of the primary project? (3) Would the VMT mitigation measure be implemented in an area with higher, lower, or equal PM2.5 levels as the site of the primary project? (4) Would the VMT mitigation measure be implemented in an area with higher, lower, or equal vehicular traffic density levels as the site of the primary project?	• CalEnviroScreen Indicator Maps • Transportation Disparities Mapping Tool

Below is a detailed discussion of how each category of equity metrics can be operationalized for use in assessing the equity effects of VMT mitigation measures at the project level.

Options for Identifying Disadvantaged Community Metrics Using Equity Analysis Tools

Indicators of disadvantaged communities identify areas where the population faces burdens associated with socioeconomic characteristics, environmental exposure, health outcomes, and similar factors. Multiple options exist for defining and identifying disadvantaged communities; there is no standard measure for doing so. Different tools focus on or weight more highly certain metrics that comprise a disadvantaged community definition. Nevertheless, multiple tools currently exist in wide practice to identify disadvantaged communities in California. Two such tools include the Caltrans Transportation Equity Index (EQI) and CalEnviroScreen 4.0 developed by the California Office of Environmental Health Hazard Assessment. Two additional federal government tools, the USDOT Equitable Transportation Community (ETC) Explorer and the Council on Economic Quality Climate and Economic Justice Screening Tool (CEJST), are no longer available as official data sources but have been archived for non-federal government use.

The Caltrans EQI spatial tool uses multiple "screens" to identify disadvantaged communities at the census block level, which are known as transportation-based priority populations. This definition of disadvantage emphasizes the benefits (access to destinations) and burdens (exposure to traffic volume and crashes) of transportation together with two demographic criteria: low-income status, which includes households earning at or below 80% of the statewide median income, and proximity to tribal lands (Caltrans, 2024a). An area must meet the criteria for access to destinations, traffic exposure, and demographics to be identified as a transportation-based priority population area.

CalEnviroScreen 4.0 is an environmental justice tool designed to identify disadvantaged communities by assessing both pollution burden and population vulnerability. It uses indicators such as air quality (ozone, PM2.5), diesel particulate matter, drinking water contaminants, pesticide use, toxic releases, and traffic impacts, revealing environmental stressors these communities endure (California Office of Environmental Health Hazard Assessment, 2021). The tool's Pollution Burden component measures exposure and environmental degradation, including indicators like diesel emissions, water contaminants, and proximity to cleanup and hazardous waste sites, showing the proximity and intensity of pollution that communities face. The Population Characteristics component focuses on community vulnerability through health and socioeconomic indicators, such as asthma and cardiovascular disease rates, poverty levels, unemployment, education attainment, and housing cost burden. Together, these indicators highlight communities with limited capacity to cope with pollution impacts and increased sensitivity to environmental risks. By providing cumulative scores, CalEnviroScreen enables precise identification of communities most affected by both environmental and socioeconomic disadvantages. State law further defines disadvantaged communities by CalEnviroScreen scores. Pursuant to Senate Bill 535 (2012), CalEPA defines disadvantaged communities as those that have the highest 25% of overall CalEnviroScreen scores, those without overall scores but that have the highest 5% of cumulative pollution burden, those defined as disadvantaged in the previous version of the definition, and Tribal lands (California Environmental Protection Agency, 2022).

The former USDOT ETC Explorer identifies disadvantaged communities using five core factors—transportation insecurity, environmental burden, social vulnerability, health vulnerability, and climate and disaster risk burden. The tool assesses transportation insecurity by measuring access factors like household car ownership, transit frequency, commute time, and job accessibility. The tool assesses environmental and health vulnerabilities through indicators like PM2.5, ozone levels, hazardous sites, chronic disease rates, and healthcare access. The tool also incorporates socioeconomic factors (e.g., poverty, education) and climate risks from extreme weather (USDOT, 2023a, b).[2]

The former Climate and Economic Justice Screening Tool (CEJST) identifies disadvantaged communities by assessing census tracts across various environmental, health, socioeconomic, and climate vulnerabilities. It uses a category-based approach that identifies census tracts surpassing set thresholds in specific burden categories such as transportation barriers, pollution, health outcomes, and climate risks (White House Council on Environmental Quality, 2024). For example, areas facing high levels of diesel emissions, PM2.5, traffic proximity, or other transportation burdens are marked as disadvantaged if they meet income thresholds. This dual-condition system ensures that only communities that are both environmentally and socioeconomically burdened are flagged.

Displacement and Gentrification Risk

Gentrification is a complex phenomenon that involves investment in low-income neighborhoods, generally followed by the influx of wealthier individuals or businesses. Investments can include public investment, such as transportation infrastructure and amenities like parks and recreation spaces, and private investment, such as real estate development. Displacement is a distinct process that may follow from gentrification. Displacement may be direct, in which residents or businesses are physically displaced to make room for new development, whether via buyout, eviction by the property owner, or eminent domain. Displacement can also occur over a longer period, where a new development increases surrounding property values and living costs, gentrifying the

[2] While the data documentation for the ETC is currently available at USDOT, the data and tool are not. There is not yet a publicly accessible archive for the ETC data removed in the presidential transition.

neighborhood and strengthening displacement pressures as higher-income individuals seek housing in the neighborhood.

Measuring direct short-term displacement is relatively simple. Project developers are likely to know how many and what types of residents and businesses will be displaced and by what means. Forecasting longer-term gentrification and associated displacement pressures is much trickier, given the multitudinous factors that affect neighborhood change and the lack of empirical evidence on the gentrifying effects of many VMT mitigation measures. For example, some VMT mitigation measures, including public transit investments and transit-oriented development (TOD), can lead to displacement of existing low-income residents and longer-term gentrification of the surrounding neighborhood. As one measure of equity, scenario analyses often examine the potential for displacement alongside housing affordability metrics (Alexander et al., 2021, 2024). Caltrans (2020) also suggested the need to incorporate affordability considerations when implementing VMT mitigation strategies like TODs to prevent the displacement of existing low-income residents (Caltrans, 2020).

A simple approach to considering gentrification and displacement effects is to determine whether the VMT mitigation measure would be implemented in an area with high gentrification potential, using a tool like the UC Berkeley Urban Displacement Project's Housing Precarity Risk Model. This model uses a composite score based on vulnerability and demographic data, such as income levels, racial demographics, renter rates, and housing costs, to map areas where residents face high precarity in housing stability. Such a neighborhood-based gentrification risk assessment could be paired with a review of the empirical literature on the gentrification-related effects of the specific VMT mitigation measure at issue, where such evidence is available.

Access to Services and Economic Opportunities

One important aspect of transportation equity is accessibility. Roadway expansion projects have the potential to enhance or reduce access to services and economic opportunities, including access to jobs (McMullen & Eckstein, 2011), access to basic services (e.g., food, healthcare facilities, schools, parks, etc.), and access to diverse transportation options (Alexander et al., 2021). So, too, do VMT mitigation strategies associated with those roadway projects. This metric would assess how VMT mitigation measures affect access to jobs and basic services. Accessibility analyses for jobs and basic services could be done using a tool like Conveyal Analysis, which can run both single-point and regional accessibility analyses (Conveyal, 2024). In our case studies, we use access to grocery stores as a proxy for and one example of access to basic services.

Community Approval and Engagement

One of the key concerns voiced by the workshop participants was that affected communities should be engaged in the types and locations of VMT mitigation measures to be employed. Engagement can help meet community members where they are at and hone mitigation measures accordingly, rather than treating the community like a uniform entity and choosing mitigation measures based solely on aggregate measures (Alexander et al., 2024; Nguyen & Barajas, 2023). Community engagement occurs on a spectrum delineated by the process via which the public agency interacts with communities (Arnstein, 1969; Facilitating Power, 2019; US EPA, 2014). At one end of the spectrum, public agencies come to the community to inform or consult in which decisions have largely been made, and communities are engaged in their reaction to the proposed decisions. On the other hand, public agencies defer to community decision-making and implement solutions.

Unlike the other equity-related categories, there are no similar pre-built tools to assess community engagement. Quantitative methods to assess community engagement during the project approval process include identifying when, where, and how many opportunities took place for communities to engage with the project, how many comments were received and incorporated into plan revisions, and how diverse the communities and groups were that were engaged. Qualitative methods include analyzing the themes in comments received and evaluating the engagement process along one of the continuum models of community engagement and empowerment.

For our scenario analysis, we use a simple two-pronged approach. First, we will quantitatively assess engagement by tallying the number of community meetings held during the environmental impact review process and the number of written comments submitted by community residents and organizations that specifically address the proposed VMT mitigation measures. Second, we recommend implementing a qualitative assessment for future projects, asking project proponents to evaluate the level of community commitment to the proposed VMT mitigation measures. This assessment would use a four-point scale: "Very strong support," "Some support," "Limited knowledge or support," and "Unknown," with an option for textual elaboration. This approach is adapted from Barajas et al.'s (2022) recommendations to the Illinois Department of Transportation on community impact assessment. For the purpose of this project, we will focus on the quantitative measures for our case study analyses. We propose the additional qualitative assessment as a recommendation for future projects to enhance community engagement evaluation.

Geographical and Spatial Equity

Geographic and spatial equity gauges how the benefits and burdens of transportation projects are distributed geographically. Geographic equity refers to whether the mitigation project occurs within the same area as the VMT-generating project. Spatial equity considers the added layer of community characteristics related to disadvantages. Assessing geographic and spatial equity is particularly important when discussing off-site VMT mitigation programs, which allow developers to offset their VMT impacts in locations different from the project site (Alexander et al., 2021). While such measures offer flexibility and cost-efficiency, they can raise spatial equity concerns if the measures benefit less disadvantaged communities than the community near the site of the primary project (Elkind & Lamm, 2018).

A geographic and spatial equity metric would have two levels. The first would determine whether the mitigation project occurs near the VMT-generating project. The definition of "near" would vary according to the type of project and context. However, a reasonable default would be to use a 1/3-mile radius around the VMT-generating project, based on the decay rate of roadway air pollution. Karner et al. (2010), for example, found that almost all air pollutants decay to background concentrations within 570 meters (0.35 miles) from the edge of the road. If the mitigation project is not nearby, the second level would compare the characteristics of the communities in the two areas. For example, a simple comparison of demographic and transportation-related environmental burden indicators from CalEnviroScreen (poverty, ozone, PM2.5, and traffic density) would inform whether there is a disparate distribution of the benefits and burdens of the two projects.

Applying VMT Mitigation Equity Metrics: Case Studies

In this chapter, we apply the five equity metrics we developed in the prior chapter to the VMT mitigation measures proposed for two highway expansion projects that have yet to be constructed: the Yolo 80 Corridor Improvement Project and the I-5 Managed Lanes Project.

Yolo 80 Corridor Improvement Project

Project Description

The Yolo 80 Corridor Improvements Project is a highway expansion project aimed at enhancing mobility and operational efficiency along Interstate 80 (I-80) and U.S. Route 50 (US-50) in Northern California. The project focuses on sections of I-80 and US-50 within Solano, Yolo, and Sacramento Counties. The project extends approximately 20.8 miles, beginning near Kidwell Road in Solano County, continuing through Davis and the Yolo Causeway in Yolo County, and terminating at the Interstate 5 (I-5) interchange in Sacramento County.

The I-80 corridor serves as an east-west route connecting the Bay Area, Sacramento, and the Sierra Nevada region. It also functions as a transportation link for interstate commerce, commuter traffic, and regional accessibility. The geographic area includes diverse landscapes, from urban centers to sensitive ecological zones like the Yolo Bypass floodplain, which houses wetlands that provide habitat for migratory birds and other wildlife. At its western terminus, US-50 intersects with I-80 and continues eastward, providing additional connections to downtown Sacramento and regional hubs.

The Yolo 80 project area is divided into three geographic segments to facilitate detailed planning and execution (Figure 1). The first segment extends from Kidwell Road in Solano County through Davis and the Yolo Causeway to Enterprise Boulevard in West Sacramento. This segment includes an ecological and infrastructural feature, the Yolo Causeway, which requires integrating flood management and ecological preservation efforts with transportation improvements. The second segment runs from Enterprise Boulevard along I-80 to West El Camino Avenue in Sacramento. The third segment spans the area between the I-80/US-50 separation and the I-5 interchange in Sacramento. This segment integrates with other major highway systems.

The existing geometry of I-80 varies across the corridor, reflecting the diversity of its surroundings and usage patterns. From Kidwell Road to the Solano-Yolo County line, the corridor includes four general-purpose lanes in each direction, accommodating high volumes of both commuter and commercial traffic. Through Davis, the roadway narrows to three lanes in each direction due to right-of-way constraints and urban development. The Yolo Causeway is a 3.2-mile elevated viaduct with three lanes per direction. In West

Sacramento, the roadway expands to four lanes in each direction, merging with traffic from US-50 and local interchanges. The section from the I-80/US-50 separation to the I-5 interchange comprises three lanes per direction on US-50, with a complex series of merges and lane drops as vehicles transition between major interchanges.

The geometry of the preferred alternative, Build Alternative 4b, includes adding one High-Occupancy Toll (HOT) lane with three or more occupants (HOT 3+) in each direction, which would offer a toll-based option for single-occupancy vehicles and free use for vehicles with three or more occupants. HOT lanes will be constructed as part of the existing roadway footprint, utilizing median space and shoulder conversions to minimize new land acquisition. On the Yolo Causeway, adding a HOT lane in each direction will require reconstructing the viaduct's median and restriping to accommodate the new lanes while maintaining safe shoulder widths. To address merging issues, the preferred alternative includes managed lane direct connectors, particularly at the I-80/US-50 separation. At key interchanges, such as Enterprise Boulevard in West Sacramento and West El Camino Avenue in Sacramento, ramp metering systems will be installed to regulate on-ramp flows.

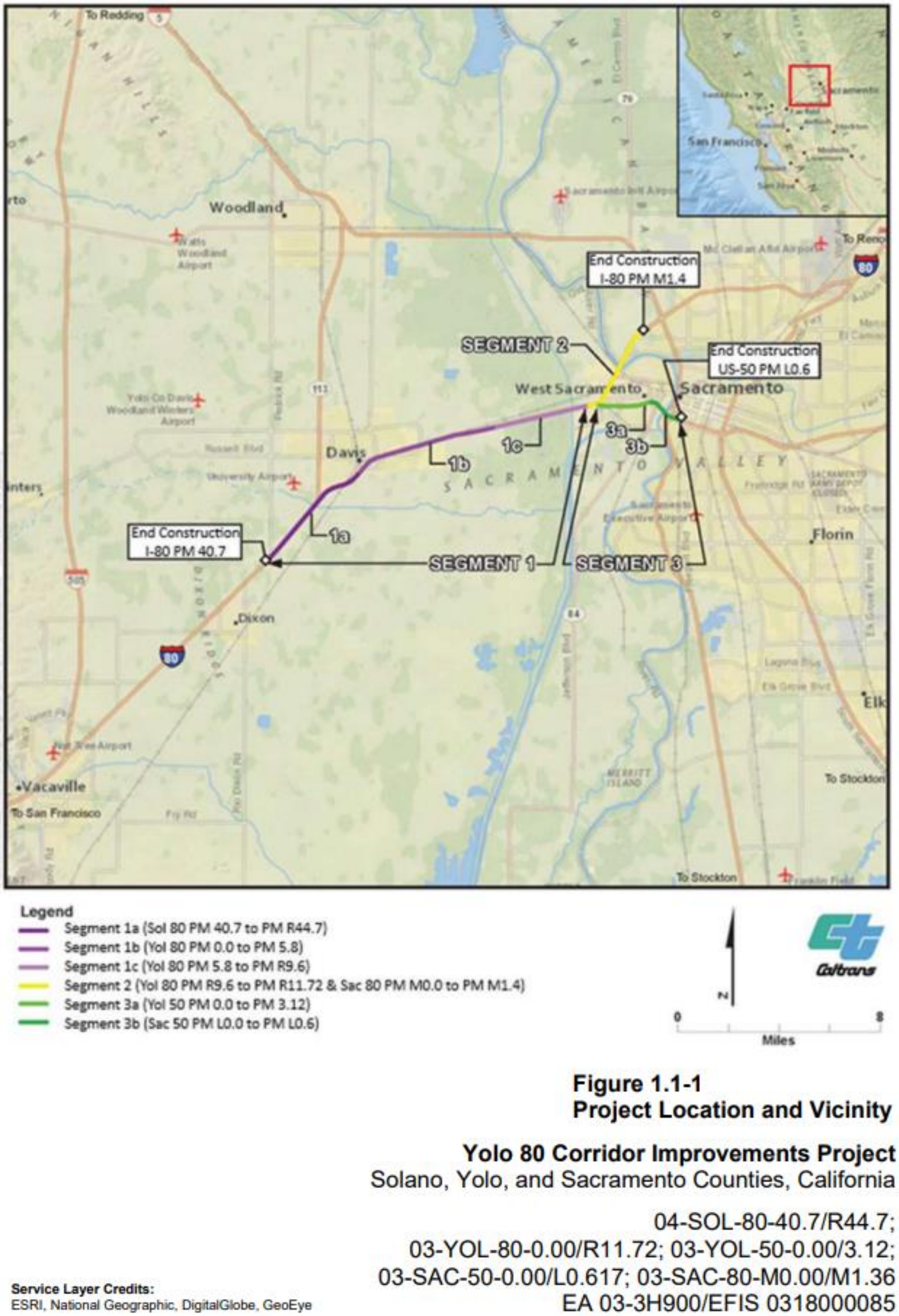

Figure 1. Yolo 80 Corridor Improvement Project location and nearby areas. (Source: Yolo 80 Corridor Improvement Project – Final Environmental Impact Report, p.1-2).

Environmental analysis for the project was conducted pursuant to the National Environmental Policy Act (NEPA) and the California Environmental Quality Act (CEQA). Caltrans, acting as the lead agency, prepared an Environmental Impact Report/Environmental Assessment (EIR/EA) to evaluate the potential effects of the proposed improvements. The analysis included assessments of impacts to transportation (including VMT), air quality, noise, water resources, cultural and biological resources, and potential impacts on surrounding communities. Mitigation measures have been identified to address temporary construction-related effects and long-term operational impacts.

While a Finding of No Significant Impact (FONSI) was issued for the Yolo 80 Corridor Improvements Project for NEPA purposes, several impacts were determined to be significant for CEQA purposes. Some of these impacts, such as those related to biological resources, cultural resources, and noise, could be reduced to less-than-significant levels by implementing mitigation measures. However, the project's VMT impact was deemed significant and unavoidable, even after considering mitigation efforts. This means that while the project would implement various strategies to reduce VMT, the overall increase in VMT resulting from the project could not be fully mitigated.

During the environmental review process, public input was solicited through a 61-day comment period on the Draft EIR/EA. Feedback from community members and stakeholders was incorporated into the Final EIR/EA.

VMT Mitigation Measures

Under the proposed Build Alternative 4b, the Yolo 80 Corridor Improvement Project is projected to induce approximately 110 million additional VMT annually due to the increase in roadway capacity, primarily from the addition of HOT 3+ lanes and a median connector ramp. To address these impacts, the project incorporates a detailed mitigation plan funded with an initial $55 million, which constitutes approximately 16% of the project's total capital cost. This funding is intended to reduce the induced VMT effects and is used toward the seven VMT mitigation measures summarized in Table 5.

One key mitigation strategy is the Voluntary Trip Reduction Program, which builds upon existing initiatives led by Yolo Commute. The program is designed to reduce reliance on single-occupancy vehicles and encourage sustainable transportation choices. Building on existing efforts by Yolo Commute, a transportation management association that already provides commute-related services and programs, this expanded initiative targets a broader population of workers and residents within Yolo County. The program's key features include community-based travel planning, which involves outreach and education tailored to local needs, enabling individuals and employers to develop effective strategies for reducing vehicle use. This is complemented by ridesharing incentives to increase carpooling and vanpooling participation by offering financial or other encouragement to share rides. Targeted at workers and residents across Yolo County, it aims to reduce automobile dependency, contributing to an estimated annual reduction of 24.7 million VMT.

The Capitol Corridor rail service expansion is another key VMT mitigation measure. This measure involves increasing the frequency of Capitol Corridor regional train service by adding three daily round trips between Martinez and Sacramento. The aim is to enhance interregional connectivity, particularly for commuters and other travelers who currently rely on personal vehicles. Additionally, the program incorporates transit pass subsidies, reducing the cost of public transit to make it a more affordable option, especially for regular commuters. The transit pass subsidies within the Voluntary Trip Reduction Program are expected to cover up to 80% of workers who are eligible with $20.7 million over 15 years. A fare buy-down program ($5 million annually) could be implemented as an alternative to service expansion, reducing monthly transit pass costs by a significant amount to achieve comparable ridership and VMT reduction effects. The service expansion seeks to encourage a modal shift to rail and thereby reduce VMT. The projected VMT reduction from this measure is 12.6 million miles annually, based on ridership and travel data. This estimate considers the average trip length of 68.4 miles and assumes a vehicle occupancy rate of 1.2 passengers per car. Approximately 85% of potential riders are estimated to have access to an automobile but would choose rail travel if the service is improved. These factors are consistent with the methodology and calculations provided by the Capitol Corridor Joint Powers Authority (CCJPA). Using all these data, which includes the estimated combined ridership for the three new round trips (712 passengers per day), average trip length (68.4 miles), average vehicle occupancy (1.2 passengers), and the percentage of riders with the option to use a vehicle (85%), a VMT reduction per rider value of 48.5 is calculated from the modeling tools like TDM+ and SACSIM. This suggests that by providing more frequent train service, individuals who would have otherwise driven will opt for the train, resulting in a reduction of 48.5 VMT per rider.

Another mitigation measure—microtransit expansion in Yolo County—is projected to increase service by 25%. Microtransit differs from conventional fixed-route services by offering greater flexibility in routing and scheduling, making it particularly effective in low-density regions where traditional transit is less feasible. This expansion will include additional routes and longer operating hours, ensuring that more residents have access to transit during evenings and weekends. The measure is projected to reduce VMT by over 6.2 million miles annually by shifting trips that would otherwise require private vehicles to shared transit options.

The mitigation plan also includes an expansion of fixed-route transit service—Yolobus Route 42, a key regional transit route connecting Woodland, Davis, Sacramento, and the Sacramento International Airport. This measure involves increasing service frequency to 30-minute headways throughout the day, replacing the current schedule, which offers hourly service during off-peak periods. By reducing wait times and improving reliability, the enhanced service could encourage ridership among commuters and travelers to the airport, contributing to a projected annual VMT reduction of approximately 3.7 million miles.

Another critical measure is the improvement of Causeway Connection Route 138, another fixed-route transit service route that links Davis to Sacramento. Service headways will be reduced to 15 minutes during peak travel periods and 30 minutes during off-peak hours, significantly increasing the route's attractiveness as a convenient and efficient alternative to driving. The enhanced service is anticipated to reduce VMT by nearly 5.9 million miles annually.

The mitigation plan also includes enhancements to Unitrans services in Davis. By doubling peak-period frequency from 30 minutes to 15 minutes, the measure addresses high demand during morning and evening commute hours. This service improvement is expected to reduce VMT by approximately 1.2 million miles annually while supporting the mobility needs of the UC Davis community and surrounding areas.

Complementing these transit measures are investments in active transportation infrastructure, including the expansion of the Putah Creek Trail. The project will widen and upgrade the existing trail used by cyclists and pedestrians to travel between the Olive Drive area, south Davis, and the UC Davis campus. This measure is projected to reduce VMT by approximately 1.4 million miles annually, particularly for short-distance trips.

Collectively, the EIR/EA projects that the seven mitigation measures could offset approximately 50% of the project's induced VMT.

Table 5. A list of VMT mitigation measures used in the Yolo 80 Corridor Improvement Project.

Mitigation Measure	Description	Annual VMT Reduced	Coast to Construct or Implement	Yolo 80 Managed Lane Contribution	$/VMT
Voluntary Trip Reduction Program in Yolo County	Part of an approved program provided by Yolo Commute, that include features such as community-based travel planning, ridesharing, transit pass subsidies and pay-per-mile auto insurance; no physical improvements; payments directly to Yolo Commute.	24.7 million	$1.3 million (annual cost to implement program)	$20.7 million over 15 years (to be supplemented with future toll revenue)	$0.05
Expand Capitol Corridor Frequency between Martinez and Sacramento	Increase Capitol Corridor rail service by three round trip trains between Martinez and Sacramento, on an annual basis, and/or implement buy-down program to reduce fares.	12.6 million	$5 million (annual cost to operate three (3) additional roundtrip train services and/or implement buy-down program)	$15 million over 3 years (to be supplemented with future toll revenue)	$0.40
Microtransit in Yolo County	Expand transit service by 25% to add a flexible route buses with more frequent service and/or longer service hours.	6.2 million	$1.5 million (annual cost to expand service)	$4.5 million over 3 years (to be supplemented with future toll revenue)	$0.24
Expand YoloBus Route 42	Increase Route 42 A & B services during 30-minute services all day, with the addition of 12 new trips in each direction for both the A and B routes.	3.7 million	$2.3 million (annual cost to expand service)	$6.9 million over 3 years (to be supplemented with future toll revenue)	$0.48

Mitigation Measure	Description	Annual VMT Reduced	Coast to Construct or Implement	Yolo 80 Managed Lane Contribution	$/VMT
Expand Causeway Connection Route 138	Reduce service headways from 60 minutes all day to 15 minutes for morning and afternoon peak periods and 30 minutes for midday/off-peak periods for Route 138.	5.9 million	$800k (annual cost to expand service)	$2.4 million over 3 years (to be supplemented with future toll revenue)	$0.26
Expand Unitrans	Increase service frequency from 30 to 15 minutes during the morning and afternoon peak periods.	1.2 million	$875k (annual cost to expand service)	$3.5 million over 4 years (to be supplemented with future toll revenue)	$0.75
Expand the Putah Creek Trail to Connect to the Future Nishi Student Housing Development Site	Expanding the Putah Creek Trail will improve the existing Putah Creek Trail between the Union Pacific Railroad tunnel and Old Davis Road at Hutchison Drive in Davis, and provide direct improvements and access to future Nishi Student Housing Development.	1.4 million	$3.8 million	$2 million	$1.45
Total	—	55.6 million (50% of induced VMT)	—	$55 million	

Source: Caltrans (2024b). Yolo 80 Corridor Improvements Project: Final Environmental Impact Report / Environmental Assessment with Finding of No Significant Impact, pp. 2-125 & 2-126.

Equity Analysis in the CEQA/NEPA Process

The EIR/EA includes an environmental justice analysis that incorporates some equity considerations, although it is not a comprehensive equity analysis and it does not integrate equity as a central consideration throughout all aspects of project planning and benefit distribution. The EIR/EA does not explicitly use the term "equity" in the context of the project as a whole or the VMT mitigation measures. However, the document examines whether minority and/or low-income populations would experience disproportionately high and adverse effects from the project and whether the project would benefit these communities equitably. This includes an analysis of potential impacts from the construction and operation of the project, as well as consideration of who would predominantly bear the impacts. The report concludes that the project is not expected to cause disproportionate effects on environmental justice communities, and that the project's anticipated travel benefits are expected to be similar for environmental justice communities and non-environmental justice communities. The EIR documents mention that all travelers, including environmental justice populations, would benefit from congestion relief and enhanced accessibility. However, the documents recognize that toll-based alternatives may present challenges for environmental justice populations due to potential financial barriers, which could result in unequal benefits realization. To mitigate these potential inequities, the EIR/EA proposes several strategies, such as variable pricing, improved access to toll tags or transponders, and translation services. The plan also proposes that no less than 50% of excess toll revenue would be used to improve multi-modal transit and expand transportation choices for environmental justice communities.

The EIR/EA also considers potential impacts on community character, noise, air quality, and visual resources, specifically in relation to environmental justice communities. It concludes that the project would not affect community character or quality of life in environmental justice communities in a substantially greater way than for non-environmental justice communities. The report also concludes that the build alternatives would improve circulation between I-80 and the surrounding streets, benefiting environmental justice community members using bus and transit.

While the EIR/EA addresses some equity concerns through the lens of environmental justice, it has a limited scope. The document acknowledges potential inequities related to toll facilities and linguistically isolated households. To address these issues, the EIR includes mitigation measures such as outreach and communication strategies (AMM EJ-1, EJ-2, and EJ-3) aimed at ensuring environmental justice populations are not disproportionately affected. These measures focus on issues like toll signage comprehension and toll transponder acquisition for linguistically isolated households.

However, the EIR/EA does not comprehensively address broader equity outcomes, including those related to VMT mitigation measures. While the EIR/EA evaluates VMT and associated mitigation measures, it does not explicitly structure or assess these measures in terms of their equity impacts.

Assessment of the Equity Effects of VMT Mitigation Measures

Disadvantaged Communities

Our first metric assesses whether the proposed VMT mitigation measures would be implemented in (located in or otherwise benefiting) a disadvantaged community.

The Community Impact Assessment (CIA) report for the Yolo 80 Corridor Improvements Project identifies "disadvantaged communities" using the CalEnviroScreen model developed by the California Office of Environmental Health Hazard Assessment. According to the EIR/EA, Census tracts identified as disadvantaged communities under SB 535, located in areas such as West Sacramento and near the US-50/I-5 interchange, face significant socioeconomic and environmental challenges. Figure 2 uses CalEnviroScreen 4.0 results to identify disadvantaged communities within the Yolo I-80 Corridor Improvement Project study area. The CalEnviroScreen percentile scores indicate environmental and social vulnerability, with higher percentiles (red areas) representing more disadvantaged communities. Census tracts with the highest scores are concentrated in West Sacramento (i.e., Segment 2). Figure 3 shows census tracts along segments 2 and 3 in the project are likely have a higher vulnerability index score, representing disadvantaged communities. These challenges, indicated by CalEnviroScreen scores exceeding the 75th percentile, make these areas particularly sensitive to changes in transportation infrastructure and policy. Modifications in these corridors could lead to positive outcomes, such as improved mobility and economic opportunities, and negative impacts, such as displacement and environmental degradation.

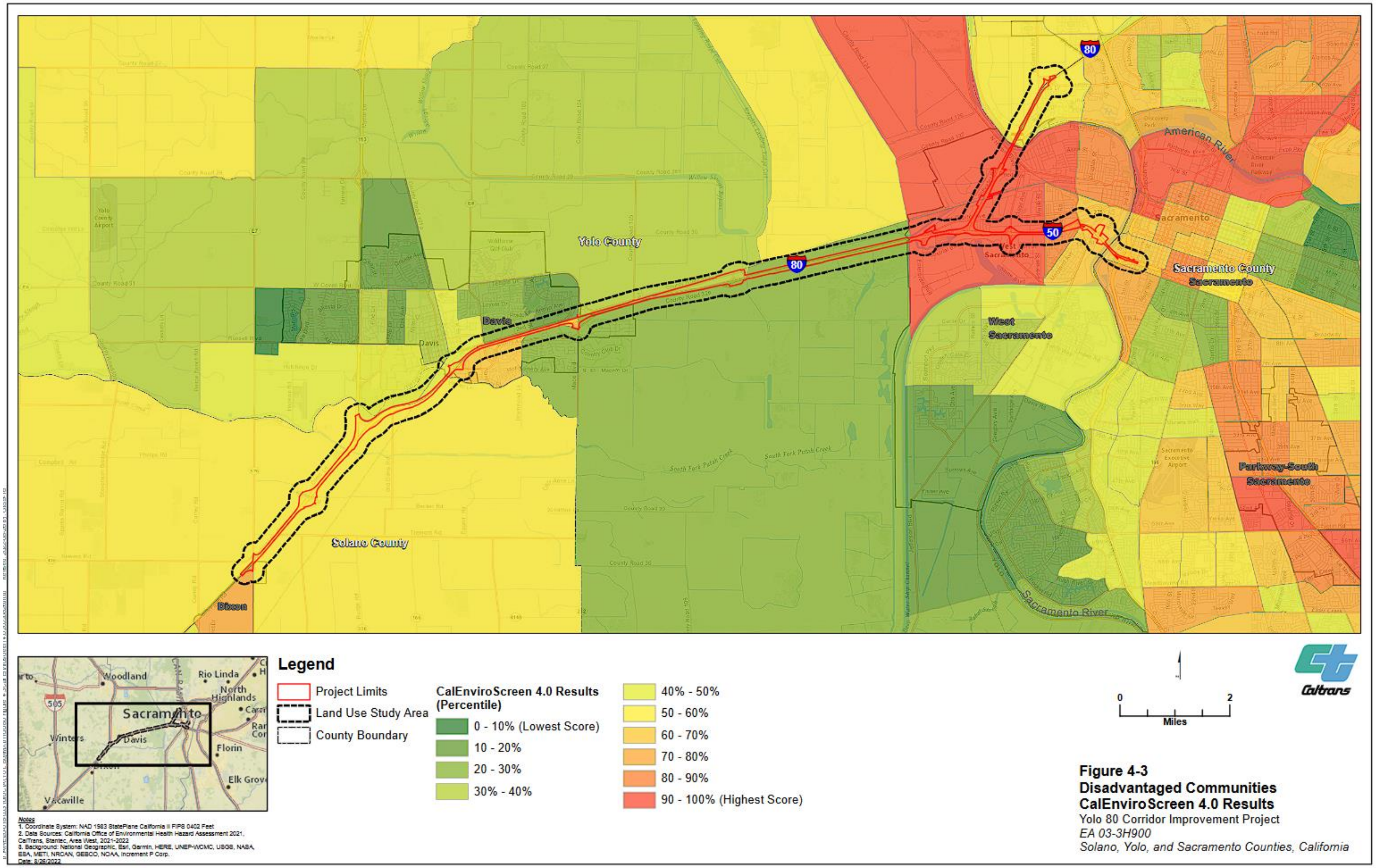

Figure 2. SB 535 Disadvantaged Communities Area near the Yolo 80 Corridor Project Area from the CalEnviroScreen model: Percentile. (Source: CIA Report (2023). P4-58)

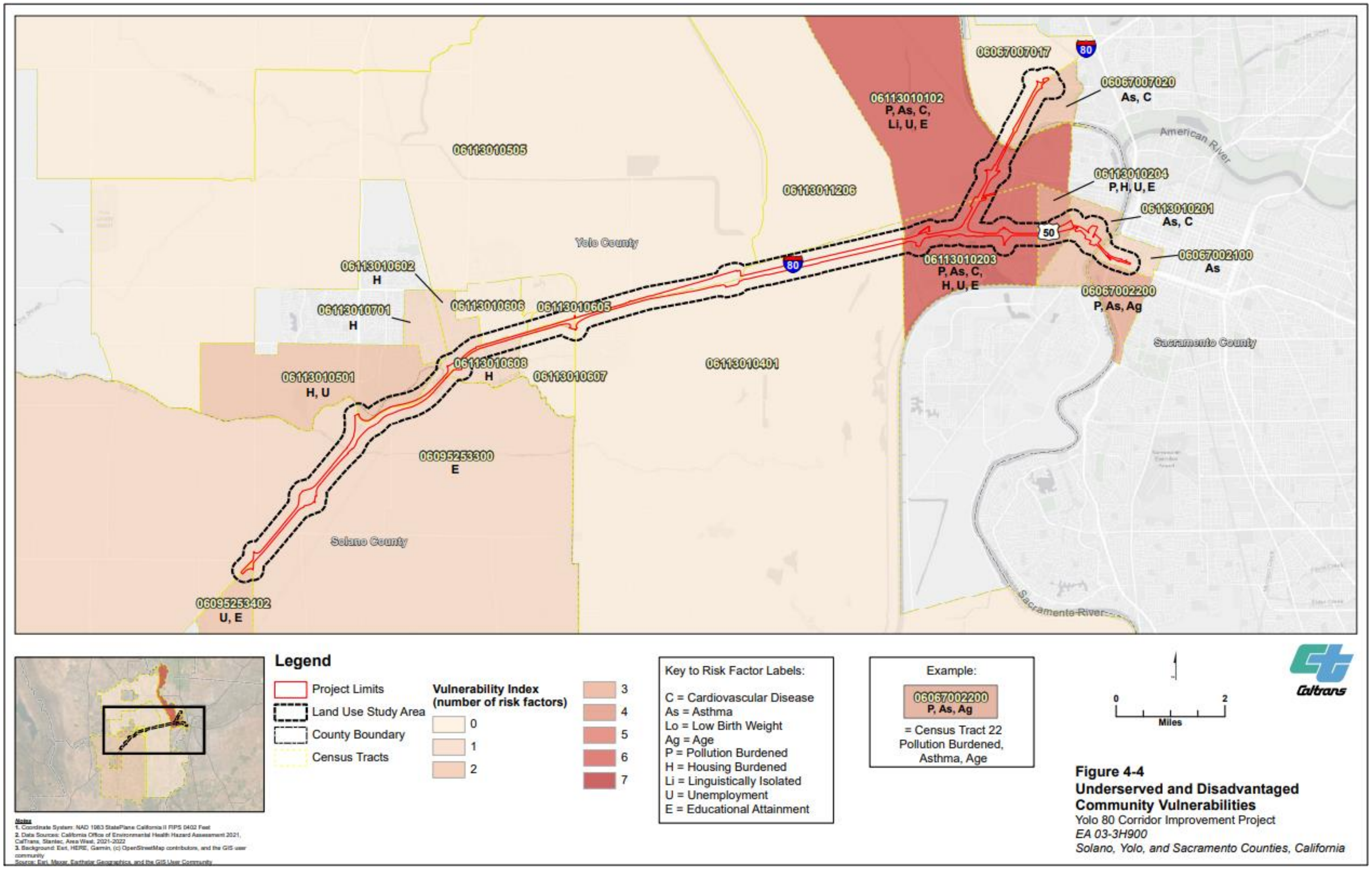

Figure 3. SB 535 Disadvantaged Communities Areas near the Yolo 80 Corridor Project Area from the CalEnviroScreen model: Vulnerability Index. (Source: CIA Report (2023). p. 4-62)

To assess whether the project's seven VMT mitigation measures would be implemented in a disadvantaged community, we first compared the physical location of the measures to the CIA report's maps of disadvantaged communities. For those measures that do not have a fixed location, we reviewed the EIR/EAs description of the measure to assess whether it would likely benefit at least some residents of disadvantaged communities.

We concluded from overlaying the routes of the four fixed-route transit measures on Figure 2 that three of the measures—expanding Capitol Corridor frequency, Causeway Connection Route 138, and Yolobus Route 42—would be located at least partly in communities with at least a 50-60 percentile score, while one measure—expanding Unitrans—would not. Our map-based analysis also indicates that expanding the Putah Creek Trail would not be located in a disadvantaged community.

The locations of the remaining two mitigation measures—the voluntary trip reduction program in Yolo County and expanding microtransit in Yolo County—are not clearly defined (beyond being in Yolo County). However, the EIR/EA indicates that both programs would likely benefit residents of the disadvantaged communities within Yolo County. For example, the voluntary trip reduction program aims to reduce the financial burden of travel for low-income individuals through community-based travel planning, ridesharing, transit pass subsidies, and pay-per-mile auto insurance. As part of the trip reduction program, at least 50% of excess toll revenue will be allocated to improving multi-modal transit, expanding transportation options, and other transportation enhancements that benefit environmental justice communities.

Table 6 summarizes our conclusions for the seven mitigation measures with respect to the disadvantaged community metric.

Table 6. Equity analysis results (Yolo 80 Corridor Improvement Projects): Disadvantaged Communities.

VMT Mitigation Measures	Will the VMT mitigation measure be located in/serve disadvantaged communities specified in the project?
Voluntary Trip Reduction Program in Yolo County	Yes
Expand Capitol Corridor Frequency between Martinez and Sacramento	Yes
Microtransit in Yolo County	Yes
Expand YoloBus Route 42	Yes
Expand Causeway Connection Route 138	Yes
Expand Unitrans	No
Expand the Putah Creek Trail to Connect to the Future Nishi Student Housing Development Site	No

Displacement/Gentrification

Our second metric assesses whether the proposed VMT mitigation measures would cause immediate physical displacement of residences or businesses, and/or cause longer-term residential gentrification.

There is no indication that any of the project's seven VMT mitigation measures would physically displace any residences or businesses. The proposed measures focus on enhancing existing multimodal transportation options without expanding physical footprints.

With respect to longer-term gentrification, we suggest using a tool like the Urban Displacement Project's Housing Precarity Risk Model to identify areas with high gentrification potential. VMT mitigation measures located in those areas could potentially contribute to gentrification. Figure 4 shows the Urban Displacement Project's housing precarity and displacement vulnerability assessments for the project area. While some project-adjacent or nearby areas show a high housing precarity risk, particularly in West Sacramento and Sacramento, the proposed VMT mitigation measures are unlikely to substantially increase the risk of gentrification. All seven measures constitute either enhancements to transit services, active transportation facilities, or TDM strategies. These are all infrastructure-light solutions. They would not directly displace existing uses (residences, businesses, parks, etc.) and would also not expand the existing transportation network much. Instead, the measures focus on increasing the service on the existing networks or otherwise incentivizing increased transit and active transportation use.

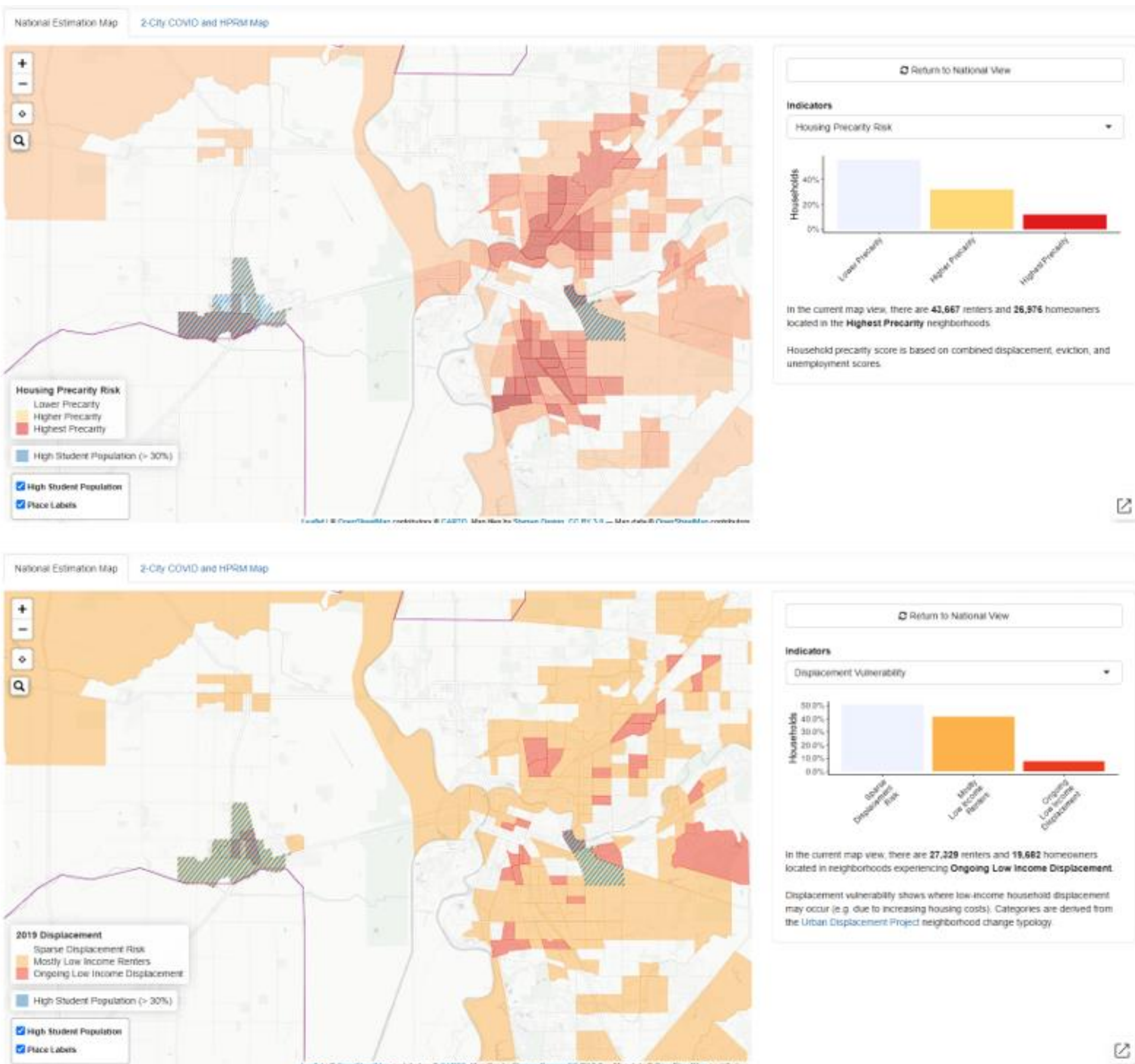

Figure 4. Urban Displacement Project's Housing Precarity Risk Model result maps: Housing Precarity Risk (top) and Displacement Vulnerability Assessment (bottom).

Table 7 summarizes our conclusions for the seven mitigation measures with respect to the displacement and gentrification metric.

Table 7. Equity metrics results (Yolo 80 Corridor Improvement Projects): Gentrification/Displacement.

VMT Mitigation Measures	Longer-term residential gentrification: Would the VMT mitigation measures be implemented in an area with a high risk of gentrification?	Residential displacement near the VMT mitigation measure sites: Would the VMT mitigation measures cause physical displacement of existing housing units or residential areas (e.g., redevelopment, buyout, or eminent domain)?	Business displacement near the VMT mitigation measure sites: Would the VMT mitigation measures cause physical displacement of existing businesses (e.g., redevelopment, buyout, or eminent domain)?
Voluntary Trip Reduction Program in Yolo County	Low	No	No
Expand Capitol Corridor Frequency between Martinez and Sacramento	Low	No	No
Microtransit in Yolo County	Low	No	No
Expand YoloBus Route 42	Low	No	No
Expand Causeway Connection Route 138	Low	No	No
Expand Unitrans	Low	No	No
Expand the Putah Creek Trail to Connect to the Future Nishi Student Housing Development Site	Low	No	No

Access

Our third metric assesses whether the proposed VMT mitigation measures would increase accessibility to jobs and grocery stores. For future projects, we recommend conducting an accessibility analysis using a tool like Conveyal Analysis, which can run both single-point and regional accessibility analyses (Conveyal, 2024). Because we did not have access to Conveyal Analysis, we qualitatively assessed whether the project's seven VMT mitigation measures would increase accessibility to jobs and grocery stores, using a three-part scale:

"high," "low," and "unknown." We use access to grocery stores as one example of an indicator for access to basic services.

The VMT mitigation measures proposed for this project have a substantial potential to improve accessibility to jobs by enhancing public transit and active transportation options. Increasing the frequency of the Capitol Corridor train service between Martinez and Sacramento is a key measure that will improve access to jobs, especially for longer-distance commuters. The Capitol Corridor connects major job markets in the Bay Area and Sacramento, and increasing its service frequency will provide a more reliable and convenient option for those commuting to these areas. Additionally, expanding flexible-route bus services and microtransit will improve job access, particularly in areas less served by traditional bus routes. This measure increases transit options for those seeking employment within Yolo County. Furthermore, expanding existing bus routes, specifically YoloBus Route 42, can provide more direct and convenient connections to employment centers within Yolo County, making job opportunities more accessible to residents of the area. The expansion of the Causeway Connection Route 138 improves job accessibility along the route, especially between the UC Davis campus and the UC Davis Medical Center, directly benefiting commuters and facilitating connections between major employment areas. As the transit system for UC Davis, expanding Unitrans improves job accessibility for students, employees, and anyone accessing jobs within the city of Davis. Improved transit service directly benefits the UC Davis community and facilitates access to employment within the area.

In addition to transit improvements, the expansion of the Putah Creek Trail enhances bicycle and pedestrian paths primarily for recreation, but it can also indirectly improve access to jobs. Those who live or work near the trail can use it to commute by bike or on foot. The project also includes a Voluntary Trip Reduction Program in Yolo County, which, while not directly enhancing job accessibility, encourages alternative transportation, potentially making commutes more efficient for individuals by funding the current approved program and providing incentives and education to the public on the benefits of transit.

Based on the descriptions of the measures and their intended impacts in the EIR documents and technical reports for this project, the following qualitative assessment of the relative potential of each VMT mitigation measure to increase job accessibility can be summarized as follows:

- **Voluntary Trip Reduction Program in Yolo County**: This measure is rated as "**high**" for increasing job accessibility. It expands an existing program to encourage alternative modes of transportation by providing incentives and education. While it does not directly create new transit routes, it may improve commuting efficiency for some by encouraging carpooling, transit use, and other options, and makes these options more accessible through the provision of information and incentives.

- **Expand Capitol Corridor Frequency between Martinez and Sacramento**: This measure is rated as "**high"** for increasing job accessibility. Increasing the frequency of train service directly improves access to jobs in major employment centers along the corridor and provides a reliable option for commuters traveling longer distances, connecting the Bay Area to Sacramento.
- **Microtransit in Yolo County**: This measure is rated as "**high"** for increasing job accessibility. Expanding flexible-route bus service increases transit options, particularly in areas not well-served by traditional bus routes, making job opportunities within Yolo County more accessible. The EIR/EA and related documentation for the project explicitly state that the measure is intended to benefit commuters in the area.
- **Expand YoloBus Route 42**: This measure is rated as "**high**" for increasing job accessibility. By enhancing existing bus service, this measure creates more direct and convenient connections to employment centers within Yolo County, improving access to jobs for local residents. However, the increase in service may be limited.
- **Expand Causeway Connection Route 138**: This measure is rated as "**high**" for increasing job accessibility. Increased service on this route improves job access, specifically for those traveling between UC Davis and the UC Davis Medical Center.
- **Expand Unitrans**: This measure is rated as "**high**" for increasing job accessibility. As the transit system for UC Davis, expanding Unitrans improves job accessibility for students, employees, and others accessing jobs within the city of Davis.
- **Expand Putah Creek Trail**: This measure is rated as "**low"** for increasing job accessibility. While the expansion of the trail enhances a recreational path, it also has a limited effect on access to jobs, as the VMT reduction is only found for new connections and not enhancements to existing ones. However, individuals who live and work near the trail can use it as an option for commuting by bicycle or on foot.

We also applied the same scale (high, low, and unknown) to qualitatively assess whether the proposed VMT mitigation measures would increase access to grocery stores:

- **Voluntary Trip Reduction Program in Yolo County:** This measure has a "**high**" potential to increase access to grocery stores. It encourages using alternative modes of transportation like carpooling, transit, and biking. To the extent that it encourages people to use transit and that those transit routes pass near grocery stores, this may enhance access to some grocery stores. However, it does not directly create new routes or stops near such facilities.
- **Expand Capitol Corridor Frequency between Martinez and Sacramento:** This measure has a **"low"** potential to increase access to grocery stores, as this train service is focused on intercity travel between major employment centers, not local access to facilities like grocery stores. While it may indirectly improve access for those traveling between the Bay Area and Sacramento, it is unlikely to directly impact access to grocery stores within the project area.

- **Microtransit in Yolo County:** This measure has an **"unknown"** potential to increase access to grocery stores. Although many microtransit programs ultimately benefit all types of trips—from shopping to medical appointments—the EIR/EA documentation (including the VMT Mitigation Plan) does not specify that the proposed microtransit service must incorporate specific grocery stops or commercial areas. There is no firm requirement in the plan to guarantee route coverage near major grocery stores. Therefore, at this stage, we classified grocery store access potential as "unknown" to reflect the currently limited data regarding microtransit stops and exact service areas related to non-work trips.
- **Expand YoloBus Route 42:** This measure has a "**low**" potential to increase access to grocery stores. Enhancing this existing bus service could create more direct and convenient connections to basic service facilities in Yolo County, but this bus route mostly supports intercity travel and access to major employment centers and transportation hubs, including access to the Sacramento Airport.
- **Expand Causeway Connection Route 138:** This measure has a **"low"** potential to increase access to grocery stores. The route focuses on travel between the UC Davis campus and the UC Davis Medical Center, which are not typically located near grocery stores. Therefore, it is unlikely to significantly impact access to such facilities.
- **Expand Unitrans:** This measure has a "**high**" potential to increase access to grocery stores. Unitrans primarily serves the UC Davis campus and surrounding areas. Depending on the routes, it could improve access to grocery stores and other grocery stores located within the city of Davis, but the sources do not specify such details.
- **Expand Putah Creek Trail:** This measure has a "**low"** potential to increase access to grocery stores. While some may use the expansion of this recreational path to reach nearby services, it is unlikely to have a significant impact, as VMT reduction is only found for new connections, not for enhancing existing ones.

Table 8 summarizes the qualitative assessment of the potential of each VMT mitigation measure in terms of accessibility to jobs and basic service facilities like grocery stores.

Table 8. Equity analysis results (Yolo 80 Corridor Improvement Projects): Access.

VMT Mitigation Measures	Would the VMT mitigation measure increase accessibility to jobs?	Would the VMT mitigation measure increase accessibility to grocery store?
Voluntary Trip Reduction Program in Yolo County	High	High
Expand Capitol Corridor Frequency between Martinez and Sacramento	High	Low
Microtransit in Yolo County	High	Unknown
Expand YoloBus Route 42	High	Low
Expand Causeway Connection Route 138	High	Low
Expand Unitrans	High	High
Expand the Putah Creek Trail to Connect to the Future Nishi Student Housing Development Site	Low	Low

Community Approval/Community Engagement

Our fourth metric assesses how the proposed VMT mitigation measures have been received by community members in the area where the measures would be located, as well as the level of engagement and empowerment with the community. For this case study, we quantitatively measured engagement by tallying the number of community meetings and public comments, especially those that addressed VMT mitigation. For future projects, we recommend that the lead agencies also implement a qualitative assessment, asking project proponents to evaluate the level of community commitment to the proposed VMT mitigation measures as described above.

During the environmental impact review process, the project steering committee, including local stakeholders, held 14 public meetings in the Cities of Davis, Sacramento, and West Sacramento to discuss the project and gather community input. Additionally, two public scoping meetings were held virtually on August 25, 2021, as part of the Draft EIR/EA circulation process. Then, after the initial scoping period, the EIR/EA reports 40 correspondences, meetings, and other notable discussions with stakeholders between December 20, 2022, and March 4, 2024 (after the public comment period closed and two months before final project approval). As for written engagement, the EIR/EA reports that 139 comments were received on the Draft EIR/EA from individuals (108 comments), organizations (19 comments), and agencies (12 comments).

Beyond those who submitted formal comments, the public meetings for the Yolo 80 Corridor Improvements Project involved a variety of participants. The project established a steering committee that included local stakeholders, such as the Cities of Davis and West Sacramento, Yolo County, Sacramento Area Council of Governments (SACOG), Yolo Transportation District (YoloTD), University of California (UC) Davis, and the Bicycle Coalition. This committee held three public meetings within the Cities of Davis, Sacramento, and West Sacramento. The project also had a Project Development Team (PDT) that met monthly and included representatives from Caltrans, SACOG, West Sacramento, Davis, Yolo County, UC Davis, and YoloTD. These meetings (approximately 60 regular meetings during the six-year development period) were a forum for coordination, issue resolution, and information feedback between the agencies. In addition to these meetings, Caltrans coordinated with a variety of participants, including steering committee members, PDT members, members of the public who attended scoping meetings and open houses, wildlife professionals, Native American tribal representatives, and members of minority and low-income communities to discuss project details and the environment review process as well as habitat concerns (Caltrans, 2023d, pp. 4-1 to 4-10).

The EIR provides "Master responses" that grouped similar comments received from multiple respondents during the public comment period. Among nine "Master responses (A to I)," Master response A focuses on addressing public comments related to induced travel demand and the strategies proposed to mitigate Vehicle Miles Traveled (VMT) impacts for the Yolo 80 Corridor Improvements Project. The individuals, organizations, and agencies that mentioned "VMT mitigation" measures in their comments include the California Air Resources Board (CARB), which provided comments on the adequacy of VMT mitigation funding and methodologies; the City of Davis, which raised concerns regarding the sufficiency and effectiveness of VMT mitigation strategies; the City of West Sacramento, which addressed the alignment of mitigation measures with regional planning goals; and the Sacramento Metropolitan Air Quality Management District, which highlighted air quality implications of VMT mitigation efforts. Organizations include the Environmental Council of Sacramento (ECOS), which focused on the environmental and policy compliance of VMT mitigation strategies; the Center for Biological Diversity, which discussed the environmental and legal sufficiency of proposed measures; the Natural Resources Defense Council (NRDC), which emphasized rigorous implementation and accountability of VMT measures; the Planning & Conservation League, which provided feedback on the feasibility of the measures; and the Sierra Club Yolano Group, which focused on sustainability outcomes related to the proposed measures. Individuals include Bapu Vaitla, a community resident and councilmember who commented on the alternatives and mitigation strategies, and Alan Hirsch, who raised technical questions about the VMT mitigation calculations and methodologies, as well as other unnamed residents during public meetings who provided verbal or written input on the VMT mitigation plan.

Geographical and Spatial Equity

Our fifth metric assesses geographical and spatial equity, specifically whether the VMT mitigation measures would be implemented in the same community as the primary project and, if not, whether they would be implemented in communities with similar poverty levels, ozone levels, PM2.5 levels, and vehicular traffic density, using CalEnviroScreen. For purposes of our case studies, we focus on the first question—whether the VMT mitigation measures would be implemented in the same community as the primary project.

The Community Impact Assessment (CIA) document for the Yolo 80 Corridor Improvement project defines three different study areas to evaluate the project's impacts on different topics: Land Use Study area (LUSA), Community Study area (CSA), and Regional Study area (RSA). The Land Use Study Area (LUSA) is specifically defined to capture the immediate and direct effects of the Yolo 80 project on the surrounding environment and population. Geographically, the LUSA encompasses the area immediately adjacent to the I-80/US-50 corridor, the project's primary focus. To ensure a comprehensive assessment, it extends 1,000 feet outward from the corridor's boundaries, creating a buffer zone that accounts for both direct and indirect impacts. While the LUSA emphasizes physical land use, the Community Study Area (CSA) is defined as all census tracts and block groups directly adjacent to the project footprint. It is designed to provide a critical lens for understanding the project's broader socioeconomic impacts on nearby communities. The Regional Study Area encompasses much larger areas—the greater Sacramento area—and is designed to account for "planned growth in the region." In this report, we use the LUSA and CSA to assess whether the VMT mitigation measures would be implemented in the same community as the project.

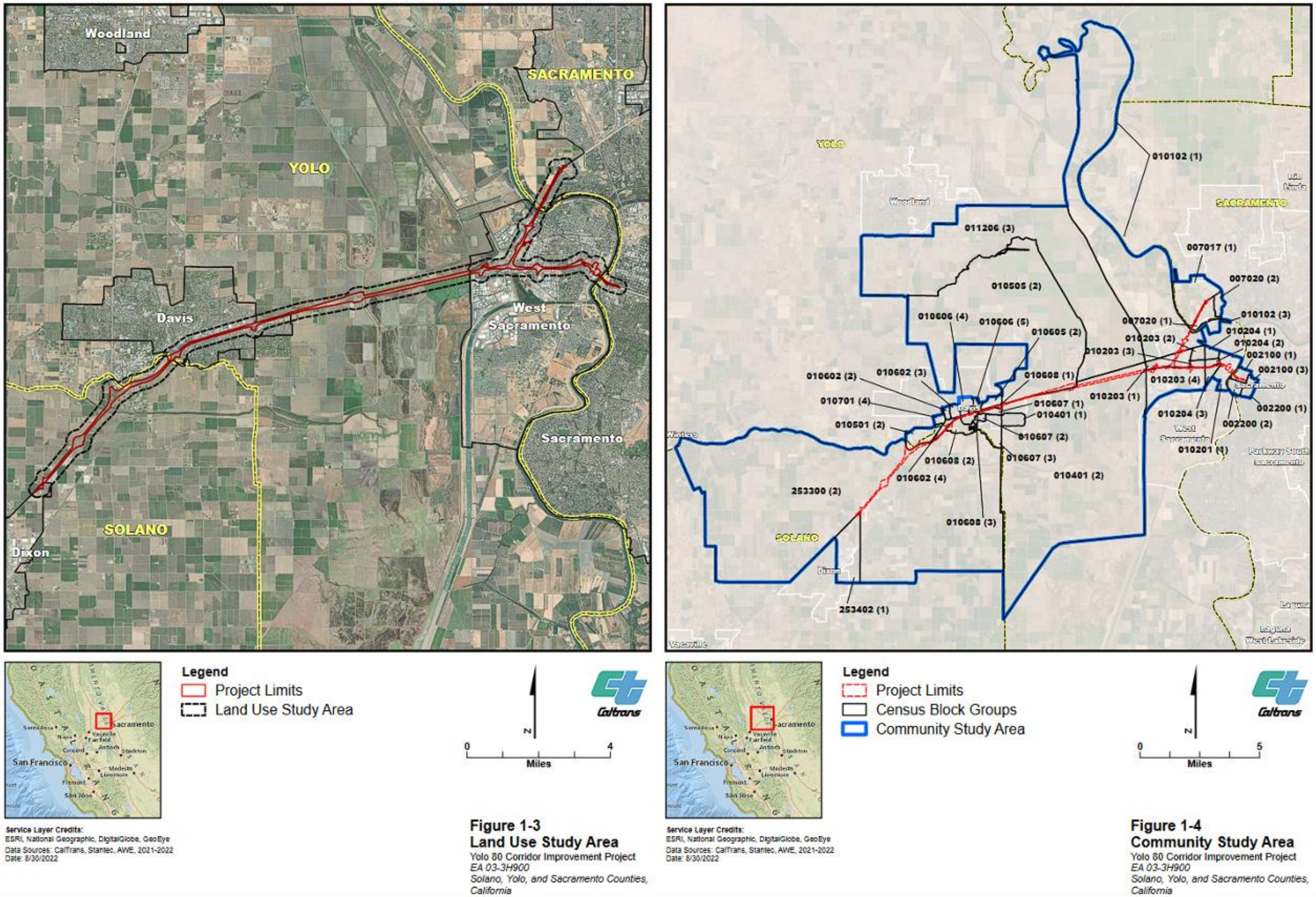

Figure 5. Land Use Study Area and the Community Study Area.

The Voluntary Trip Reduction Program in Yolo County involves expanding the current program provided by Yolo Commute to include features such as community-based travel planning, ridesharing, transit pass subsidies, and pay-per-mile auto insurance. Given these definitions, the Voluntary Trip Reduction Program would not be limited to the LUSA but would primarily be implemented within the broader CSA, specifically targeting communities within Yolo County.

The expansion of the Capitol Corridor frequency between Martinez and Sacramento would augment the frequency of train service between Martinez and Sacramento. This expansion would involve adding three round trips to the Capitol Corridor route. As for the geographical and spatial equity of this VMT mitigation measure, the implementation of the Capitol Corridor expansion would extend beyond the immediate LUSA. While the LUSA focuses on localized physical impacts, the Capitol Corridor expansion targets regional transportation patterns. Although the Capitol Corridor expansion does not occur solely in the LUSA, it is also not primarily focused on the CSA. The CSA focuses on communities immediately adjacent to the project footprint. The Capitol Corridor expansion occurs between Martinez and Sacramento. The LUSA and CSA are smaller and more localized than the area in which the Capitol Corridor Expansion occurs. The Capitol Corridor expansion is an effort to reduce VMT in the broader region.

The Microtransit in Yolo County initiative would expand transit service by 25% to add flexible route buses with more frequent service and/or longer service hours. Yolobus is expected to provide the additional transit service. The Microtransit in Yolo County initiative would not be limited to the LUSA but would primarily be implemented within the broader CSA.

Expanding YoloBus Route 42 is designed to reduce the induced VMT effects of the Yolo 80 project. This initiative increases service on Route 42 A & B to 30-minute services all day, with the addition of 12 new trips in each direction for both the A and B routes. The Expand YoloBus Route 42 initiative would be implemented within the broader geographic area. While the LUSA captures the immediate physical impacts of the project, the YoloBus Route 42 expansion aims to influence travel behavior and reduce VMT across a wider geographic area, including the communities most directly affected by the project's socioeconomic impacts.

Expanding the Causeway Connection Route 138 focuses on enhancing the Causeway Connection Route 138, a zero-emission bus service that operates between Davis and Sacramento. Considering these definitions and the characteristics of the Expand Causeway Connection Route 138 initiative, it becomes clear that its implementation would extend beyond the boundaries of the LUSA and primarily target the broader CSA. The Causeway Connection Route 138 directly links Davis and Sacramento, two key locations situated within the broader regional context of the Yolo 80 project. This implies that its implementation extends beyond the immediate vicinity of the I-80/US-50 corridor, targeting communities throughout the county.

Expanding Unitrans, which serves the city of Davis and the UC Davis campus, would involve increasing service frequency from 30 to 15 minutes during the AM and PM peak periods. Given the definitions of the LUSA and the CSA, the implementation of the "Expand Unitrans" initiative could extend beyond the immediate vicinity of the I-80/US-50 corridor, though the program has the potential to contribute to decreased traffic congestion and improved air quality within the LUSA, benefiting residents and businesses located close to the I-80/US-50 corridor.

Expanding the Putah Creek Trail will improve the existing Putah Creek Trail between the Union Pacific Railroad tunnel and Old Davis Road at Hutchison Drive in Davis and provide direct improvements and access to the future Nishi Student Housing Development. Given these definitions, the "Expand Putah Creek Trail" initiative is expected to be implemented within both the LUSA and CSA.

I-5 Managed Lanes Project (Red Hill Ave. to OC/LA County Line)

Project Description

The I-5 Managed Lanes Project, proposed by Caltrans District 12, involves modifications to the existing managed lane infrastructure along a 15.5-mile segment of Interstate 5 (I-5). I-5 is a major regional freeway supporting local and regional traffic, surrounded by a mix of residential, commercial, and industrial land uses, as well as public facilities such as schools and parks. This segment that the project would modify runs from Red Hill Avenue in Irvine to the Orange County/Los Angeles County line, passing through the cities of Tustin, Santa Ana, Orange, Anaheim, Fullerton, Buena Park, La Mirada, and Santa Fe Springs.

The freeway consists of general-purpose lanes, auxiliary lanes, and single HOV lanes in each direction, with the HOV lanes operating under a two-person minimum occupancy requirement. The existing configuration has been identified as inadequate to meet traffic demand, with HOV lanes experiencing congestion and operational inefficiencies. The proposed project would reconfigure these facilities in an attempt to address these issues by modifying the lane structure and adding new infrastructure.

The proposed changes vary by alternative. The first alternative (the no-build alternative) would retain the existing roadway configuration, including the two-person HOV lanes, without any modifications. The second alternative proposes changing the occupancy requirement for the HOV lanes from two persons to three persons, with no physical expansion or new lanes. This alternative includes updates to roadway signage and pavement markings to reflect the new standards. The third alternative involves converting the existing HOV lanes into express lanes with electronic tolling systems while maintaining the current number of lanes. The fourth alternative expands on the third by converting the HOV lanes into express lanes and adding an additional express lane in certain sections, which will require roadway widening. This alternative also includes adjustments to auxiliary lanes and shoulders to accommodate the additional lanes. Figure 6 depicts the four alternatives, while Figure 7 shows the project location.

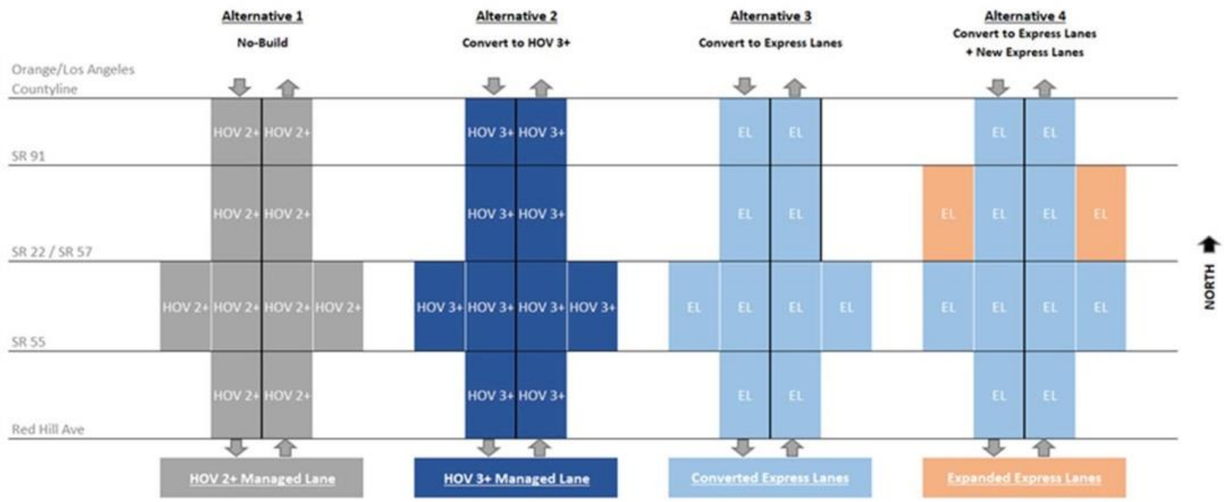

Figure 6. Proposed alternatives for the I-5 Managed Lanes Project.

In all the "Build" alternatives, the project would introduce two park-and-ride facilities within the existing freeway right-of-way. These facilities are designed to support ridesharing and transit use, providing infrastructure for carpooling and other multimodal travel options. Tolling infrastructure, advanced signage, and updated pavement markings would also be implemented to support the functionality of the express lanes. In specific locations, ingress and egress weaving zones would be created to facilitate smooth transitions between general-purpose and express lanes. The project would also modify interchanges with State Route 55, State Route 57, and State Route 91.

The environmental review process, conducted as part of the Environmental Impact Report/Environmental Assessment (EIR/EA), is ongoing. This process has assessed potential impacts on transportation (including VMT), air quality, noise levels, biological resources, water quality, and the surrounding community. Compliance with federal and state regulations, including Section 4(f) of the Department of Transportation Act, is also being evaluated. The final selection of a preferred alternative has not yet been made, as the project is still under review. Construction timelines and implementation will depend on the completion of the environmental review, public consultation, and funding allocation processes.

Figure 7. I-5 Managed Lanes Project (Orange/Los Angeles County Line).

VMT Mitigation Measures

The I-5 Managed Lanes Project, as described in the EIR/EA, would incorporate several measures to mitigate VMT impacts associated with the build alternatives. These measures, identified in the document as TR-1 through TR-5, represent a range of strategies aimed at reducing the additional VMT generated by the project.

One mitigation measure, TR-1, involves financial contributions to affordable housing development throughout Orange County. This approach is based on the principle that increasing the availability and density of affordable housing near major transit corridors can decrease travel distances and the reliance on personal vehicles. The measure acknowledges that proximity to workplaces, services, and transit can lead to shorter commutes and a reduction in overall vehicle usage. By facilitating housing affordability in these areas, the measure addresses a key factor influencing VMT growth.

TR-2 focuses on expanding and enhancing transit services. Specifically, the project proposes funding improvements to multiple transit routes as identified in the Orange County Transportation Authority's (OCTA) Making Better Connections Study. The planned enhancements include increasing the service frequency and reliability of 33 locally fixed routes, 6 community routes, 2 intra-county express routes, 1 Metrolink station route, and 3 inter-county express routes. These improvements aim to make transit a more viable and competitive alternative to single-occupancy vehicle travel.

The project also includes TR-3, which targets transit efficiencies by reducing wait times and improving service reliability for existing transit options. This measure involves operational upgrades that are designed to make public transportation more convenient and accessible, thereby encouraging a shift from personal vehicles to transit. Improved reliability and reduced travel times are critical factors in promoting transit use among commuters.

TR-4 emphasizes providing transit pass subsidies as a means of incentivizing transit usage. By lowering the financial cost associated with using public transportation, this measure seeks to encourage commuters to opt for transit over driving. The subsidies are intended to reduce economic barriers to transit access, making it a more attractive option for a broader segment of the population.

TR-5 supports active transportation by proposing investments in new Class II bikeway facilities along corridors parallel to the I-5 project area. These bikeways are designed to provide safe and accessible routes for bicyclists, encouraging non-motorized travel as an alternative to driving for short- and medium-distance trips. By improving infrastructure for active transportation, the measure facilitates a mode shift that can reduce VMT.

The EIR/EA highlights that these mitigation measures, while significant, would not fully eliminate the additional VMT generated by the project. For Alternative 4, which involves the addition of express lanes, the measures are expected to mitigate approximately 22,257,680 VMT annually. This represents a reduction of 26.2% of the additional VMT generated by the project. Despite the mitigation, because approximately 62,688,320 annual VMT would remain unmitigated, the EIR/EA concludes that the project would still result in a significant and unavoidable transportation impact under CEQA.

Equity Analysis in the CEQA/NEPA Process

The project EIR/EA does not analyze the equity effects of the proposed VMT mitigation measures, but it does examine the equity effects of some components of the project itself, such as changes to HOV lanes and the introduction of express lanes. The analysis evaluates whether these measures could result in disparities in accessibility or affordability for disadvantaged populations.

For instance, the conversion of HOV lanes to ELs under Alternatives 3 and 4 is projected to reduce VMT in the project corridor by 5% to 7% during peak hours due to enhanced traffic flow and the potential encouragement of carpooling and transit use. However, the analysis acknowledges that these tolling strategies may pose financial challenges for low-income users. To address this, the EIR/EA proposes the Equity Assistance Plan (Measure EQ-1), which includes financial subsidies for qualifying individuals and outreach programs to mitigate barriers to accessing the benefits of the managed lanes. Additionally, complementary measures such as park-and-ride facilities are evaluated for their role in supporting VMT reductions, with an estimated impact of reducing single-occupancy vehicle trips by 2% to 3% in the corridor. These facilities are expected to improve access to shared mobility options, although the EIR/EA highlights the importance of ensuring effective outreach and transit integration to maximize their use by disadvantaged populations.

The equity analysis integrates findings from community workshops and surveys, identifying affordability and access as primary concerns. The EIR/EA links the equity-related measures to broader efforts to reduce transportation-related emissions and improve mobility for disadvantaged communities within the project area.

Assessment of the Equity Effects of VMT Mitigation Measures

Disadvantaged Communities

Our first metric assesses whether the proposed VMT mitigation measures would be implemented in (located in or otherwise benefiting) a disadvantaged community.

Figure 8 highlights disadvantaged communities at the Census Tract level, as defined by CalEnviroScreen 4.0 and SB 535, in relation to the I-5 Managed Lane Project in Los Angeles and Orange Counties. These disadvantaged communities are primarily located in Orange County, including areas in Anaheim, Santa Ana, and Garden Grove. The project route and adjacent study areas include a mix of disadvantaged communities and non-disadvantaged communities, suggesting varying levels of potential impact of VMT mitigation measures on different communities.

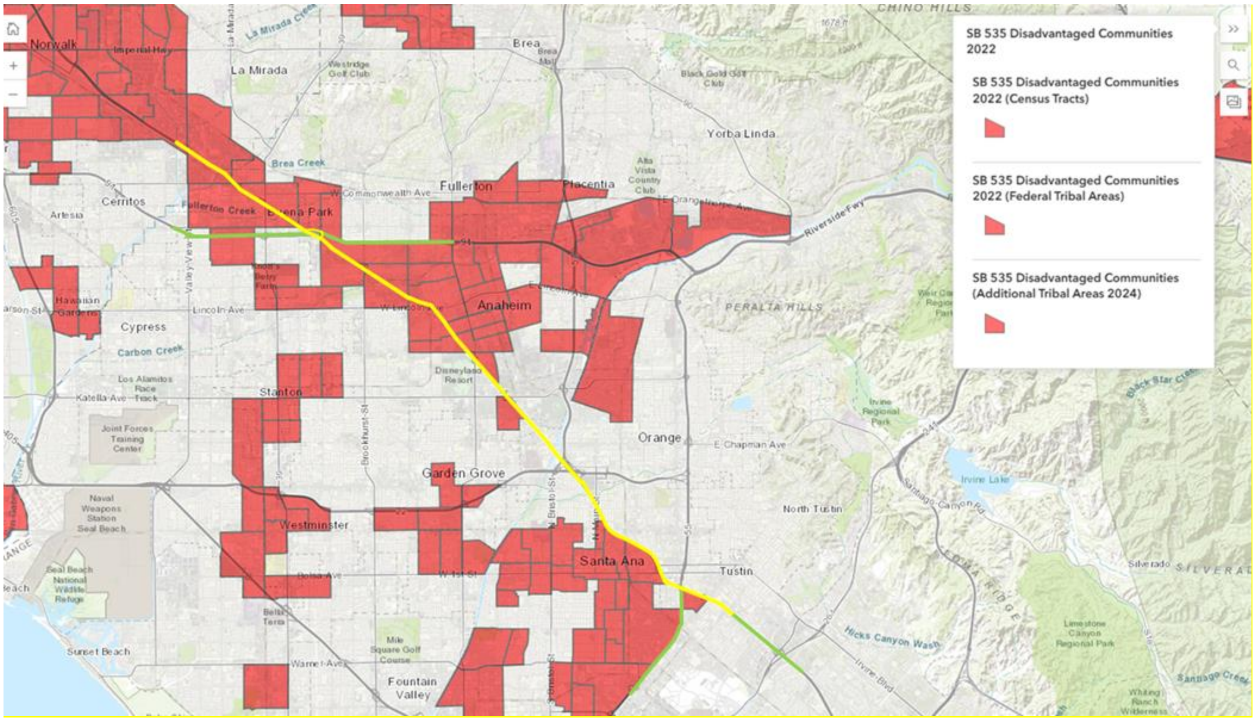

Figure 8. Project area (yellow line) and census tracts for Disadvantaged Communities from CalEnviroScreen 4.0.

The EIR/EA also defines the “Study Area”—the community surrounding the Project Area (i.e., the I-5 Managed Lane route itself) where secondary or indirect impacts may occur. Figure 9 highlights a high concentration of disadvantaged communities, particularly in Santa Ana, Anaheim, and Westminster, directly intersected by the project route. Among 45 census tracts designated as “Study Areas,” 20 are “disadvantaged communities” census tracts defined by CalEnvironScreen 4.0 and SB 535. These areas will likely experience direct impacts from the project, such as changes in traffic patterns, air quality, noise levels, and accessibility.

Figure 9. Census tracts defined as "Study Areas" along the I-5 Managed Lane Project Area.

To assess whether the project's five VMT mitigation measures would be implemented in a disadvantaged community, we first sought to compare the physical location of the measures to the maps of disadvantaged communities. However, the EIR/EA does not have sufficient locational detail for any of the measures to make the assessment. We also reviewed the EIR/EAs description of the measures to assess whether they would likely benefit at least some residents of disadvantaged communities, but the descriptions did not provide sufficient detail to answer that question either. For instance, it is not specified whether affordable housing projects under TR-1 would be located in disadvantaged communities or if transit service improvements under TR-2 and TR-3 would prioritize routes serving these areas. It is likely that the TR-5 bike facilities proposed for routes parallel to I-5 would pass through some of the disadvantaged communities affected by the project, but the routes are not sufficiently specified. To gain a comprehensive understanding of how VMT mitigation measures would be implemented in disadvantaged communities, further information is needed regarding:

- **Geographic targeting:** Will the implementation of VMT mitigation measures specifically target census tracts designated as disadvantaged communities?
- **Prioritization of projects and services:** Will the selection of affordable housing projects, transit routes for improvement, and locations for new bikeway facilities prioritize the needs of disadvantaged communities?
- **Community engagement:** How will Caltrans engage with residents of disadvantaged communities to ensure that VMT mitigation measures are responsive to their needs and concerns?

Displacement/Gentrification

Our second metric assesses whether the proposed VMT mitigation measures would cause immediate physical displacement of residences or businesses, and/or cause longer-term residential gentrification.

With respect to displacement, the EIR/EA intimates that none of the project's five VMT mitigation measures would physically displace any residences or businesses. And that conclusion makes sense for most of the proposed measures (TR-2 through TR-5), which focus on enhancing existing multimodal transportation options without expanding physical footprints, and as such would not likely physically displace any residences or businesses. TR-1, on the other hand, could conceivably contribute to direct displacement if the affordable housing funded by the measure were to be built on sites currently occupied by residences or businesses.

With respect to longer-term gentrification, we suggest using a tool like the Urban Displacement Project's Housing Precarity Risk Model to identify areas with high gentrification potential. Figure 10 shows the housing precarity scores for the Census tracts in the project area. VMT mitigation measures implemented in those areas could potentially contribute to gentrification, especially if they involve physical infrastructure, like housing or new bike facilities. However, the EIR/EA does not provide sufficient locational detail for the mitigation measures to assess whether the measures would be implemented in areas with high housing precarity risk. As a result, we base our assessment on the types of mitigation measures proposed and their respective gentrifying potential. Most of the proposed measures (TR-2 through TR-5) focus on enhancing existing multimodal transportation options without expanding physical footprints—even class II bike lanes, like those proposed in TR-5, are generally added to existing roads without much physical change to the roadway. These are all infrastructure-light solutions that likely have low gentrifying potential, even if they were to be implemented in areas with high housing precarity. On the other hand, new affordable housing developments (TR-1) could cause gentrification depending on type, pricing, and location of the housing. Because we do not have specific information about those characteristics, we mark TR-1 as having an unknown gentrifying potential. They would not directly displace existing uses (residences, businesses, parks, etc.) and would also not expand the existing transportation network much. Instead, the measures focus on increasing the service on the existing networks or otherwise incentivizing increased transit and active transportation use.

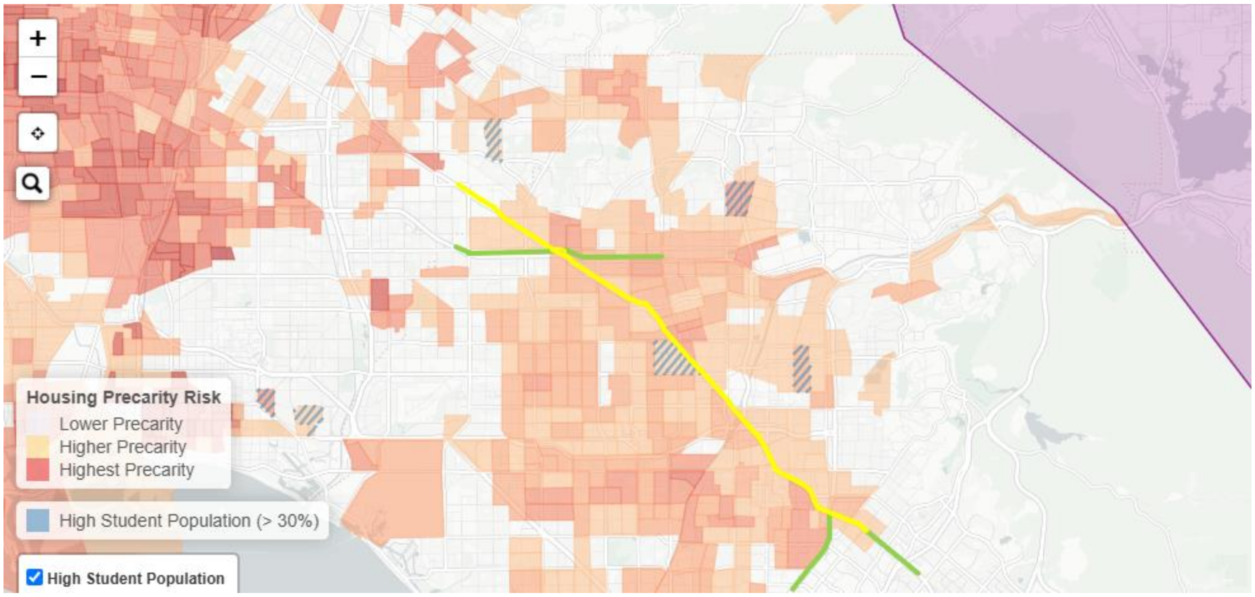

Figure 10. Housing Precarity Risk points at the census tract level from the Housing Precarity Risk Model. (Source: https://www.urbandisplacement.org/maps/housing-precarity-risk-model/)

Table 9 summarizes our conclusions for the five mitigation measures with respect to the displacement and gentrification metric.

Table 9. Equity analysis results (I-5 Managed Lanes): Gentrification/Displacement.

VMT Mitigation Measures	Longer-term residential gentrification: Would the VMT mitigation measures be implemented in an area with a high risk of gentrification?	Residential displacement near the VMT mitigation measure sites: Would the VMT mitigation measures cause physical displacement of existing housing units or residential areas (e.g., redevelopment, buyout, or eminent domain)?	Business displacement near the VMT mitigation measure sites: Would the VMT mitigation measures cause physical displacement of existing businesses (e.g., redevelopment, buyout, or eminent domain)?
TR-1: Housing Density and Affordability	Unknown	Unknown	Unknown
TR-2: New Transit Service (BRT, Increased Service)	Low	No	No
TR-3: Transit Efficiencies (Improve Existing Service)	Low	No	No
TR-4: Transit Pass Subsidies	Low	No	No
TR-5: Active Transportation (Bike – New Parallel Facilities)	Low	No	No

Access

Our third metric assesses whether the proposed VMT mitigation measures would increase accessibility to jobs and grocery stores. For future projects, we recommend conducting an accessibility analysis using a tool like Conveyal Analysis, which can run both single-point and regional accessibility analyses (Conveyal, 2024). Because we did not have access to Conveyal Analysis, we qualitatively assessed whether the project's five VMT mitigation measures would increase accessibility to jobs and grocery stores, using a three-part scale: "high," "low," and "unknown."

The VMT mitigation measures proposed for this project have a substantial potential to improve accessibility to jobs by enhancing public transit and active transportation options.

The EIR/EA and technical documents indicate that VMT mitigation measures, specifically those related to transit (TR-2, TR-3, and TR-4), would increase accessibility to jobs. While the EIR does not explicitly state that these measures are specifically intended to increase accessibility to jobs, the expansion of transit services generally improves access to various destinations, including employment centers. Additionally, the project includes the addition of park-and-ride facilities. These facilities, combined with the transit improvements, could also facilitate access to jobs. However, the EIR/EA does not provide enough information about the location of the affordable housing (TR-1) or bike lanes (TR-5) to assess whether and by how much they would increase job accessibility.

As for accessibility to basic services—we use grocery stores as a proxy here—the same mitigation measures related to transit (TR-2, TR-3, and TR-4) can also improve access to grocery stores. Although the EIR does not provide information about how many people or communities in the Study Area the VMT mitigation measures would affect, a community survey summarized in the EIR/EA indicated that the project corridor is used for access to groceries (42%) and healthcare services (33%), in addition to work and leisure.

Table 10 summarizes our conclusions for the five mitigation measures with respect to the accessibility metric.

Table 10. Equity analysis results (I-5 Managed Lanes): Access.

VMT Mitigation Measures	Would the VMT mitigation measure increase accessibility to jobs?	Would the VMT mitigation measure increase accessibility to grocery stores?
TR-1: Housing Density and Affordability	Unknown	Unknown
TR-2: New Transit Service (BRT, Increased Service)	High	High
TR-3: Transit Efficiencies (Improve Existing Service)	High	High
TR-4: Transit Pass Subsidies	High	High
TR-5: Active Transportation (Bike – New Parallel Facilities)	Unknown	Unknown

Community Approval/Community Engagement

Our fourth metric assesses how the proposed VMT mitigation measures have been received by community members in the area where the measures would be located, as well as the level of engagement and/or empowerment with the community. For this case study, we quantitatively measured engagement by tallying the number of community meetings and public comments, especially those that addressed VMT mitigation. For future projects, we recommend that the lead agencies also implement a qualitative assessment, asking project proponents to evaluate the level of community commitment to the proposed VMT mitigation measures. This assessment would use a four-point scale: "Very strong support," "Some support," "Limited knowledge or support," and "Unknown," with an option for textual elaboration. This approach is adapted from Barajas et al.'s (2022) recommendations to the Illinois Department of Transportation on community impact assessment.

During the environmental review process for the I-5 Managed Lanes Project, there were two public scoping meetings and two community equity workshops. The public scoping meetings were held in May 2022, with one in-person meeting and one virtual meeting, while the community equity workshops were held in October 2022 and March 2023. However, the EIR/EA does not provide any detailed information about the comments by these four community workshops. In addition to four community workshops, five Project Development Team (PDT) meetings were held regularly, with representatives from various agencies and organizations, though these were not public community meetings. According to the EIR/EA, participants in the regular PDT meetings discussed various aspects of the VMT process, including evaluating potential mitigations, the methodology and procedures under SB 743, and a summary of VMT methodologies and mitigations. Nevertheless, details about how VMT mitigation measures were assessed in the meetings remain unclear, as the meeting minutes were unavailable in the EIR/EA and associated reports. In addition to four community equity workshops and five PDT meetings, a community survey was conducted, which recorded 235 participants' responses, but these responses were not written comments and were mostly in response to specific questions. The survey was designed to fill gaps in understanding unfilled by traditional data sources used by the project's Equity Study, the CIA, and the Traffic Study. However, the sources do not provide a breakdown of how many comments focused specifically on VMT mitigation measures. It is possible that some of the general comments may have touched upon this topic, but the sources do not provide the level of detail to confirm this.

The EIR/EA notes that during the public scoping meetings, which included an in-person and a virtual component, one comment was provided to the court reporter at the in-person meeting, and two comments were provided to the court reporter at the virtual meeting. However, it is not specified whether these comments were related to VMT mitigation measures. While no written comment cards were received at the in-person meeting, general comments were received through the project email and regular mail. These comments included issues related to the scope of alternatives, the need for the project, right-of-way impacts, equity concerns, tolling, noise, and project cost. However, the number of written comments received is not specified, nor is whether any of them specifically addressed VMT mitigation measures.

The EIR mentions a desire for transparency and authenticity from government officials and representatives. It also highlights efforts to include minority and low-income communities in the engagement process, including language interpretation and targeted outreach to community organizations. Despite targeted outreach efforts, including equity-focused workshops aimed at engaging minority and low-income communities, attendance at the community workshops was low, with fewer than 15 public participants at each session. Workshop notices were disseminated through various channels, such as website postings, social media, geofenced advertisements, and postcard mailers. However, the workshops and surveys primarily focused on collecting input, rather than empowering the community to directly shape the project's decisions. For example, the workshops presented preliminary equity data maps, draft equity project goals, and key case studies, seeking feedback rather than collaboratively defining them.

Overall, it appears that the project team, rather than the community, was the primary force in identifying and evaluating potential VMT mitigation strategies. There is no evidence that the community was involved in co-creating the VMT mitigation strategies. Community engagement also seems limited to responding to ideas already developed rather than collaborating on development.

Geographic and Spatial Equity

Our fifth metric assesses geographical and spatial equity, specifically whether the VMT mitigation measures would be implemented in the same community as the primary project and, if not, whether they would be implemented in communities with similar poverty levels, ozone levels, PM2.5 levels, and vehicular traffic density, using CalEnviroScreen. For purposes of our case studies, we focus on the first question—whether the VMT mitigation measures would be implemented in the same community as the primary project.

The Community Impact Assessment Report for the I-5 Managed Lanes project defines two types of affected areas—Project Area (PA) and Study Area (SA). The Project Area is defined as the geographic area that would experience direct physical impacts during the construction phase of the proposed project. It is essentially the footprint of the construction activity and is coterminous with the maximum disturbance limits for each of the Build Alternatives under consideration. The Community Impacts Study Area encompasses the region surrounding the PA where secondary or indirect community impacts could occur. These impacts typically diminish as the distance from the project site increases. The SA generally extends to areas within a half mile of the PA, where most of the proposed improvements are planned. However, it excludes portions of the PA that involve only the installation of advance signage within state and local right-of-way, as such activities are not likely to have a community impact.

To facilitate the collection and analysis of community profile data, the Study Area is further divided into census tracts. Census tracts within the cities of Cerritos, Garden Grove, Irvine, La Palma, Norwalk, and Santa Fe Springs are generally excluded from the Study Area. Other Census tracts are defined as Census tracts excluded from consideration in the CIA due to their distance from the Project Area because the bulk of the population within those census tracts is more than a half mile from the Project Area.

TR-1 involves increasing housing density and affordability, aiming to reduce VMT by providing housing options closer to jobs and services. Mitigation may include contributing to affordable housing projects throughout Orange County, which may be outside the project's Study Area.

TR-2 (TDM) and the TR-3 (improving existing service) aim to reduce VMT by providing preferential parking for carpools and vanpools, offering financial incentives for participation, and increasing the frequency of bus and train service. However, the Community Impact Assessment and other documents do not clearly mention the spatial scope of each VMT measure. Nonetheless, they are likely to affect at least some residents of the Study Area.

TR-4 aims to offer discounted transit passes to residents, particularly low-income individuals, students, and seniors, ensuring that transit pass subsidy programs are accessible to all residents, particularly those in underserved communities. The TR-4 measure would likely be focused within the Study Area, where meaningfully greater minority and low-income populations than Orange County are concentrated, but it would also be implemented beyond both the Study Area and the Community Impacts Study Area.

TR-5 involves constructing new bike lanes, improving existing bike paths, providing bike parking facilities, and launching bike-sharing programs. The EIR/EA indicates that the measure would be implemented on routes parallel to the project, so it is likely that it would be implemented in either the Study Area or the Community Impacts Study Areas.

Conclusion

For nearly 50 years, LOS was the primary metric of transportation-related environmental impacts under CEQA. SB 743 upended the status quo, leading to VMT replacing LOS as the primary metric for analyzing the transportation impacts for CEQA purposes. We investigated the equity effects of VMT mitigation measures, developed a framework for evaluating those effects at the project level, and applied our framework to two highway expansion case studies in California: the Yolo 80 Corridor Improvements Project and the I-5 Managed Lanes Project. We found that most VMT mitigation measures proposed for the two case study projects would be implemented at least partially within the project impact areas, as well as some disadvantaged communities, but would generally benefit communities outside of the project area, too. We also found that most of the proposed mitigation measures would not displace existing residences or businesses or pose a significant risk of gentrification. Many of the measures showed substantial potential to improve accessibility to jobs, though less potential to improve accessibility to grocery stores. Community engagement and empowerment was harder to gauge. Overall, our five-part framework can provide a first-cut assessment of the equity effects of VMT mitigation measures during the environmental review phase of VMT-generating projects, like roadway expansions. However, our case study assessments were often stymied insufficient details in project documentation. A more comprehensive equity impact assessment would require more details about the VMT mitigation measures, including specific locations and specific target populations (e.g., for TDM-type measures). We also recommend using additional tools that we did not have access to for this project, including a tool like Conveyal Analysis for accessibility analyses and a qualitative assessment of community empowerment, in which the lead agency would evaluate the level of community commitment to the proposed VMT mitigation measures.

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