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Review of the Travel Demand Model Benchmarking Method Used to Estimate Induced VMT for the I-680 Express Lane Project

December 1, 2025

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UC DAVIS Institute of Transportation Studies

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Executive Summary

California policy has slowly shifted to both acknowledge and require analysis of the "induced travel" effect – the phenomenon whereby increasing roadway capacity increases vehicle miles traveled (VMT). For example, the California Department of Transportation's (Caltrans') Transportation Analysis Framework (TAF) requires analyzing the induced VMT effects of projects on the State Highway System as a part of the environmental review process under the California Environmental Quality Act. Because the TDMs currently used in California generally cannot pass the TAF's checklist for model adequacy for estimating project-level induced VMT, agencies are often faced with the decision to estimate induced VMT using either the California Calculator – an elasticity-based web tool that is based on empirical evidence of the induced travel effect – or employ a hybrid approach, where the applicable TDM is benchmarked to the California Calculator's induced VMT estimates. One of the early efforts to use benchmarking is the induced VMT analysis completed for the I-680 Northbound Express Lane Completion Project's (I-680 Express Lane Project's) Draft Environmental Impact Report/Environmental Assessment.

In this report, we review the empirical evidence on induced travel, discuss the limitations of using TDMs to estimate project-level induced VMT, and then examine the hybrid induced VMT estimation method used for the I-680 Express Lane Project. We find that the benchmarking method used for the I-680 Express Lane Project yielded significantly greater induced VMT estimates than the county's non-benchmarked TDM, but the estimates were still 32% to 54% lower than the California Calculator's estimates. More broadly, we find that benchmarking can yield similar induced VMT estimates to the elasticity-based estimation methods, and also has the added benefit of producing VMT outputs in a format (e.g., VMT by speed bins) that can be readily used as inputs to analyses of related impacts (like greenhouse gas emissions and local air pollutant emissions). However, for purposes of TAF compliance, benchmarking methods should be carefully examined to ensure that they are, in fact, yielding similar induced VMT estimates to the California Calculator.

Introduction

Over the last decade or so, California policy has slowly shifted to both acknowledge and require analysis of the "induced travel" effect – the phenomenon whereby increasing roadway capacity increases vehicle miles traveled (VMT). For example, the California Department of Transportation's (Caltrans') Transportation Analysis Framework (TAF), developed in response to SB 743, requires analyzing the induced VMT effects of projects on the State Highway System (SHS) as a part of the environmental review process under the California Environmental Quality Act (CEQA).

The TAF outlines methods for analyzing the induced VMT effect of SHS projects. For SHS expansion projects located withing metropolitan statistical areas, like Contra Costa County, the TAF recommends estimating induced VMT using either (1) the California Calculator (also called the "NCST Calculator") – an elasticity-based web tool based on empirical evidence of the induced travel effect that was developed by the National Center for Sustainable Transportation (NCST) and maintained by the Institute of Transportation Studies at the University of California, Davis,[1] or (2) a regional travel demand model (TDM) that passes a checklist of TDM mechanisms and modeling practices, and whose induced VMT results vary by no more than 20% from the California Calculator's estimates. If the TDM does not pass the checklist, the TAF recommends either using the California Calculator exclusively or using the California Calculator's estimates to benchmark the TDM results – effectively, to calibrate the TDM model run to achieve similar induced VMT estimates (Caltrans, 2020). One of the early efforts to use benchmarking – or "hybrid" approach – is the induced VMT analysis completed for the I-680 Northbound Express Lane Completion Project's (I-680 Express Lane Project) Draft Environmental Impact Report/Environmental Assessment (DEIR) (Caltrans & Contra Costa Transportation Authority [cited hereafter as "DEIR"], 2024).

In this report, we review and assess the hybrid induced VMT estimation method used for the I-680 Express Lane Project. This report proceeds as follows. The next (second) section provides background on induced travel. The third section summarizes the use – and capacities – of travel demand models to estimate project-level induced VMT. The fourth section summarizes and assesses the hybrid method used in the DEIR for the I-680 Express Lane Project. And the fifth section concludes.

[1] The California Calculator is available here: https://travelcalculator.ncst.ucdavis.edu

Background on Induced Travel

When we widen and extend roads, people drive more. This is the “induced travel”[2] effect—a net increase in vehicle miles traveled (VMT) across the roadway network due to an increase in roadway capacity. The basic economic principles of supply and demand explain this phenomenon. Adding capacity can increase the average travel speed on the roadway (at least initially), increase travel time reliability, and make driving on the roadway appear safer or feel less stressful. It might also provide access to previously inaccessible areas. All of these effects reduce the perceived “cost” of driving. And when the cost of driving goes down, the quantity of driving goes up (Figure 1). Short-term changes in behavior include changes in trip timing, route changes, shifts in travel mode, destination changes, and entirely new trips. Longer-term changes in residential and commercial locations as well as changes in land development patterns and auto ownership can also occur.

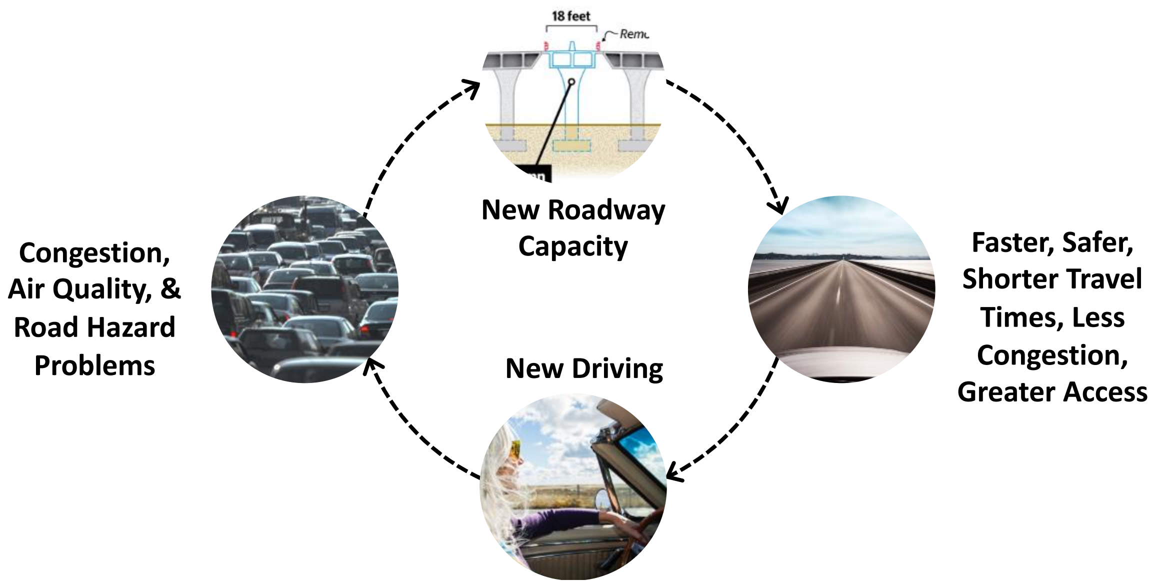

Figure 1. Induced Travel Effect of Roadway Capacity Expansions

A substantial body of high-quality evidence shows that roadway capacity expansion causes increases in VMT, as summarized in multiple recent literature reviews (Handy & Volker, 2025; Manville, 2024; Volker, 2025; Volker & Handy, 2022). The many studies synthesized in those reviews use time-series data and sophisticated statistical techniques to estimate the effect of increased capacity on VMT. All of those studies also control for other factors that might also affect VMT, such as population changes, income changes, geographic effects, and time period effects. In addition, most studies control for the endogeneity of roadway capacity—the possibility that VMT growth can cause roadway capacity expansion and not just the other way around.

In general, despite using different data, different geographies, and/or different control variables, the studies arrive at the same conclusion: the long-term elasticity of VMT with respect to lane miles centers around 1.0. This means that a 10% increase in lane miles is likely to increase VMT by 10% in the long-run

[2] This is often referred to as “induced demand.” Technically, however, induced demand is just one component of the overall induced travel effect. Induced demand is the increase in VMT attributable to an increase in population or businesses following a roadway capacity expansion. In economic terms, it is the portion of induced VMT caused by a shift in the driving demand curve following a shift in the roadway supply curve.

(within three to 10 years). In the short run (within 3 years), the empirical research indicates an elasticity of approximately 0.3-0.8. The evidence also shows that additional traffic on the new or widened highway is not simply traffic that shifted from slower and more congested roads but is actually an overall increase in VMT across the network (Duranton & Turner, 2011; Hansen & Huang, 1997).

The empirical studies mostly focus on major general-purpose roadways including interstates (designated by the Federal Highway Administration [FHWA] as class 1 facilities), other freeways and expressways (class 2), principal arterials (class 3), and minor arterials (class 4), and show a potentially greater effect for interstates. Expansions of collectors (classes 5 and 6) and local roads (class 7) are also likely to induce VMT, though the effect might be smaller (lower elasticity) and the empirical evidence as to the relative magnitude of the effect is limited (Noland, 2025).

With respect to managed lanes, both theory (Manville, 2024) and the available evidence (Anderson et al., 2021) suggest that new high-occupancy vehicle (HOV) lanes and high-occupancy toll (HOT) lanes likely have similar induced travel effects as general-purpose lane expansions. Indeed, on very congested roadways, adding an HOT or pure toll lane could induce greater VMT than adding a general-purpose lane, assuming the lanes are priced so as to prevent congestion to the point where traffic becomes so dense that both speed and flows decrease (Small & Chu, 2003).

Empirically, Anderson et al. (2021) estimated the short-run effects on traffic flows of four capacity expansion projects in California, used time series loop detector data and a statistical regression method that isolates the effect of the intervention (the capacity expansion) by controlling for temporal trends. The four projects they studied include one project that added general-purpose lane miles and three projects that added either HOV or HOT lane miles. They estimated "implied" short-run (one- or two-year time period) induced travel elasticities for all four study sites, calculated as the ratio of the percentage change in total traffic flows (across all lanes combined) to the percentage change in total lanes.[3] Table 1 shows the elasticities, which are actually higher for the managed lane projects (ranging from 0.334 to 0.843) than for the general-purpose lane project (0.152).

[3] See Volker and Handy (2022) for a fuller summary of the research design and statistical analyses that Anderson et al. (2021) used.

Table 1. Implied Elasticity Estimates for the Four Study Sites from Anderson et al. (2021)

Expansion Project Name	Roadway	County	Year of Expansion	Type of Expansion	Change in Total Lanes	Change in Total Flows	Implied Short-Run Elasticity
I-580 Express Lanes	I-580 (class 1)	Alameda	2016	One new HOT lane	+25% (4 to 5)	+17.5%	0.700
West County Connectors	I-405 (class 1)	Orange	2014	One new HOV lane and new connectors	+14% (7 to 8)	+11.8%	0.843
San Bernardino Widening Project	I-215 (class 1)	San Bernardino	2010	One new HOV lane and one new general-purpose lane	+67% (3 to 5)	+22.4%	0.334
Caldecott Tunnel Fourth Bore	SR-24 (class 2)	Alameda and Contra Costa	2013	Two new general-purpose lanes	+100% (2 to 4)	+15.2%	0.152

Source: Anderson et al. (2021, pp. 13, 66).

While Anderson et al.'s (2021) facility-level analyses assess traffic flows (not VMT) and do not capture the expansion projects' full regional effects on travel and are not necessarily generalizable to other locations, the results nonetheless indicate that the induced travel effect for HOV and HOT lanes can be just as large as the effect for general-purpose lanes. Volker (2025) details additional empirical evidence from California that supports those conclusions. Two additional pieces of empirical evidence from California support those conclusions.

First, Bento et al. (2014) analyzed loop detector data from all freeways with HOV lanes in the Los Angeles metro areas at the beginning and the end of a policy that allowed vehicles with a "clean air vehicle" sticker to use HOV lanes alongside high-occupancy vehicles. Using a regression discontinuity model, they found statistically significant short-run increases in traffic flows on the region's HOV lanes, but no statistically significant change in flows on the general-purpose lanes. The authors concluded that while "policymakers may have expected congestion decreases in the mainline to be a potential benefit of the policy, these results are suggestive of the presence of induced demand" (Bento et al., 2014, p. 19).

Second, Caltrans loop detector data from 2024 show that the average annual traffic flows on the state's HOV and HOT lanes were higher than on the adjacent general-purpose lanes. Flows on the HOV and HOT lanes averaged 1,046 vehicles/hour/lane across the morning and afternoon peak periods (5am-10am, 3pm-8pm), about 2% higher than on the adjacent general-purpose lanes during the same time periods (1,029 vehicles/hour/lane) (Caltrans, 2025). The similar flows indicate that, despite their access restrictions, HOV and HOT lanes will eventually reach similar flows as general-purpose lanes during periods of peak congestion. That in turn suggests that adding HOV and HOT lanes has induced travel effects (elasticities) similar to those of general-purpose lane expansions, assuming that traffic flows in the general-purpose lanes do not decrease after the managed lane addition. The findings from both Anderson et al. (2021) and Bento et al. (2014) support that assumption.

In terms of location, the research shows that induced travel occurs in both urban and rural areas and on roadways with different levels of existing congestion (see summaries in Volker and Handy [2025], Volker [2025], and Volker and Handy [2022]). Indeed, induced travel can be expected to occur anytime a project increases average travel speed, increases travel time reliability, makes driving on the roadway appear safer or feel less stressful, or provides access to previously inaccessible areas. However, the induced travel effect might be slightly smaller in rural areas, at least in the short run (Duranton & Turner, 2011; Noland, 2001; Rentziou et al., 2012). For example, Noland (2001) found slightly larger longer-term elasticities in urban areas than in rural areas for class 1 and 2 roads combined (~0.8 v. ~0.75) and class 3 and 4 roads combined (~0.8 v. ~0.7). Conversely, the limited available evidence indicates that metropolitan areas with higher baseline levels of congestion could potentially have lower elasticities than metro areas with less congestion (Chang et al., 2023). This could possibly result because it takes relatively greater capacity expansions to reduce congestion (at least initially) or otherwise reduce the perceived cost of driving in areas with worse and more geographically pervasive congestion across the roadway network. Regardless, the body of research on how congestion affects induced VMT elasticities is far too limited to be conclusive one way or the other (Volker, 2025; Volker & Handy, 2025).

Using Travel Demand Models to Estimate Induced VMT

MPOs rely on travel demand models to forecast the outcomes of transportation investments. TDMs were originally used primarily to determine how much additional roadway capacity was needed in the future to maintain acceptable levels of congestion, but are now used for a wide array of purposes, including assessment of environmental impacts. The TDMs used today in California were designed for operation at the regional level, primarily to assess outcomes of regional plans. However, these models, or versions of them, are also used today by other agencies to assess outcomes of individual projects. For all of these use cases, the ability of a TDM to accurately forecast VMT, which requires accurate forecasting of induced VMT, is an indicator of its ability to accurately forecast other outcomes, including both congestion and environmental impacts.[4]

To forecast project-level VMT accurately, a TDM must fully account for the effect of changes in travel time (and travel cost, more generally) on travel behavior (Deakin et al., 2020; Fehr & Peers, 2025; Handy et al., 2024; Milam et al., 2017). That is difficult to do. At the very least, the TDM should incorporate "feedback" loops in the model in which the travel times estimated by the model are fed back into each of the elements of the model. Known as the "iteration" of travel times, this practice ensures that estimates of different aspects of travel behavior are sensitive to changes in travel time resulting from changes in roadway capacity. These presence of these feedback loops differs from model to model, and activity-based models (ABMs) tend to include more feedback loops than the more common 3- or 4-step models (Handy et al., 2024). However, ABMs tend to be much "noisier" than 4-step models because they use stochastic simulation (Zhou et al., 2023). This is especially pronounced when estimating the effect of a single roadway expansion project, and can make it difficult to identify the "signal" (the induced VMT) through the noise (Lee & Chang, 2020). Furthermore, no TDM currently used in California – ABM or not – has a feedback loop to the land use effects of transportation investments that is sufficiently sensitive for project-level assessment (Fehr & Peers, 2025).

Fehr & Peers' (2025) recent review of California TDMs for Caltrans identifies numerous additional limitations of TDMs that hamper their ability to accurately forecast project-level induced VMT. For example, most TDMs use static rather than dynamic trip assignment, which can lead to major errors in induced travel assessment on congested corridors. Another limitation is that maximum speeds are held artificially low in most TDMs. Underrepresenting maximum speeds suppresses the amount of induced VMT forecasted by the TDM by overestimating travel times and thus suppressing the appeal of longer trips.

In part because of the absence of key feedback loops, in part because of the other limitations of TDMs, in part because we often lack empirical evidence on the magnitude of each feedback loop, and in part due to statistical noise in the model outputs, the TDMs in use today regularly and – and sometimes substantially – underestimate project-level induced VMT. One study compared induced VMT estimates based on TDMs to estimates based on the elasticity-based California Calculator for a sample of projects in California and found that VMT was underestimated by as much as a factor of 10 (Volker, et al. 2020). Another study did a sensitivity analysis of three MPOs' TDMs and found underestimation of induced VMT up to 102% and overestimation of reductions in travel time up to 236% when feedback to land use was not included (Rodier, 2004). Even for shorter-term forecasts, TDMs often underestimate the effects of induced travel. For example, Hoque et al. (2022) compared forecasted average daily traffic (ADT) versus observed post-opening (short-term) ADT for hundreds of road projects in the US and Europe. For the subset of projects that expanded roadway capacity, the study found that the average observed counts exceeded forecasted

[4] For example, if the model provides an underestimate of VMT, it is also underestimating volumes and misestimating vehicle speeds, and for all of these reasons it will misestimate air pollutant and greenhouse gas emissions.

ADT, which the authors concluded “could reflect capacity expansion projects generating more induced traffic” not captured in the forecasts (Hoque et al., 2022, p. 458). Furthermore, TDM predictions of speeds and travel time savings from roadway expansions are notoriously unreliable (Metz, 2021, 2023).

In the TAF, which guides project-level analysis of induced VMT for projects on the State Highway System, Caltrans (2020) establishes a number of criteria for TDM features and characteristics that are needed for accurate assessment of induced travel in CEQA analyses of transportation impacts, including that the TDM’s “specification of future land use” must be “sensitive to travel time and cost” (p. 21) – the land use feedback loop just mentioned. If the TDM does not pass the checklist, the TAF recommends either using the California Calculator exclusively or using the California Calculator’s estimates to benchmark the TDM results – effectively, to calibrate the TDM model run to achieve similar induced VMT estimates (Caltrans, 2020).

For the I-680 Express Lane Project, the Contra Costa Transportation Authority’s (CCTA’s) four-step model (Countywide Model) was used to help with project-level transportation impact analyses. Because the Countywide Model does not meet the criteria specified in the TAF, the DEIR uses a hybrid approach to estimate the VMT impacts from the project (DKS, 2023, Appendix A, p. 11). The approach runs the California Calculator’s induced VMT estimate for the project and uses the result to calibrate the Countywide Model.

Assessing the Hybrid Method Used to Estimate Induced VMT for the I-680 Northbound Express Lane Completion Project

Background and Project Description

Caltrans and CCTA have proposed the I-680 Express Lane Project to fill in a "gap" in the existing managed lane system between Crow Canyon Road (PM R4.4) and Marina Vista Avenue (PM 24.5) in western Contra Costa County. The project is currently undergoing environmental review, pursuant to CEQA and the National Environmental Policy Act (NEPA). The DEIR for the project was published in May 2024 (Caltrans & CCTA, 2024). A final EIR has not yet been published and the project has not yet been approved. Figure 2 shows the project site.

Figure 2. I-680 Express Lane Project Location (Source: DEIR, p. 1-3)

The DEIR analyzes a no-build alternative and the following four build alternatives (DEIR, pp. S-ii to S-iii):

- Alternative 1C would add a high-occupancy toll (HOT) lane (i.e., an express lane) on northbound I-680 from Livorna Road to SR-242 (an addition of approximately 7.5 lane miles) and convert the existing high-occupancy vehicle (HOV) lane to an HOT lane from SR-242 to the Arthur Road on-ramp. This alternative would also realign southbound I-680 through the SR-24 interchange.
- Alternative 2 would also add an HOT lane on northbound 1-680 from Livorna Road to SR-242, albeit with a 2-mile gap through the SR-24 interchange (an addition of approximately 5 lane miles), and convert the existing HOV lane to an HOT lane from SR-242 to the Arthur Road on-ramp. This alternative would also construct braided ramps between the Lawrence Way on-ramp and the Treat Boulevard off-ramp.
- Alternative 3 combines alternatives 1C and 2, adding approximately 7.5 HOT lane miles to northbound I-680 and making all other modifications included in alternatives 1C and 2.
- Alternative 5 would not add any new HOT lane miles. Instead, it would convert the inside general-purpose lane to an HOT lane from south of North Main Street to SR-242. It would also construct braided ramps between the Lawrence Way on-ramp and the Treat Boulevard off-ramp and convert the existing HOV lane to an HOT lane from SR-242 to the Arthur Road on-ramp.

Summary of the Induced Travel Estimation Method for the I-680 Express Lane Project

The DEIR uses a hybrid approach to estimate the VMT impacts from the I-680 Express Lane Project. The approach is described in detail in the I-680 NB Express Lane Completion Project Traffic Operations Analysis Report (DKS, 2023). It involved running the California Calculator for the project and using the induced VMT result to benchmark the CCTA's 4-step TDM (the Countywide Model). The benchmarking method included the following steps (DKS, 2023, Appendix A, pp. 12-16):

1. The analysts used NCST calculator to estimate the annual VMT induced by adding 6.41 interstate lane miles in the San Francisco-Oakland-Hayward metropolitan statistical area (which encompasses the I-680 Express Lane Project location). They then divided the total by 365 to get an estimate of average daily induced VMT. The Calculator predicted induced VMT of 49.6 million annually from adding the 6.41 lane miles, or 135,890 induced daily VMT.
2. The analysts then created a "benchmark" travel demand model network, starting with the 2047 (design year) no-build network. To the base 2047 network, they then added a new general-purpose lane to northbound I-680, stretching from the northern end of the existing HOT lane at Livorna Road to the beginning of the existing HOV lane at Willow Pass Road.
3. The analysts used the benchmark network with the new general-purpose lane to run a select link analysis with the Countywide Model. The select link analysis identified the origins, destinations, and VMT for trips that use the sections of I-680 where the I-680 Express Lane Project would add new HOT lane miles. The analysis identified trips on four segments of I-680 for the 4-hour AM peak period, the 4-hour PM peak periods, and the off-peak period, resulting in a matrix of origins and destinations that use the four identified segments.
4. The analysts then used the Countywide Model to run initial traffic assignments for both the benchmark scenario (the 2047 no-build network with 6.41 new general-purpose lane miles) and the 2047 no-build scenario. They used the results to calculate travel time and travel time savings for the studied sections of I-680 in the benchmark scenario compared to the no-build scenario.

5. The analysts then used the travel time savings estimates to derive an induced VMT adjustment factor that could be applied to the select origin-destination trips using each segment of the corridor to increase total trips and total VMT forecasted by the Countywide Model to more closely align with the Calculator's induced VMT estimate than the model's unadjusted estimates. The underlying assumption is that the increase in trips (and induced VMT) on each affected segment is proportional to the travel time savings on that segment. After three test iterations, they calibrated the induced VMT adjustment factor at 0.0064, which resulted in an induced VMT estimate for the benchmark scenario with 6.41 miles of new general-purpose lanes that was within 1.9% of the induced VMT estimated by the Calculator. They applied the adjustment factor using the following formula:

   $$Additional\ Induced\ Trips = Select\ Link\ Trips * Travel\ Time\ Savings * Induced\ VMT\ Factor$$

   (Eq. 1)

6. The analysts then applied the induced VMT adjustment factor (0.0064) within the Countywide Model for each of the three build alternatives for the I-680 Express Lane Project that would add new lane miles (alternatives, 1C, 2, and 3). For each of the three build scenarios, they first coded the proposed new HOT lanes into the Countywide Model network, then ran the model and traffic assignments without the induced VMT adjustment factor. They then compared the AM and PM peak period travel times on the study segments to the no-build travel times to estimate potential travel time savings for the build scenarios. For each of the build alternatives, they estimated the additional induced trips by multiplying the average travel time savings for each group of select link trips by the number of trips in each group and the induced VMT adjustment factor, per Equation 1. They then used the Countywide Model to assign the adjusted trips to the road network and estimate VMT with the additional trips.
7. The final step the analysts took was to remove trucks from the VMT estimates for the studied alternatives, pursuant to state guidance. To do so, they simply used the current percentage of truck traffic in the region to reduce the total VMT and induced VMT estimates for all studied alternatives by the same proportion.

Table 2 shows the adjusted VMT estimates reported in the DEIR for the no-build scenario and the three build alternatives that would add HOT lane miles to the network. For comparison, the California Calculator (135,890 daily induced VMT) and the adjusted Countywide Model (~133,300 daily induced VMT) both estimate substantially greater induced VMT for the benchmark scenario of adding 6.41 general-purpose lane miles. The hybrid approach thus results in at least a 29% lower induced VMT estimate for all HOT lane alternatives versus a general-purpose lane alternative, despite the fact that the general-purpose lane alternative would add fewer lane miles than two of the HOT lane alternatives. The Traffic Operations Analysis Report explains the lower induced VMT estimates for the HOT lane alternatives as follows:

Various express lane alternatives may result in lower weighted average travel time savings than the general-purpose lane addition used to benchmark the analysis. This is because pricing would be used to limit the traffic volume on the express lane to a maximum of approximately 1,650 vehicles per hour to ensure acceptable operations, compared to maximum volumes of over 2,000 vehicles per hour that could use a general-purpose lane.

(DKS, 2023, p. 16).

Table 2. VMT Estimates from Adjusted Countywide Model

Alternatives	No Build	1C	2	3
2027 Daily VMT	102,853,478	102,922,450	102,916,580	102,925,286
2047 Daily VMT w/ Trucks	115,101,953	115,204,075	115,186,351	115,204,937
2047 Daily VMT w/o Trucks	111,404,543	111,503,933	111,486,896	111,504,529
2047 Daily Induced VMT w/ Trucks (difference from no-build)		102,122	84,398	102,985
2047 Daily Induced VMT w/o Trucks (difference from no-build)		99,389	82,353	99,986

Source: DEIR, Table 3.2.17-1, pg. 3.2-43

Assessment of the Induced Travel Estimation Method for the I-680 Express Lane Project

The approach described here uses the California Calculator's induced VMT estimates to benchmark – effectively, to calibrate – CCTA's Countywide Model. One benefit of the approach vis-à-vis using a non-benchmarked TDM is that it reduces the likelihood of underestimating induced VMT by using an average effect based on empirical induced travel studies. As compared to off-model induced VMT estimation tools, the benchmarking approach offers the benefit of producing VMT outputs in a format (e.g., VMT by speed bins) that can be readily used as inputs to analyses of related impacts, like greenhouse gas emissions and local air pollutant emissions. This reduces the likelihood that the VMT-related estimates used in any of the other analyses underestimate induced travel and thereby underestimate the greenhouse gas emissions, local air pollutant emissions, or other impacts. However, depending on where on the model's road network the additional VMT is loaded, benchmarking could lead to over- or underestimation of traffic volumes and speeds on particular links, which could also bias the estimation of greenhouse gas emissions, air pollution, or other impacts.

The benchmarking approach also has multiple risks and drawbacks. One primary disadvantage of benchmarking in general is that it can diminish the TDM's accuracy beyond VMT estimation, including for project-level forecasting, including for VMT, traffic flow, and speed outcomes. However, as discussed above, even non-benchmarked TDMs are frequently inaccurate and unreliable in forecasting those outcomes.

We also have specific concerns with the hybrid approach used for the I-680 Express Lane Project, including the following four. First, neither the DEIR nor the traffic operations report explains why the hypothetical general-purpose project used to calibrate the Countywide Model is only 6.41 miles long. That is more than one lane mile less than the length of the HOT additions proposed in alternatives 1C and 3, which makes the hypothetical project and its induced VMT estimates less comparable to the build alternatives.

Second, the method assumes that managed lanes will result in less travel time savings, and thus induce less VMT, than general-purpose lanes. For the hypothetical 6.41-mile general-purpose lane addition used in the traffic operations analysis report to calibrate the Countywide Model, the Calculator estimated 135,890 induced daily VMT (DKS, 2023). That is nearly 32% higher than the highest induced VMT estimates (with trucks, since the Calculator's estimate also includes trucks) for the three build scenarios – 102,985 for alternative 3 – as shown in Table 2. The difference would be even greater – increasing from 32% to 54% – if the hypothetical general-purpose lane project added the same number of lane miles as alternatives 1C and 3 (about 7.5 miles). As discussed in depth above, both theory (Manville, 2024) and the available empirical evidence (Anderson et al., 2021; Bento et al., 2014; California Department of Transportation, 2025) suggest that HOV and HOT lanes likely have similar induced travel effects as general-purpose lane expansions, not substantially smaller effects like those estimated by the benchmarking method for the I-680 Express Lane Project.

Third, it appears that the method adjusts the trips (and thus VMT) only for the AM and PM peak periods, and not for the remaining times of day. In its summary of how the induced VMT adjustment factor is applied for the build alternatives, the traffic operations analysis report states that the method just “[c]ompare[s] the congested AM and PM peak period travel times on the study segments to the No Build travel times to determine potential travel time savings” (DKS, 2023, Appendix A, p. 15). However, induced travel can also occur outside of peak periods. If the method does indeed adjust only the peak-period trips and not the off-peak trips, it would underestimate total induced VMT and also misestimate the temporal distribution of the VMT. This is evidenced by results from the same study’s own benchmarking exercise, which adds a hypothetical general-purpose lane and finds travel time savings for all relevant segments in the peak and off-peak periods alike (DKS, 2023, Appendix A, p. 15). Indeed, the benchmarking model run indicated greater time savings in the off-peak period for the north segment (SR-24 EB on-ramp to SR-242) than during the AM peak period.

Fourth, from the perspective of the TDM’s behavioral integrity, the benchmarking method puts too much emphasis on travel time savings as the sole cause of induced travel. Travel time savings are a key driver of induced travel, but they are not the only driver. Other factors include increased travel time reliability (at least initially), making driving on the roadway appear safer or feel less stressful, and/or providing access to previously inaccessible areas (Volker, 2025).

An alternative approach to benchmarking would be to use the California Calculator or another elasticity-based tool to estimate the induced VMT from a project. GHG emissions and local air pollutant emissions could then be estimated by multiplying the induced VMT estimate by emissions factors that account for regional vehicle fleet composition and traffic speed distributions. For example, the SHIFT Calculator estimates both project-induced VMT, using an approach based on the California Calculator, and cumulative GHG emissions through 2050 from that induced VMT (Rocky Mountain Institute, 2021).

Conclusions

Caltrans' Transportation Analysis Framework recommends estimating project-level induced VMT using either (1) the elasticity-based California Calculator, or (2) a regional travel demand model (TDM) that passes a checklist of TDM mechanisms and modeling practices. Since effectively no TDM currently used in California passes the TAF checklist, agencies are often faced with the decision to either use the California Calculator or employ a hybrid approach, where the applicable TDM is benchmarked to the California Calculator's induced VMT estimates. Benchmarking can yield similar induced VMT estimates to the California Calculator (or other elasticity-based estimation method). It also has the added benefit of producing VMT outputs in a format (e.g., VMT by speed bins) that can be readily used as inputs to analyses of related impacts (like greenhouse gas emissions and local air pollutant emissions), which can increase consistency in the VMT estimates used across the various impact analyses and reduce the chance that those analyses underestimate project effects by failing to account for induced travel. However, for purposes of TAF compliance, benchmarking methods should be carefully documented and they should be examined to ensure that they are, in fact, yielding similar induced VMT estimates to the California Calculator. Significant inconsistencies should be justified. Benchmarking methods should also be examined to ensure that the traffic volume and speed outputs for the affected network links are reasonable. The benchmarking method used for the I-680 Northbound Express Lane Completion Project's DEIR yielded significantly greater induced VMT estimates than the non-benchmarked TDM, but the estimates were still 32% to 54% lower than the California Calculator's estimates based on the empirical literature.

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