STREETLIGHT InSight

SB 743 VMT Metric Methodology and Validation White Paper

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STREETLIGHT

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Introduction

This technical document describes the data sources, methodology, and validation processes used by StreetLight Data to develop a set of VMT measurements (our SB 743 Metric) to address California Senate Bill 743. As a result of SB 743, there are many applications for our Metric, however we developed this Metric with two specific use cases in mind: screening projects (streamlined review for residential and office projects located in low VMT generating areas); and analyzing comparable sites (trip generation, trip length, and VMT estimation for comparable sites to estimate VMT generation for your own site). We expect many more use cases to come out of SB 743 and we invite you to share other examples and applications for this Metric, along with requests for any new data products that may emerge. This document will be updated as the Metric evolves and adapts to meet the needs of organizations fulfilling the goals of SB 743 and environmental impact analysis compliance.

Background on California SB 743 and Data Needs

California Senate Bill 743 (SB 743) was signed in 2013 and later incorporated into the California Environmental Quality Act (CEQA) in 2018. Starting July 1, 2020, all new land-use development and transportation projects will be expected to evaluate transportation impacts under CEQA using vehicle miles traveled (VMT) instead of Level of Service (LOS). While LOS requires the estimation of traffic volumes on the roadway, typically conducted by manual surveys or tube counts, calculating baseline VMT for SB 743 requires data on the amount of vehicle trips, trip lengths, and vehicle occupant classification (resident vs. employee).

Unfortunately, traditional data collection methods cannot provide the nuanced details needed to comply with SB 743—the length of entire trips or the classification of a vehicle as a resident or employee of the area—at a reasonable cost. Instead, planners typically turn to local travel demand models which are based on periodic household or employer travel surveys. When it comes to estimating VMT with models, there are some limitations:

- Surveys are expensive, time consuming, and respondents may suffer from recall biases.
- Models are computationally expensive as well as technically difficult to manage.
- Models are geographically constrained, and depreciate in accuracy as the model approaches regional boundaries.
- Most models are aggregated to a geography such as TAZ, making them unable to capture local behavioral nuances.
- Models are updated infrequently and rely on outdated travel surveys.
- Models expand from a relatively low sample size and limited geographies, especially in non-urban communities.

Travel demand models perform a crucial role in land-use scenario planning, and they also offer a solution for estimating macro-level VMT trends. However, due to the stringent specifications of SB 743, developers, planners, and policy makers need granular, up-to-date VMT estimates with more precision.

The Locational Data Approach to VMT

The CEQA Guidelines and previous case law have raised expectations for lead agencies performing technical analysis to use the "best available data." Extending this expectation to VMT spotlights some limitations in using travel demand models, especially those developed for regional applications (i.e., MPO models). Travel demand models are equipped to simulate regional trends, they often lack the nuances of local travel patterns due to the sparseness of the household travel surveys that underpin them. For VMT estimation, Location Based Data (LBS) serves as a powerful alternative for the following reasons:

- Estimations are based on a large sample size that can cover 365 days a year.
- Trips are tracked from start to finish with no boundaries.
- Trips in different geographic regions can be compared apples-to-apples, without concern for whether the underlying survey data is dissimilar.
- The region of analysis can be as small (parcel) or as large (county, MPO) as desired.
- StreetLight's Metric is updated every month.
- StreetLight has historical data from the last few years, allowing for temporal comparisons.

While LBS is not a perfect source (it still relies on a sample which is subject to sampling biases, privacy restriction, etc.), it is superior to regional travel demand models in estimating granular VMT patterns especially for individual land use types, trip purposes, and vehicle occupants because of its large sample size and historical availability.

Development of StreetLight's SB 743 Metric

Following SB 743's ratification in 2013, the California's Governor's Office of Planning and Research (OPR) developed a technical advisory to outline the important questions to be answered in VMT estimation and impact analysis. We designed our SB 743 Metric specifically to meet the expectations outlined in OPR's technical advisory.

The policy goal for SB 743 is to reduce greenhouse gas emissions and other environmental impacts by quantifying and mitigating VMT that results from new developments. Since developments take many forms, central in the technical advisory's recommendation is that VMT should not be measured by a single factor. Instead, VMT calculations, to the extent possible, should account for the full length of vehicle trips, the occupant (i.e., resident, worker, or visitor), and the purpose of the trip. VMT reporting segmented along these lines will allow planners to articulate the impacts of new developments more precisely.

Methodology for Measuring SB 743 with Locational Data

The following are the steps that we take to ingest LBS data and produce our SB 743 VMT Metric in accordance with OPR guidelines.

STEP 1: GET TRIPS

First, we retrieve a set of trips from the billions of trips in our repository for a specific data period and geography. Trips are created using anonymized locational records, passively collected from smart phones, and grouped into key patterns. (see this link for our standard methodology document)

STEP 2: ASSIGN TRIPS TO RESIDENCE STATUS

From these travel patterns, we can infer probable home and work locations for composite groups of people. 'Home' and 'Work' locations are determined based on the frequency of daytime and nighttime hours of the devices responsible for the trips and land use (contact your StreetLight representative for more details on our Home and Work locations methodology.) In each zone, devices with home or work locations in that Block Group are considered 'Residents' or 'Workers,' respectively. All other devices are considered 'Visitors.'

STEP 3: ASSIGN TRIPS TO PURPOSES

Trip origins and destinations are sorted into 'Home,' 'Work,' or 'Other' based on proximity to that device's home and work locations. Next, the trips are distributed to their appropriate trip purpose bin, as demonstrated in Figure 1.

	Home-to-Work (H2W)	Work-to-Home (W2H)	Home-to-Other (H2O)	Other-to-Home (O2H)	Work-to-Other (W2O)	Other-to-Work (O2W)	Other-to-Other (O2O)
Resident VMT							
Employee VMT							
Visitor VMT	n/a	n/a					

Figure 1: SB 743 requires trips be segmented by trip purpose and residence classification. The table above demonstrates the possible combinations trips are sorted into. N/A's exist because if a trip started or ended at a home or work location, the device cannot be classified as a visitor.

It's important to note that the OPR technical advisory recommends inter-regional trips to be counted in both the origin region and the destination region.

STEP 4: AVERAGE TRIP LENGTH

Next, we calculate the average trip length and the volume of trips for each combination of residence status and trip purpose.

STEP 5: CALCULATE VMT PER DEVICE-DAY

After trips have been assigned and expanded to real-world estimations, the next step is to normalize VMT per device-day. Residence VMT and Employee VMT are divided by the number of days residents[1] and employees[2] devices are active, respectively.

Step 6: Summarize Based on OPR Classifications

Finally, in order to apply our Metric to proposed developments, we summarize the VMT/Device-Days based on OPR's recommendations for VMT classifications, visualized in Figure 2.

	H2W	W2H	H2O	O2H	W2O	O2W	O2O
Resident VMT							
Employee VMT							
Visitor VMT	n/a	n/a					

Figure 2: The table above is color coded to indicate our relevant Metrics for assessing residential and commercial developments. Impact of employees is assessed based on their trips to and from work. Impact of Residents are assessed based on all trips to or from home.

These classifications are important because our VMT estimations can be used for mixed-use development projects, such as ones with 200 residents and 50 employees. OPR partnered with a handful of expert stakeholders to develop this technique using 5 case studies as examples.

Step 7 (Optional): Obtain Regional Comparisons for a Screening Map

One specific application OPR calls for is a screening application to determine if a proposed development location is in an area of 'less than significant impact.' The assessment area, a Block Group for example, is compared against the City, County, and MPO VMT averages. To calculate regional VMT averages, we take the product sum for all of the sub-geographies. Since inter-regional trips may be counted as 'resident' in the origin region but 'employee' in the destination region, it's important to summarize each residence status separately, in order to avoid double-counting these trips.

Validation of Our SB 743 VMT Metric

Fehr & Peers (F&P), a consulting firm, performed an independent validation of our results. In the validation, F&P compared our SB 743 Metric to results from the Sacramento Council of Government (SACOG)'s Activity Based Model, SACSIM. SACSIM synthesizes region-wide daily travel patterns collected from their household survey done in 2018. SACOG has one of the most robust survey/demand model processes, and a very diverse set of communities and land uses, making it a good candidate for validation. Placer County was selected as the specific jurisdiction for comparison.

[1] For the number of residents, we used the American Community Survey data source (ACS, 2018)
[2] For the number of employees, we used the Longitudinal Employer-Household Dynamics data source (LEHD, 2017)

F&P first validated the trips by looking at the 'resident' trip volumes, segmented by trip purpose. They only compared resident trips to align with the survey's methodology. As demonstrated in Figure 3 below, StreetLight's results fell within .5% on resident home-based trips counts.

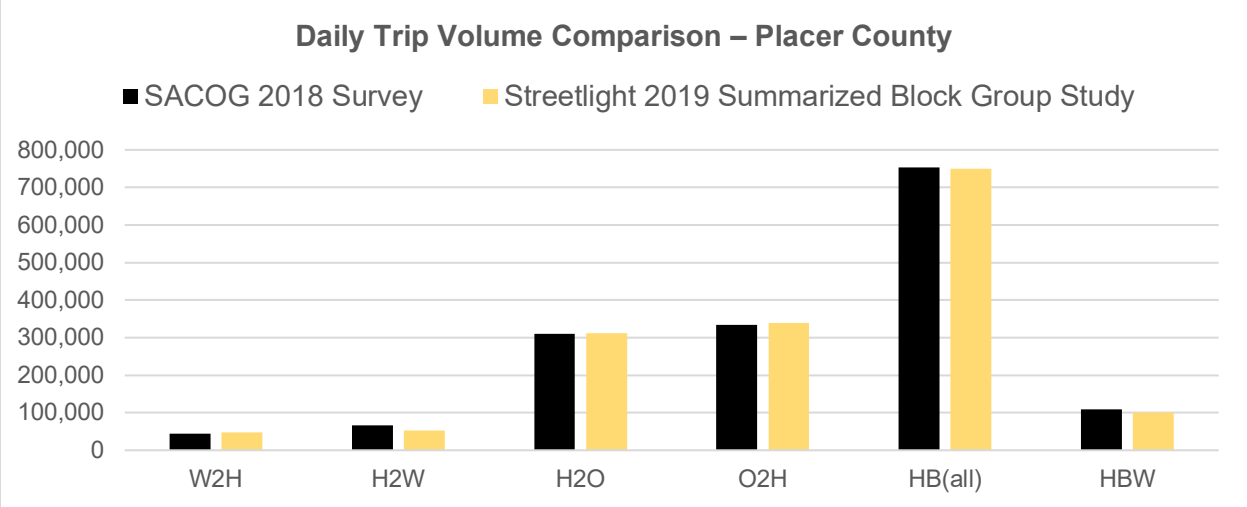

Figure 3: Comparison of daily trip volume by purpose for residents of Placer County.

Next, F&P compared the second component of VMT, average trip length, against the survey results. Similar to the first validation, they compared trip lengths across Placer County for each trip purpose. Shown in Figure 4 below, average trip lengths also had a close alignment between each trip purpose. Work-related trips had the closest matches, while StreetLight estimates of home-based trip purpose trip lengths was generally higher. This is due to the exclusion of vehicle trips under 500 meters in the StreetLight estimates, as a part of our trip creation criteria – thus, StreetLight has 18% of vehicle trips under two miles whereas the SACSIM model had 36% of vehicle trips under two miles (see this link for our standard methodology document for more details on trip creation), which has a big impact on average. Another potential factor is that the StreetLight Metric represents weekdays throughout the year and would capture long-distance vacation and recreational trips leaving or returning to home and that do not occur on a routine basis and are not captured in conventional household travel surveys or the SACSIM model.

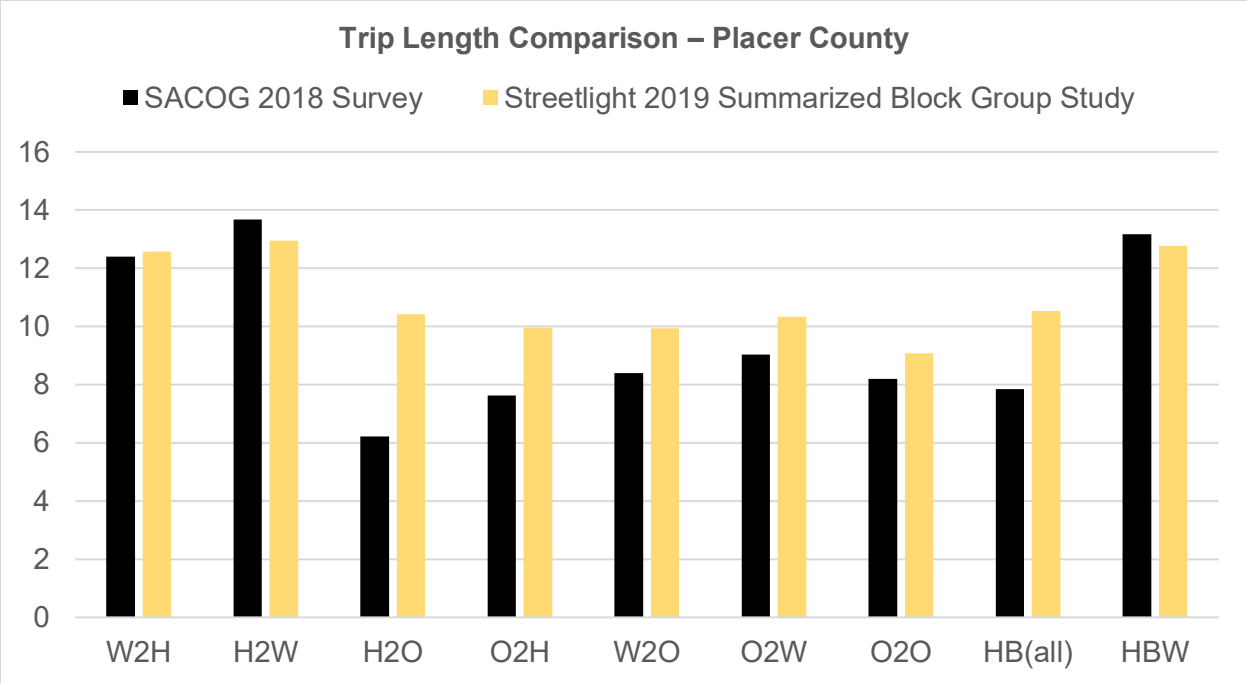

Figure 4: Comparison of average trip lengths by purpose for residents of Placer County. StreetLight's longer "other" purposes are partially a result of our inclusion of the full trip when trips cross model boundaries (for example, Bay Area residents driving to Sacramento region).

After, F&P compared our Metric to SACSIM under two different settings at smaller geographic resolution. Figure 5 below shows the impact on VMT when trips outside a model's boundary are excluded. Additionally, it demonstrates the close alignment of our results, which don't have geographic and temporal boundaries.

StreetLight and SACSIM VMT per Resident Comparison			
Jurisdiction	**SACSIM 2016 Excluding IX/XI[3]**	**SACSIM 2016 Including IX/XI[4]**	**StreetLight 2019**
Auburn	13.97	21.63	20.52
Lincoln	17.49	22.58	19.63
Rocklin	12.78	17.77	18.92
Roseville	12.13	17.18	16.75
Placer County	15.71	21.29	21.47

Figure 5: Comparison of average VMT per resident in five Placer County cities, according to SACSIM and StreetLight. The difference between SACSIM and StreetLight shows the impact on VMT when trips outside a model's boundary are excluded.

[3] Excludes internal-external (IX) and external-internal (XI) trips and trip lengths outside model boundary.
[4] Total VMT per resident—Includes non-home-based trips plus internal-external (IX) and external-internal (XI) trips. Excludes trip length outside model boundary

Overall, Fehr &Peers found our results comparable, and followed up in their quantitative investigation by demonstrating multiple development locations where our results picked up on local travel patterns that SACSIM missed. In Figure 6 below, F&P demonstrates how our results more accurately identified areas of lower average VMT in a small, dense development compared to SACSIM.

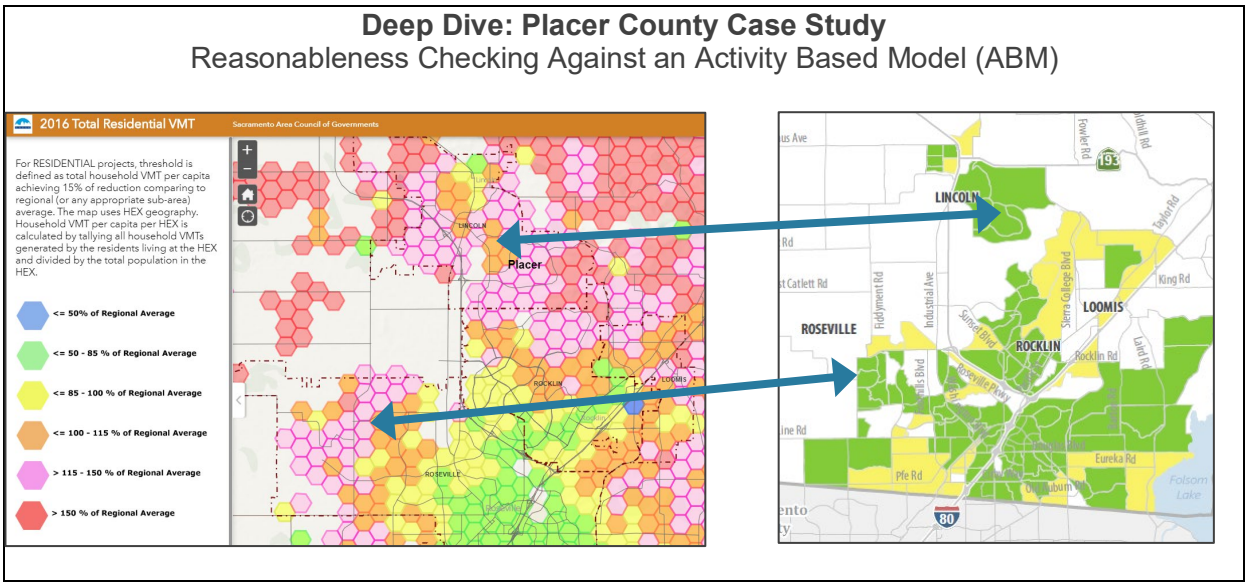

Figure 6: Comparison of SACSIM (left) and StreetLight (right) demonstrates how StreetLight's Metric correctly identified the influence of 'age qualified' housing (i.e., only 55 or over), which generates vehicle trips at about one-third the rate of surrounding single-family homes, resulting in lower average VMT.

Find more examples of F&P's validation, and the rest of the slides from the joint webinar here.

Conclusion

StreetLight's VMT Metric is an easy and affordable way to get SB 743 compliant VMT data anywhere in the state. This data can be used for screening, direct VMT estimation, and for mitigation monitoring over time. Transitioning to VMT is a big difference in how California thinks about impacts of development – not just "to drivers" but "of driving" – and we want to equip organizations with accurate, repeatable metrics to easily respond to the transition from LOS to VMT. Since SB 743 is new legislation, as more organizations and agencies use this Metric to satisfy the new requirements, we may improve our methodology as time moves forward and the needs of the community evolve.

About StreetLight Data

StreetLight Data, Inc. pioneered the use of Big Data analytics to help transportation professionals solve their biggest problems. Applying proprietary machine-learning algorithms to over 100 billion location data points every month, StreetLight measures multimodal travel patterns and makes them available on-demand via the world's first SaaS platform for mobility, StreetLight InSight®. From identifying sources of congestion to optimizing new infrastructure to planning for autonomous vehicles, StreetLight powers more than 10,000 projects every month.

Acknowledgements

We'd like to thank Fehr & Peers for contributing to this white paper, along with providing guidance and industry expertise as we developed the white paper.

Appendix

Example Scenario: Device home & work located in different Block Groups

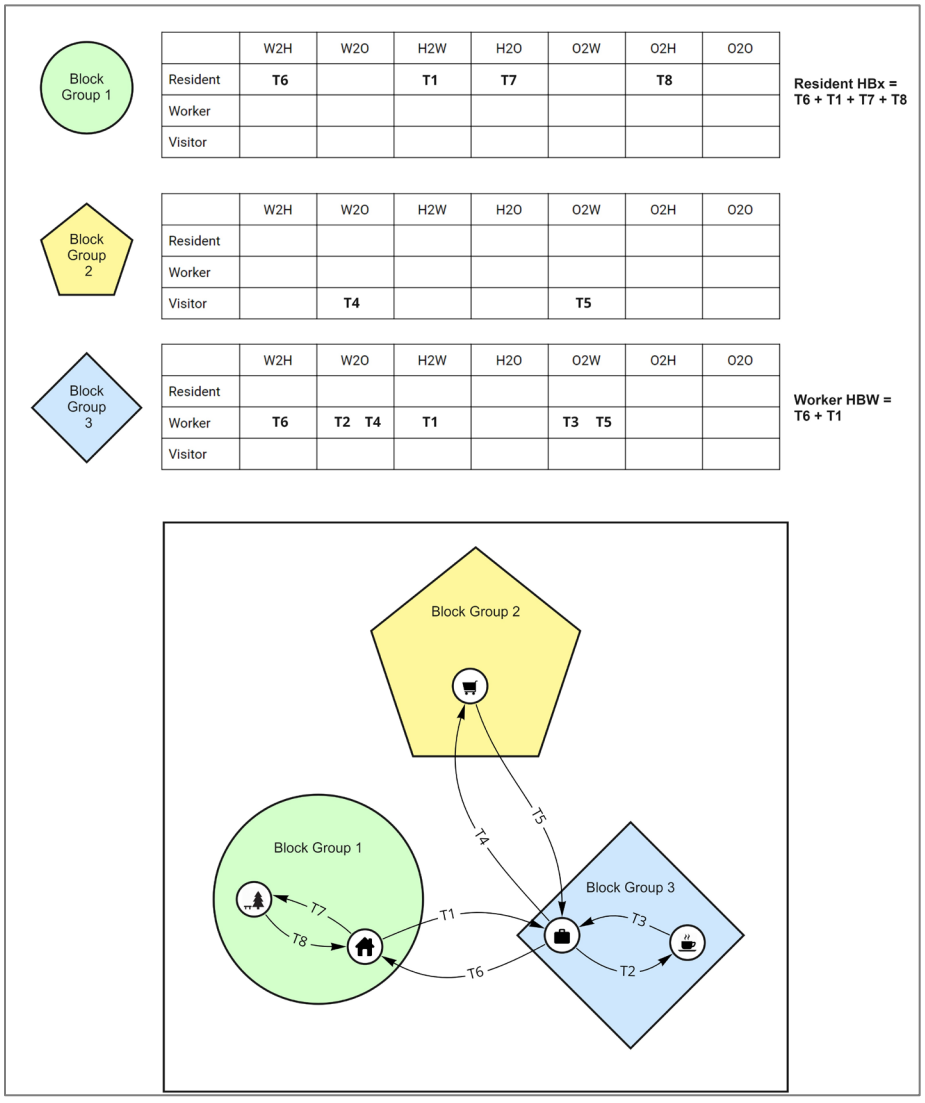

Figure 7: Illustration of how trips are allocated when the device home and work locations are located in different block groups.

We can explore alterations to these definitions on custom implementations and are open to feedback about having additional options for definitions as we move forward with SB 743 support.

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