NELSON
NYGAARD

MEMORANDUM

To: City of Fremont

Metropolitan Transportation Commission

From: Nelson\Nygaard Team

Date: September 4, 2019

Subject: Task 3.1 Summary Memo: VMT Analysis Tools, Data Review, and Relevance for Fremont

INTRODUCTION

This memorandum provides a review of travel demand models and the associated vehicle miles traveled (VMT) outputs that are relevant for the City of Fremont. The Metropolitan Transportation Commission (MTC) and the Alameda County Transportation Commission (Alameda CTC) have built and maintained the two most relevant regional travel demand models. The VMT outputs of either model can be used to implement two key aspects of SB 743: 1) creating map-based screens, and 2) establishing the VMT base from which to build additional VMT analysis. This memorandum also covers additional considerations, such as sketch model tools, and the Office of Planning and Research's Technical Advisory's guidance on modeling VMT impacts.

OFFICE OF PLANNING AND RESEARCH TECHNICAL ADVISORY CONSIDERATIONS

The Governor's Office of Planning and Research (OPR) released the Technical Advisory on Evaluating Transportation Impacts in CEQA in December 2018[1], which provides advice and recommendations for implementing SB 743.

SB 743 allows for the use of models to estimate a project's VMT per capita and defers to lead agencies to choose the methodology for analyzing environmental impacts. VMT models require a variety of inputs to predict travel patterns based on land uses and transportation infrastructure. The OPR Technical Advisory provides guidance on how the following elements should be considered when applying model output to transportation analysis:

- **Vehicle types.** SB 743 refers to automobile travel attributable to the project. Automobile refers to passenger vehicles, which includes cars and light trucks.

[1] Governor's Office of Planning and Research, Technical Advisory on Evaluating Transportation Impacts in CEQA, December 2018.

Heavy-duty truck VMT can be included for ease of calculation but is not required. Vehicle types considered should be consistent.

- **Residential and Office Projects**. Tour- and trip-based models offer the best methods for assessing VMT per capita/employee from residential/office projects. Trip-based models estimate VMT from trips to and from a project, and do not count side trips or trip-chaining. Tour-based models estimate VMT from the entire "tour," or roundtrip to and from a project, including side trips or trip-chaining. Tour-based assessment is ideal, when available, because it captures travel behavior more comprehensively.
- **Model Consistency**. Where a travel demand model is used to determine thresholds, the same model should also be used to assess project VMT.
- **Retail Projects**. VMT impacts of a retail project should be assessed as a change in total VMT since retail projects typically re-route travel from other retail destinations.
- **Jurisdictional Boundaries**. VMT analysis should not be truncated because of jurisdictional or other boundaries.
- **Combining Land Uses**. Given the difficulties in connecting different mixes to a significance threshold, OPR recommends analyzing each use separately and comparing each result to the appropriate threshold. Additionally, the analysis can focus on the dominant land use of a mixed use project, if there is one.
- **Cumulative Impacts**. Efficiency-based metrics used to analyze residential and office projects (per capita or per employee) do not have a cumulative impact distinct from the project impact as long as they are below the efficiency threshold and aligned with long-term environmental goals and relevant plans. Retail and transportation projects use an absolute VMT metric (total VMT) that does allow for a cumulative impact analysis. For land use projects near planned transportation or other investments that are anticipated to reduce VMT, the significance thresholds will still need to be met or mitigated in the base year. If transit improves and the future per capita VMT in that location is reduced through future investments, it is possible that TDM programs could be reviewed and scaled back at a later date. Area plans allow more flexibility in interpreting cumulative impacts alongside other area plan investments that are schedule to be completed in phases.

EXISTING VMT MODELS

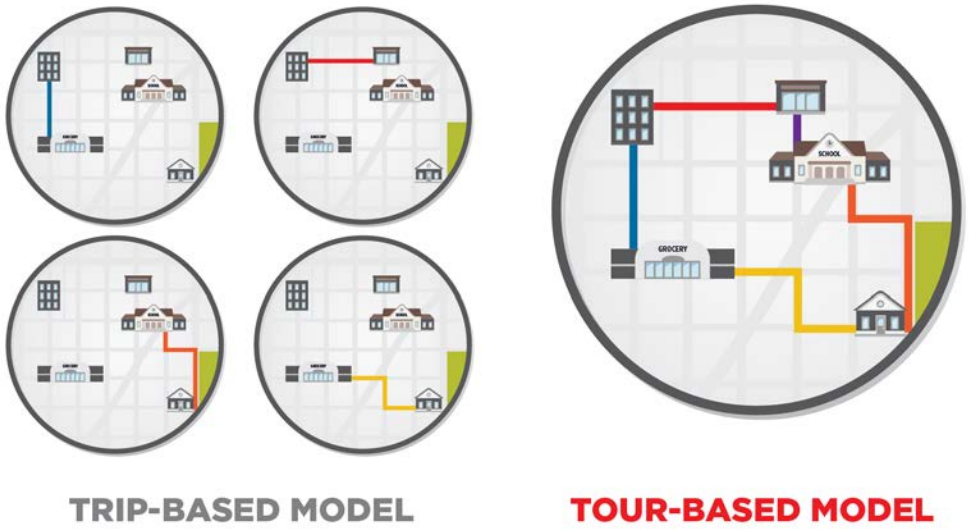
Regional Travel Forecasting Models are used to understand the long-range impacts to travel demand of alternative policies and investments in transportation and land use. One of many outputs produced by such models is VMT. VMT is currently used for planning and greenhouse gas emissions modeling. For CEQA purposes the VMT estimates illustrate relative travel patterns and do not describe precise absolute VMT. MTC builds and maintains an activity-based[2] regional travel model for the nine county San Francisco Bay Area and Alameda CTC builds and maintains a regional trip-based

[2] Travel forecasting resource: tour-based models, terminology. Accessed from: http://tfresource.org/Tour-based_models

model with more granularity in Alameda County. This section describes each model's purpose, primary inputs, outputs, and model sophistication.

Figure 1 shows the difference in how the same travel is captured by the different models. A trip-based model captures individual trips such as home-work and home-school trips. A tour-based model captures the entire "tour" from home-school-lunch-visit a friend-grocery store-home, including the additional VMT for side trips to get lunch or go shopping.

Figure 1 Comparison of Trip-Based and Tour-Based Models



MTC's Regional Travel Model

Background

MTC and the Association of Bay Area Governments (ABAG) lead regional planning for the nine county Bay Area. MTC built *Travel Model 1*, a travel demand model for *Plan Bay Area*—the 2040 long range plan adopted in 2013. The model was updated when the final *Plan Bay Area 2040* was adopted in 2017.

Transportation Analysis Zones (TAZs) are used to build MTC's travel and land use model structures. The TAZs are consistent with the 2010 Census Tract boundaries and for Fremont and Alameda County the MTC model TAZs are larger than the Alameda CTC model TAZs. The MTC model has 40 TAZs in Fremont with a median size of 1350 acres.

Model Specifics

Travel Model 1 is an activity-based model. The model creates a synthetic population of households and individuals using census data for past year model runs and future land use forecasts for future year model runs. Travel behavior responses are modeled for the synthetic population in response to various other inputs such as pricing, land use

changes, and transportation system changes. Activity-based models can model realistic constraints of time and space, and the linkages among activities and travel. The MTC model is a partial activity-based model since it aggregates transit and commercial vehicles behavior on roadways and transit facilities rather than modeling them as individual tours. An activity-based model is a tour-based model since it is able to model tours, or trip-chaining (home to work to store to home) rather than separate trips (home to work / work to store / store to home). Modelling at an individual tour-based level allows the model to more realistically represent the effect of travel conditions on activity and travel choices than a trip-based model[3].

Running the model requires the following steps:

- Step 1. MTC's population synthesizer creates a population of agents that represent the existing population and is calibrated using existing census data and land use forecasts.
- Step 2. The travel model simulates a series of travel-related choices for the synthetic population. Travel decisions are constrained by a variety of factors including location, time, automobile access, congestion, transit access, and price.

The following are the primary **inputs** in addition to the population synthesizer described above:

- **Land use.** Existing and future land use scenarios can be tested based on how they change the synthetic population and where they live and work.
- **Roadway and transit supply.** The travel model constrains travel choices based on road capacity, congestion, and transit capacity.
- **Prices**. Prices are used to model how different travelers respond to time and monetary costs for the following: value of time, bridge tolls, express lane tolls, parking prices, transit fares, and vehicle operating costs.

Model Validation[4]

MTC's model was validated by modeling a run with the land use and transportation network of 2010, compared against American Community Survey and Census Data as well as real 2010 counts of traffic volumes and transit ridership. The overall model is refined until it is statistically valid and accepted by the MTC board and other modeling agencies such as the various county models. Corridor level deviations from observed travel patterns do not invalidate the model for CEQA purposes.

VMT Outputs

VMT is one of the outputs of the model. Figure 2 shows the per capita VMT for the nine county Bay Area region and Fremont, and the 15% reduction from that number. The 15% reduction below average is a recommended threshold from OPR and is provided here to demonstrate the possible VMT per capita threshold for the City of Fremont.

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[3] Transportation Research Board, Activity Based Travel Demand Models: A primer, 2015.

[4] Year 2010 Validation of Travel Model One, 2013. Accessed from: https://mtcdrive.app.box.com/s/sqin680x0xnum12dy9oje9tjb8yaach3

Figure 3 shows a map of per capita VMT using the MTC model data and each TAZ is labeled with the number of miles above or below the City's average per capita VMT. Given that the regional VMT is lower than Fremont, the map uses Fremont's average VMT per capita as the baseline.

The 15% reduction from the City's average is shown in the map in the darker blue, projects in those areas could be presumed to have no significant VMT impact. (If Fremont were to use the regional average VMT per capita to set thresholds there would be no TAZ in the City that is currently less than the proposed threshold of 15% below average.) Per OPR Technical Advisory, residential projects proposed in any of those darker blue TAZs can be assumed to have a less than significant impact on VMT if they are consistent with a few additional minimum density and design requirements. The light blue shows TAZs below the City's average and indicate the easiest areas to mitigate VMT. The light yellow shows areas above average, but where a residential project could potentially still mitigate VMT with a substantial investment in TDM. Areas in dark yellow are 15% or more above the City's average per capita VMT. Residential projects in those areas that are large enough to require environmental review would not be able to mitigate VMT through TDM alone.

Figure 2 MTC Daily VMT per Capita

Geography	VMT per Capita (miles)	
	Average for 2020	15% below 2020 average
Regional	15	12.75
Fremont	19	16.18

Figure 3 MTC Model, Variation from Fremont Citywide Average VMT per Capita (2020)

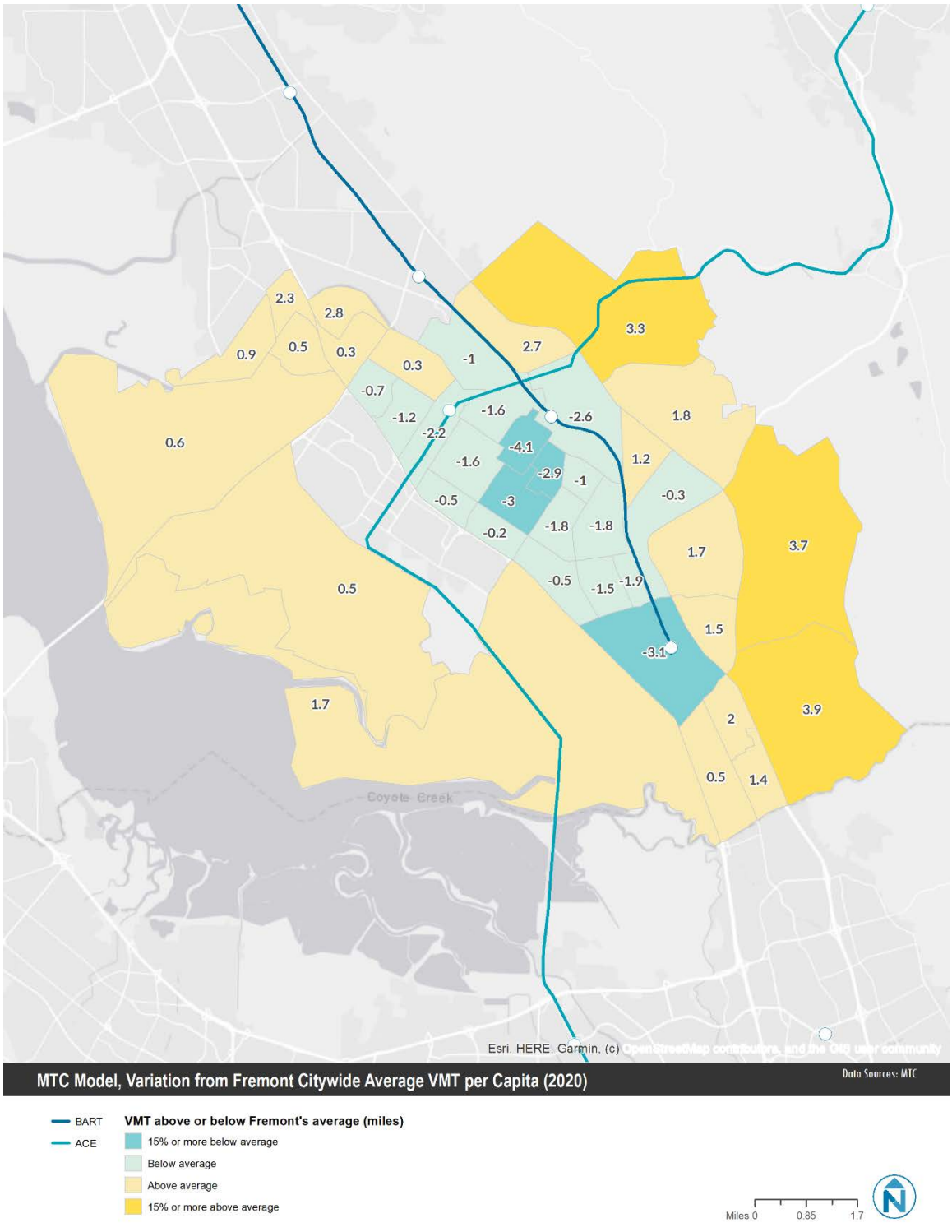


Figure 4 shows the average per employee VMT for the nine county Bay Area region and Fremont and the 15% reduction from that number. Figure 5 shows a map of per

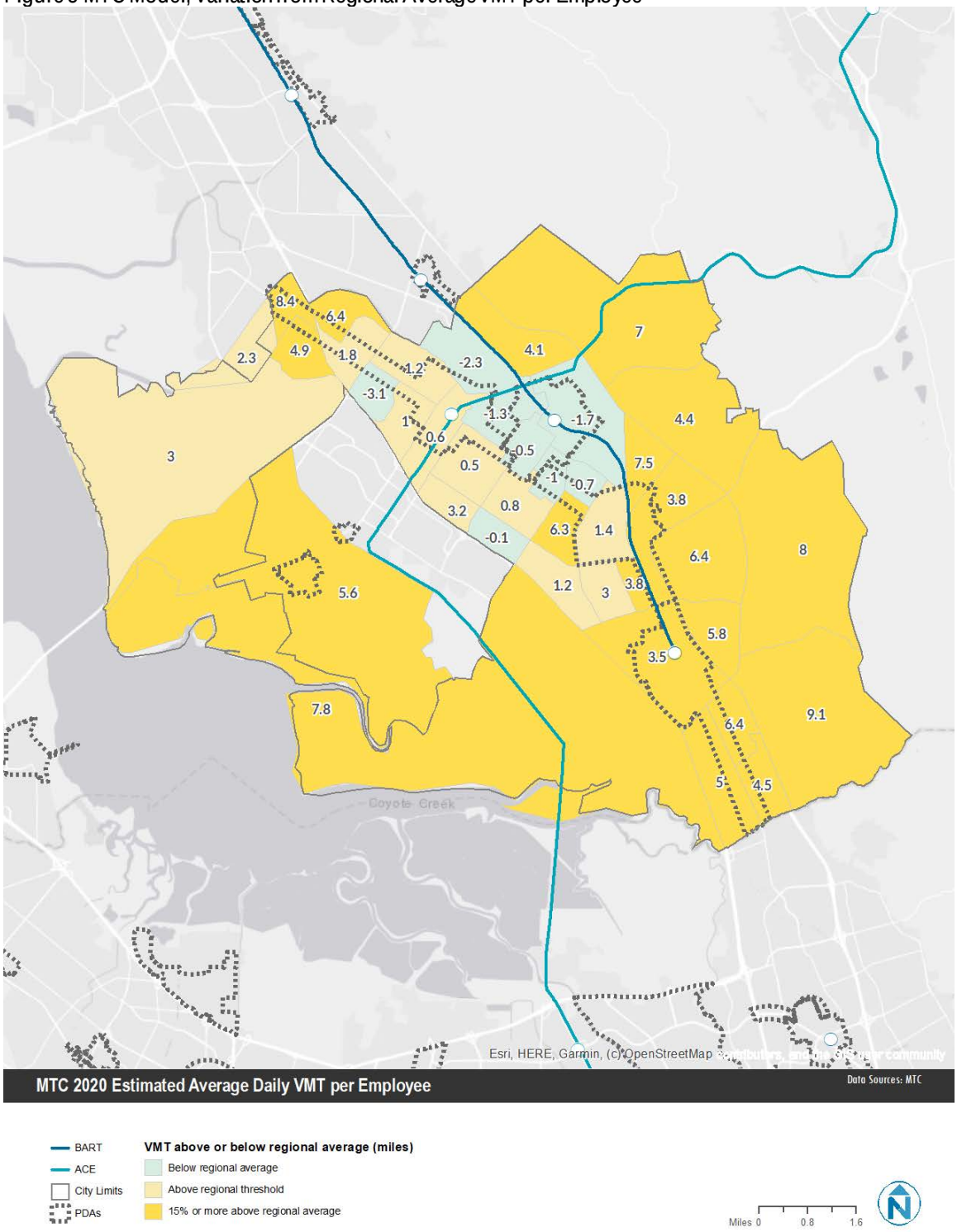
employee VMT using the MTC model data and with the daily miles. Unlike residential land use, employment land uses typically induce regional trips as people who work in a city do not necessarily live there, so the OPR Technical Advisory recommends using regional averages to define the employment land use threshold. While residential land use around Warm Springs BART is modeled to have a low VMT per capita, the same TAZ has a relatively high VMT per employee at just over 15% above the regional average per employee. The employment land uses were built before the BART stations and therefore have a limited VMT reduction potential from Warm Springs compared to Central Fremont where land use has built up around a BART station for decades longer. Additionally, the historical land uses are industrial, logistics, and other uses that are spread out and typically have a higher per employee VMT. This map, however, does not negate the Warms Springs/South Fremont Community Plan, which calls for a mix of uses, urban design, and TDM Strategies that will lower the per employee VMT, and that are not considered in the MTC Model.

There are no TAZs in Fremont that are currently more than 15% below the regional average per employee. As a result, Fremont may not be able to use a map-based screen for employment land use outside of the half mile TOD overlay district around the rail stations. With proper planning and TDM programs, however, employment land uses can still receive a negative declaration or mitigated negative declaration.

Figure 4 MTC Daily VMT per Employee

Geography	VMT per Employee (miles)	
	Average for 2020	15% below 2020 Average
Regional (required)	23.03	19.58
Fremont	26.4	22.44

Figure 5 MTC Model, Variation from Regional Average VMT per Employee



Alameda County Travel Model

Background

Alameda CTC is the Congestion Management Agency (CMA) for the county. CMAs are responsible for assessing, monitoring, and improving the regional transportation network of Alameda County. Part of that role is maintaining a countywide travel demand model for Alameda County. The latest model was updated in 2018 with land use and demographic input consistent with *Plan Bay Area 2040*, updated AC Transit Service, future road and transit improvements consistent with *Plan Bay Area 2040*, updated pricing inputs, including bridge tolls, express lane tolls, and parking costs.[5]

Alameda CTC's model is maintained and updated in compliance with Congestion Management Program (CMP) legislation. CMAs are required to develop a uniform database on traffic impacts for use in a countywide travel demand model and be consistent with the regional travel demand model. Fremont is in Planning Area 3 (South) along with Newark, Union City, and unincorporated parts of Alameda County.

The Alameda CTC model uses TAZs to build the model structure. The TAZs are consistent with the 2010 Census Tract boundaries, allowing for nesting into tract boundaries. The ACTC model has 145 TAZs in Fremont with a median size of 340

acres

Model Specifics

The Alameda County Model is a trip-based model. A trip-based model typically involves four steps[6]:

1. Trip Generation: Estimation of the number of trips produced by and attracted to each TAZ.
2. Trip Distribution: Connect where trips are produced and where they are attracted to.
3. Mode Choice: Determination of mode choice for each trip.
4. Trip Assignment: Assignment prediction to specific network facilities or routes used for each trip.

Once the model runs through the four steps, it has a feedback loop that runs five times to re-assign trips based on congested travel conditions, taking time of day into account.

The following are the primary inputs:

- **Land use data.** Consistent with *Plan Bay Area 2040* but applied to a more detailed geography given the smaller TAZ size and based on input from jurisdictions.
- **Transportation networks**. Including road, transit and bicycle facilities. The future network is built using the project list in *Plan Bay Area 2040*.
- **Pricing information**. Vehicle operating costs, parking costs, bridge tolls, express lanes, transit fares.
- **Trip generators**. Other than population and employment (e.g. port, airport).

[5] Alameda Countywide Travel Model: Plan Bay Area Update, Final Document Report. January 2019, p 3

[6] Transportation Research Board, Activity Based Travel Demand Models: A primer, 2015.

Model Validation

Alameda CTC's model was also validated by modeling 2010 against real 2010 counts of traffic volumes, transit boardings, and bicycle volumes. It was also validated against and required to be consistent with the MTC's regional model. After calibrating to the MTC model, the Alameda CTC model had an average 3% difference in VMT. The overall model is refined until it is statistically valid and accepted by the Alameda CTC board and other modeling agencies such as MTC. Corridor level deviations from observed travel patterns do not invalidate the model for CEQA purposes.

VMT Outputs

Figure 6 shows the per capita VMT for Alameda County and Fremont and the 15% reduction from that number. Alameda County has a lower average per capita VMT than Fremont. Figure 7 shows a map of per capita VMT using the Alameda CTC model data and with the number of miles above or below the City's average per capita VMT. The 15% reduction from the City's average is shown in the map in the darker blue, projects in those areas could be presumed to have no significant VMT impact. The light blue show TAZs below the City's average and indicate the easiest areas to mitigate VMT. The light yellow shows areas above average, but where residential project could potentially still mitigate VMT with a substantial investment in TDM. Areas in dark yellow are 15% or more above the City's average per capita VMT. Residential projects in those areas that are larger enough to require environmental review would not be able to mitigate VMT through TDM alone. environmental review would not be able to mitigate VMT through TDM alone.

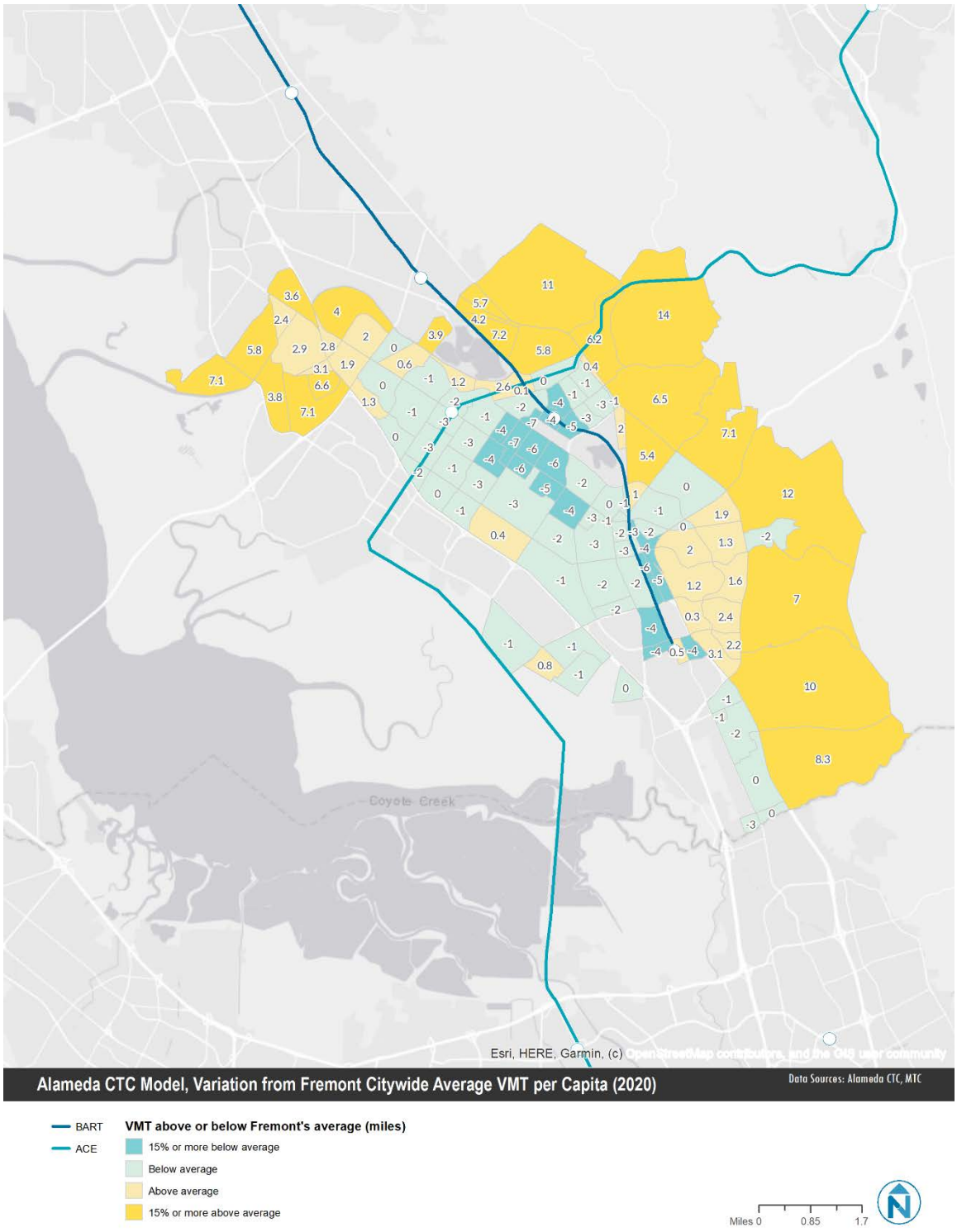
The Alameda CTC map has many TAZs with zero population and, therefore, the per capita VMT cannot be calculated. This may present a challenge if Alameda CTC's model updates do not reflect the new and planned development near the Warm Springs/South Fremont BART Station.

Figure 6 Alameda CTC Daily VMT per Capita[7]

Geography	Daily VMT per Capita (miles)	
	Average for 2020	15% reduction below average
Alameda County	19.3	16.4
Fremont	23.5	19.98

[7] Alameda Countywide Travel Model: Plan Bay Area Update, Final Document Report. January 2019, p 83.

Figure 7 Alameda CTC Model, Variation from Fremont Citywide Average VMT per Capita (2020)



Alameda CTC's Model had erroneous result for employee VMT. While their modeling team and consultant resolve the issue, there is currently no Alameda CTC data available to produce a map for per employee VMT in Fremont.

Regional Model Differences

Geographic Granularity

One key difference between the two models is the size of the transportation analysis zones (TAZ). The Alameda County model has 145 TAZs for Fremont, including some overlap with neighboring communities, while the MTC model has only 40 TAZs.

Model Type

Both regional models' VMT outputs measure relative changes and, therefore, different models can be used to define VMT per capita and total VMT as long comparisons are not made across models[8]. MTC uses a tour-based model and Alameda CTC uses a trip-based model. Two types of VMT metrics are used in evaluating transportation impacts in CEQA. Residential and employment generating land uses use VMT per capita or per employee. This is an efficiency metric that measures VMT generated per person rather than total VMT. In contrast, retail projects and transportation projects use change in total VMT to measure transportation impact.

Since the per capita or per worker VMT calculation is an efficiency metric, both trip and tour-based models provide sufficient analytical rigor for analyzing VMT in CEQA[9]. However, OPR's Technical Advisory on Evaluating Transportation Impact in CEQA recommends use of a tour-based model if available for analyzing residential and employment land use project impacts because this type of model captures travel behavior more comprehensively than trip-based models and is therefore a more accurate representation of actual travel. The MTC model is a tour-based model while the County model is a trip-based model.

Tour-based models analyze tours and individuals, elements that provide a more refined picture of travel. A trip-based model analyzes trips and aggregates zonal totals, losing some detail in the aggregation process. Since VMT is a standard output of both models, the level of sophistication in modelling the travel behavior may not be the most critical consideration.

Relevance for Fremont

Both regional models have positive attributes compared to the other. Alameda CTC's model may be better calibrated to the County and, thus, Fremont. While MTC's model provides a more accurate representation of the region, due to the larger geography of MTC's model they are not focused specifically on Alameda CTC when calibrating the results. MTC validates travel between counties, whereas Alameda CTC validates travel at screenlines within Alameda County. Furthermore, the Alameda CTC model uses smaller TAZs for Alameda County and neighboring San Joaquin County[10], which may enable this model to capture trips more accurately in these areas than the MTC model. Alameda

[8] Governor's Office of Planning and Research, Technical Advisory on Evaluating Transportation Impacts in CEQA, December 2018, p 5.

[9] Governor's Office of Planning and Research, Technical Advisory on Evaluating Transportation Impacts in CEQA, December 2018, p 5.

[10] Alameda Countywide Travel Model: Plan Bay Area Update, Final Document Report. January 2019, p 21.

CTC's model uses smaller TAZs especially around rail stations, which may capture transit trips more accurately.

Another consideration is how often the model is updated and which agency can best respond to Fremont's requests for updated data. Fremont will need to develop a process for updating local threshold definitions as new VMT data becomes available from either MTC or Alameda CTC. At a minimum, tools such as map-based screens based on low-VMT areas should be updated as new models are released.

Given Alameda CTC's model does not produce usable employee VMT as of writing this memorandum, the MTC model provides the most reliable basis from which to develop map-based screens, significance thresholds, and transportation impact analysis..

ADDITIONAL TOOLS TO MEASURE VMT IMPACTS

Several simple VMT estimation tools have been developed to estimate VMT generated by land use developments. These "sketch model" tools often utilize spreadsheets, rather than sophisticated travel demand models, and may be used to compare projects seeking to receive various state grants for affordable housing and sustainable communities grants. . The most basic sketch model estimates VMT for a specific land use by multiplying the number of trips generated from a project site or area by average trip distance. Traditionally, trip generation is calculated with standard trip rates for various land uses published by the Institute of Transportation Engineers (ITE). These trip rates are based on data collection from sites that are mostly in auto-oriented, suburban areas. Without adjustment, these rates can greatly overestimate trip projections for the infill, centrally located, transit-oriented development envisioned in Fremont's General Plan.

Different models take varying approaches to adjust the initial calculation of *trips generated * average trip length* to better reflect real world travel patterns and local context that is missing from the ITE trip generation rates. Average trip length typically comes from a travel demand model, household travel survey, or other source. Figure 8 summarizes four example types of VMT sketch models, the format, and primary methods of calculating and adjusting VMT estimates[11].

[11] Lee, Amy, Kevin Fang, and Susan Handy. Evaluation of Sketch-Level Vehicle Miles Traveled (VMT) Quantification Tools. National Center for Sustainable Transportation. August 2017.

Figure 8 Example VMT Sketch Model Types

Example Model	Model Format	VMT Adjustment	Method
Urban Emissions (URBEMIS) model	Spreadsheet tool	Remove trips that are not new	Trip capture, remove on-site trips "Pass by" trips from travelers who were already going by the project locations
US EPA's MXD model California Smart-Growth Trip Generation Adjustment Tool	Spreadsheet tools	Use statistical models to reduce trip estimates based on project and context characteristics	Reduces the number of trips generated based on characteristics such as transit access, mix of uses, etc.
GreenTrip Connect Urban Footprint	Map-based tools	Use statistical models that reduce VMT estimates based on project and context characteristics	Reduces VMT directly, based on characteristics such as transit access, mix of uses, etc.
CalEEMOD	Spreadsheet tool	Use separate elasticities for specific project or context characteristics to calculate reduced estimates for VMT	Uses elasticities taken from *Quantifying GHG Mitigation Measures* (by CAPCOA) to adjust VMT

In a review of the applicability of sketch models for estimating VMT, researchers found that the absolute VMT estimate is uncertain and typically unvalidated[12]. As a result, comparing results from different tools will be misleading. The tools are best suited to illustrate and compare differences between scenarios via multiple runs of the same tool to show a project's relative efficiencies.

Relevance for Fremont

While existing sketch models are likely insufficient for the rigor required by CEQA analysis, the above processes show ways of building additional analysis onto the VMT estimates from regional travel demand models to estimate VMT reductions from site-specific characteristics and impact mitigations. The cities of Alameda and San José have used this approach to quantify the effectiveness of mitigations.

A key consideration in quantifying VMT reductions is the rigor of the underlying studies upon which these tools are based. While CAPCOA is widely cited given its breadth of compiled research on the quantification of VMT reduction from TDM strategies, multiple MPOs, counties, cities, and other agencies are providing additional study to quantify percent reductions in VMT based on transportation and TDM strategies. San José's

[12] Ibid., p 30.

research into quantifying VMT reduction is not publicly available. SANDAG recently released a TDM and mobility management Toolbox, with quantified percent VMT reductions and citations[13]. More detailed information on best practices from other cities will be documented in Task 4.1.

NEXT STEPS

The Nelson\Nygaard team will work with City staff to review each model's relative strengths and determine which modeled VMT outputs are best suited to use for transportation impact analysis in the City of Fremont. The VMT outputs from the selected regional model will be used to define the City of Fremont's significance threshold and develop map-based screening criteria and VMT impact. Additional VMT estimation tools will be used to evaluate the effectiveness of VMT mitigations.

[13] SANDAG TDM for Local Governments, Tool Design Document. Accessed from: https://www.icommutesd.com/planners/tdm-local-governments