Appendix I

VMT Analysis Memo

Memorandum

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To: Chris Mundhenk, Ascent Environmental

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Subject: University of California Santa Cruz (UCSC) Long-Range Development Plan (LRDP) Santa Cruz County Regional Transportation Commission (RTC) Model Calibration Process

SJ19-1987

Introduction

As part of the UCSC LRDP EIR, Fehr & Peers conducted the vehicle miles traveled (VMT) analysis using the Santa Cruz County (SCC) Regional Travel Demand Model (SCC Travel Model). This memorandum covers the model description, the calibration and validation measures done to adjust the model for UCSC, and the results of the analyses.

Model Description

The County's travel model is a traditional four-step model that estimates daily travel behavior at the person-level for all residents and employees within the County. The inputs to model include land use data quantifying the number of persons, households, students, and jobs, as well as representations of the highway, arterial, and transit systems across the County. The model outputs provide an estimate of daily person trips for an average weekday across a range of modes: drive alone, carpool, transit, walk, and bike. The model also estimates the travel that occurs between Santa Cruz County and surrounding counties even though these areas are not included within the model's geographic boundary.

The SCC Travel Model was initially developed in 2016 and is consistent with the regional travel model developed by the Association of Monterey Bay Area Governments (AMBAG). The project team received the latest version of the SCC Travel Model from the County for use on this project. The County provided a 2019 existing scenario and a 2040 cumulative scenario. The future year cumulative scenario is presumed to be consistent with long range plans for the jurisdictions across the county. The model was run using the standard settings in TransCAD 6.0 r2 Build 9215.

Calibration and Validation

The SCC Travel Model is a subregional travel model developed to study transportation impacts of land use and multimodal transportation projects at the county or city level. The model includes a limited number of land use types that are meant to represent a broad range of the most common land uses within Santa Cruz County. For example, the model's service employment land use category is meant to capture anything from warehousing and food services uses, which individually have a wide range of trip generation characteristics and in the model is represented as an average. Thus, when looking at specific sites within a model, it is not uncommon to make adjustments at the project level to more accurately reflect the unique travel characteristics of the proposed land use; which is also known as the calibration and validation process.

The calibration and validation effort focused solely on the land uses within the campus and on roadways in the immediate vicinity. The project team did not make any modifications to land use assumptions or trip generation rates for areas outside the campus boundary.

Land Use Inputs

In the first step of the validation process the number faculty, staff, and students were updated to be consistent with existing conditions, as specified in the Project Description Chapter of the Environmental Impact Report (EIR) for the 2020 LRDP.

Travel Demand

The SCC Travel Model's estimates of travel activity to and from the UCSC campus (i.e. trip generation) was calibrated to the number of vehicles entering and exiting the campus on a typical weekday using data collected in Fall 2019 (pre-COVID). The initial model results overestimated the vehicular travel generated by the campus and the model was adjusted by changing the trip generation rates for employees and students.

Trip Generation

The trip generation results from the SCC Travel Model were compared with a trip generation tool that was previously developed in 2017 for UCSC to assist with long-range planning efforts. The tool is similar to the trip generation step within a travel model in that it estimates the volume of daily person trips coming to and from the campus based on the number of students and faculty. The tool was developed and validated with data provided by UCSC, which included survey data from residents and commuters on the type and frequency of daily campus trips, as well as, modal (vehicles, bikes, transit, shuttle, etc.) counts and vehicle parking data. **Table 1** below compares the daily person trip rates from the SCC Travel Model with the UCSC trip generation tool.

Table 1: Daily Person Trip Rate Comparison

Population	2017 Tool	SCC Model	Percent Difference (SCC Model to 2017 Tool)	Final Adjusted	Percent Difference (Final Adjusted to 2017 Tool)
Resident students	2.21	6.31	186%	2.06	-7%
Commuter students	2.01	0.22	-89%	1.83	-9%
Resident employees	1.93	6.88*	265%	2.06	7%
Commuter employees	1.42	6.88*	385%	1.51	6%

*The SCC Travel Model does not distinguish between resident and commuter faculty.

As shown in **Table 1** above the SCC Model overestimates by approximately 200 to 400% the number of trips generated by resident students and by both the resident and commuter employees compared with the UCSC tool. The model also underestimates by 90% the trips generated by commuter students.

Given that the model overestimates campus vehicle trips, the trip generation rates for the campus were adjusted to more consistent with the UCSC tool. It should be noted, that as one of the final validation steps to assess the validity of the adjust trip generation rates, the model outputs with the adjust trip generation rates were compared to the daily vehicle driveway counts discussed on page 5 and illustrated in **Table 3**.

The land use categories that are used in the model are resident students, commuter students, employees, and non-student households. Models have a set number of land use categories and you can either adjust the trip rates for a given land use, which would affect all model zones that have that land uses, or you can re-assigned your land use to a different land use categories whose model trip generation characteristics more closely match a given land use. The trip rates for resident students and commuter students on the UCSC campus were adjusted since these changes were easy to implement within the model and the changes do not affect trip generation on other college and university campus throughout the rest of the county. The employment land uses were re-classified within the model, since that land use is prevalent throughout the model and rate adjustments would invalidate the model outside of the campus model zones.

The trip rates for resident and commuter students were iteratively adjusted during the validation process to match the rates in the 2017 UCSC tool more closely as well as the vehicle driveway counts (discussed in the next section). The final student trip rates applied in the model are 2.06 daily person trips per resident student and 1.83 daily trips per commute student. Both rates are within 10 percent of the suggested rates shown in **Table 1.** Intra-campus trips for resident students are not included in the trip rate since these are primarily assumed to be walk or bike trips and any vehicle trips would general little VMT given the short distances traveled.

The trip rate for employees was adjusted by changing the land use category that these jobs are assigned to. The model initially assumed these jobs to be in the service/public administration category which has the trip rate shown in **Table 1** and representative of a land use that has many outside visitors, which the campus does not. Instead, the on-campus employment was moved to the industrial category which has a much lower trip rate of 1.51 daily person trips and is within approximately 6% of the value from the 2017 UCSC Tool.

The trip generation rates for the non-student households on campus, employees and their families, were not adjusted as part of the calibration and validation process.

Trip Distribution

The distribution of trips to and from campus was validated using anonymized cell phone GPS data, provided by Streetlight, to estimate the percentage of trips that occur within Santa Cruz County and the average lengths of those trips. The cell phone data is representative of person trips (not vehicle trips) and was sampled from March to May 2019 and September to November 2019. The Monday through Friday trips results were used to estimate an average weekday, consistent with the weekday assumptions in the travel model.

Table 2: Trip Distribution Validation with StreetLight Data

Trip Source	Streetlight Distribution	Streetlight Trip Length	Model Distribution	Model Trip Length
Intra-Campus	*Not Applicable*	1.1	*Not Applicable*	0.8
To/from Santa Cruz County	91%	4.9	93%	7.2
To/from Elsewhere	9%	58.4	7%	37.3
Total	*Not Applicable*	*5.4*	*Not Applicable*	*8.7*
Not Intra-campus	***100%***	***9.7***	***100%***	***9.4***

The StreetLight data shows that for all trips that have one end of the trip off-campus 91% are to or from somewhere within Santa Cruz County. The remaining trips are from other counties with Santa Clara County and Monterey County together accounting for 6% of those trips. The average trip length for all campus trips is 9.7 miles.

The revised version of the SCC Model used for this project estimates that for all person trips with one end of the trip off-campus, 93% of those trips start or end in Santa Cruz County. The remaining 7% are external to the County. The average trip length is 9.3 miles. While the SCC Model slightly underestimates the number of campus trips that start or end outside of Santa Cruz County, the differences are within an acceptable validation range and the parameters of the trip distribution model were not updated as part of this project.

Vehicle Assignment

As a final step, the vehicle generation and assignment model was validated using observed traffic counts collected around the UCSC campus during Fall 2019. **Table 3** shows a comparison of daily vehicle volumes at the two campus driveways after incorporating the trip generation changes described above.

Within the SCC model, the campus is presented by two transportation analysis zones (TAZs), or geographic areas. Due to the limited on-campus zonal detail within the SCC Travel Model, the model assigns most trips to the main entrance at Coolidge Drive/High Street and a smaller fraction to the west entrance. However, the total number of vehicle trips from the model accessing/leaving the campus at the two main entrances is within 10 percent of the observed data and this shows the model is reasonably estimating the daily number of trips generated by the campus. For the purpose of the VMT calculation the total number of trips accessing the campus is more important than which gate they use, since the model link distance within the campus' TAZs is about the same.

Table 3: Daily Vehicle Volumes at Campus Driveways Comparison

Location	Count	Model	*Percent*
Glenn Coolidge Drive n/o High Street	14,040	20,885	*49%*
Heller Drive e/o Empire Grade	8,662	3,275	*-62%*
Total	*22,702*	*24,160*	*6%*

Table 4 compares the daily vehicle volumes on streets surrounding the campus to validate the model's overall performance on estimating daily activity. Overall, the model is within 10 percent of the observed volumes and is reasonably estimating activity around campus. The vehicle assignment was slightly calibrated by adjusting the assumed speeds on High Street and other local roadways south of campus to shift more traffic onto Bay Drive and Mission Street.

Table 4: Daily Vehicle Volumes on Surrounding Streets Comparison

Location	Count	Model	Percent
Empire Grade n/o Heller Drive	11,875	9,521	-20%
Bay Drive s/o High Street	13,627	15,932	17%
High Street e/o Bay Drive	12,996	10,941	-16%
Total	*38,498*	*36,394*	*-5%*

Based on the trip generation, trip distribution, and assignment results, the model is considered validated to 2019 conditions for vehicular travel to and from the UCSC campus. All the calibration changes described above were incorporated into the future year scenario for consistency.

Scenario Analysis

The validated 2019 Existing SCC Travel Model was used to evaluate four scenarios for the UCSC LRDP EIR:

- 2019 Existing
- 2019 Existing plus Project
- 2040 Cumulative
- 2040 Cumulative plus Project

Compared to the 2019 Existing scenario, the 2040 Cumulative SCC Travel Model includes additional land use and transportation network changes consistent with AMBAG forecasts for population and employment growth as well as regional transportation changes per the Santa Cruz County RTC. Other than the validation adjustments discussed above, the 2040 Cumulative model was used as provided no additional adjustments were made.

The land use inputs for the campus TAZs are summarized in **Table 5**. The student enrollment and total employment is separated by on-campus residents and commuters. The total number of non-student households and the population in those households is also shown. The population was estimated using the average household size assumptions for the UCSC campus from the SCC Model.

Table 5: Land Use Inputs for Campus TAZs

Land Use	Existing	Existing plus Project	Cumulative	Cumulative plus Project
Resident Students	9,283	17,783	11,442	19,958
Commuter Students	9,235	10,217	8,058	8,042
Total Enrollment	*18,518*	*28,000*	*19,500*	*28,000*
Resident Faculty and Staff	270	828	289	867
Commuter Faculty and Staff	3,387	5,702	3,728	5,663
Non-UC Employees	640	990	640	990
Total Employment	*4,297*	*7,520*	*4,657*	*7,520*
Non-student Households	*611*	*2,027*	*701*	*2,066*
Non-student Population	*1,613*	*5,350*	*1,847*	*5,443*

No additional transportation improvement projects beyond those included in the 2040 Cumulative model were assumed in either of the project scenarios.

Results

The model results for each of the scenarios are presented in this section. The following vehicle miles traveled (VMT) metrics were calculated using the outputs from the SCC Model. Each of the metrics will be described in more detail below.

- Total Santa Cruz County VMT per capita
- Residential VMT per capita
- Employee VMT per capita
- Total USCS Campus VMT per capita

Upon reviewing the results from the 2019 and 2040 with Project scenarios, the SCC Model was generating unrealistic modal shifts from the 2019 Existing and 2040 Cumulative scenarios. For example, the percentage of off-campus walk trips was doubling under the project scenario and reducing the percentage of vehicle trips. To account for this unexpected change in travel behavior, the project team used the mode split results from the 2019 Existing and 2040 scenarios and applied those to the person trips from the With Project scenarios to generate the vehicle trip matrices. These matrices were then assigned onto the roadway networks and the results were used in the summaries below.

Santa Cruz County VMT

The total VMT on all roadways within Santa Cruz County is shown **Table 6**. The capita estimate includes the total countywide population, jobs, and UCSC enrollment. Under the project scenarios, the VMT per capita decreases by approximately 3%.

Table 6: Santa Cruz County VMT per Capita

Scenario	Existing	Existing plus Project	*Percent Change*	Cumulative	Cumulative plus Project	*Percent Change*
Capita	403,000	417,000	*3%*	469,000	482,000	*3%*
VMT	5,330,000	5,420,000	*2%*	5,750,000	5,830,000	*1%*
VMT per Capita	13.2	13.0	*-2%*	12.3	12.1	*-1%*

Residential and Employee VMT

The SCC Model was also used to calculate residential and employee VMT per capita consistent with the County's draft VMT analysis guidelines. The countywide baseline values were recalculated by the project team using the updated 2019 Existing and 2040 Cumulative scenarios from this project. The County's VMT target thresholds are 15% below the baseline values for the project generated VMT. The residential population basis includes students living on the UCSC campus and the employment VMT includes VMT generated by all job types.

The County's consultant that is helping to develop the guidelines is using a different process for estimating VMT for trips that start or end outside of Santa Cruz County. Instead of using the SCC Model's estimate of trip lengths for these external trips, the VMT thresholds are based on trip lengths derived from cell phone GPS data. Using these updated trip lengths for the UCSC campus generated data, VMT estimates would reduce by 5 to 10%, which is not consistent with the trip distribution data collected for this project. The project team continued to use the SCC Model's trip lengths to estimate project related VMT.

Table 7 shows the residential and employee VMT per capita ratios for the project compared with the countywide baseline values. The residential VMT per capita is more than 15% lower than the countywide value while the employment VMT per capita does not meet this threshold.

Table 7: Residential and Employment VMT per Capita

Scenario	Existing (Santa Cruz County)	Existing plus Project (Campus)	*Percent Difference*	Cumulative (Santa Cruz County)	Cumulative plus Project (Campus)	*Percent Difference*
Residential	10.4	5.6	*-46%*	9.8	5.4	*-45%*
Employment	10.5	12.5	*19%*	9.5	11.2	*18%*

UCSC Campus VMT

The total VMT generated by the UCSC campus is shown in **Table 8**. This estimate includes the full VMT on roadways outside of Santa Cruz County. The capita basis is the total student enrollment, employees, and non-student population. The VMT per capita decreases by 13% in the 2019 with Project scenario and by 16% in the 2040 with Project scenario.

Table 8: UCSC Campus VMT per Capita

Scenario	Existing	Existing plus Project	*Percent Change*	Cumulative	Cumulative plus Project	*Percent Change*
Capita	32,750	55,320	*69%*	36,300	57,590	*59%*
VMT	298,000	439,000	*47%*	257,000	372,000	*45%*
VMT per Capita	9.1	7.9	*-13%*	7.1	6.5	*-9%*