

# ABM3 SENSITIVITY TESTING REPORT

October 11, 2024

## SANDAG

PREPARED BY

San Diego Association of Governments

55 Railroad Row  
White River Junction, VT 05001  
802.295.4999

RSG

[www.rsginc.com](http://www.rsginc.com)

Data Perspectives Consulting

Free Language Assistance | Ayuda gratuita con el idioma | Libreng Tulong sa Wika  
Hỗ trợ ngôn ngữ miễn phí | 免费语言协助 | 免費語言協助 | مساعدة لغوية مجانية | 무료 언어 지원 | کمک زبان رایگان  
無料の言語支援 | Бесплатная языковая помощь | Assistência linguística gratuita | मुफ्त भाषा सहायता  
Assistance linguistique gratuite | ផ្អែមភាសាឥតគិតថ្លៃ | ఉచిత భాషా సహాయం | ການຊ່ວຍເຫຼືອດ້ານພາສາພຣີ  
Kaalmada Luqadda ee Bilaashka ah | Безкоштовна мовна допомога  
[SANDAG.org/LanguageAssistance](http://SANDAG.org/LanguageAssistance) | 619.699.1900



# Contents

- Contents.....2
- 1.0 Introduction.....3
- 2.0 Sensitivity Testing Methodology.....4
  - 2.1 Sensitivity Testing Methodology.....4
- 3.0 Sensitivity Testing Results.....8
  - 3.1 Transit Headway .....8
  - 3.2 Transit Fare .....12
  - 3.3 Parking Costs.....16
  - 3.4 Managed Lane Pricing.....22
  - 3.5 EV Charging Infrastructure.....22
  - 3.6 E-Bike Ownership.....23
  - 3.7 Microtransit.....25
  - 3.8 Auto Operating Cost.....29
  - 3.9 Micromobility Access Time.....35
  - 3.10 Micromobility Costs.....37
  - 3.11 Increased Growth Near Premium Transit.....38
  - 3.12 Exogenous Variables: Household Income .....41
  - 3.13 Exogenous Variables: Regional Employment .....45
  - 3.14: New Mobilities: EV Rebates.....48
  - 3.15: Telework.....49
  - 3.16: Job-Housing Balance.....52
- 4.0 Testing Conclusions.....55

# 1.0 Introduction

The San Diego Association of Governments serves as the forum for regional decision-making for the San Diego region. SANDAG is governed by a Board of Directors composed of mayors, councilmembers, and county supervisors from each of the region's 19 local governments. SANDAG also serves as the Metropolitan Planning Organization (MPO) for San Diego County, whose role it is to prioritize spending on transportation projects to improve efficiency, promote safety, increase equity, and address other transportation planning objectives. The regional travel demand model is a key tool in SANDAG's toolbox used to analyze transportation and land-use projects and investments, quantify their impacts, and assess their performance relative to these objectives.

In 2009, SANDAG began development of an activity-based travel demand model, in the family of travel models referred to as CT-RAMP (Coordinated Travel Regional Activity-Based Travel Modeling Platform). The model was completed in 2013 and used for the 2015 RTP. The model was updated several times since the initial development - calibrated to new survey data, enhanced for additional sensitivities, expanded to consider emerging transportation technologies, etc. The latest version of the SANDAG ABM is referred to as ABM2+. The objective of this project is to develop Activity-Based Model 3 (ABM3) for the 2025 Regional Plan (2025 RP). The ABM3 development for the 2025 RP includes model estimation using recent surveys, ABM software update to ActivitySim, model calibration and validation, sensitivity tests, policy analysis enhancements, streamlining processes, risk evaluation, and general ABM support.

The ABM3 model sensitivity testing report describes the sensitivity tests conducted to assess the validity of the model and its suitability to quantify Sustainable Communities Strategies. In this report, each sensitivity test is described, along with a priori expectations on how the model may respond to the test. Then the actual model results are described with descriptive tables and graphics as necessary.

# 2.0 Sensitivity Testing Methodology

## 2.1 Sensitivity Testing Methodology

Sensitivity testing is a fundamental component of the development of a new modeling system. Sensitivity testing involves systematically varying one or more model inputs to understand how the model responds to those changes. It is fundamentally different from model calibration, which involves comparing goodness-of-fit of model output against observed data using a fixed set of inputs. The purpose of sensitivity testing is to understand model response to changes in inputs. Although the activity-based (AB) model being deployed for SANDAG has been applied in a number of other regions, the project team is interested in analyzing model sensitivities specific to the land-use data, network, and policies of interest to SANDAG.

In order to be a useful metric of model sensitivity, sensitivity tests must be carefully formulated in order to isolate model responses to the inputs that vary. This requires limiting input changes to only those directly related to the sensitivity test and comparing the outputs against a baseline scenario. For this reason, typically only one variable is varied for each sensitivity test. If elasticity measurements are of interest, the model must be run several times, each with a different level of input variable.

Sensitivity tests described in this report are listed in Table 1 under which the sensitivity test falls, a description of the test, the scenario ID under which the test is stored in SANDAG's Data Lake database of model runs, the baseline scenario used for the test, and the scenario year of the test. In the following section of the report, we describe for each test the changes made to inputs in order to run the test, a priori expectations for model results, and the relevant model results for the test. In this report, we focus specifically on resident model demand changes. However, other special market models (overnight visitors, airport ground access, Mexico resident travel, commercial vehicle travel, and heavy trucks) are reflected in assignment results.

It should be noted that we often observe the largest percentage change in demand for alternatives with low baseline probabilities or market shares. This is consistent with logit math, where the formula for direct elasticity, which can be derived from the logit choice equation, is inversely proportional to the probability of the alternative<sup>1</sup>.

The 2035 no-build scenario was used as the Baseline scenario for all tests. However, the Baseline scenarios differ slightly between the sensitivity tests because of bug fixes encountered and/or model improvements made during model calibration which was running concurrently with sensitivity testing. In the case that a new version of the model was made available, both the baseline and build scenario was run with that new version to ensure consistent results.

---

<sup>1</sup> Direct Elasticity<sub>alternative a, variable v</sub> = (1 - probability<sub>a</sub>) \* coefficient<sub>v</sub> \* v

Note that the results presented in this report are the result of a baseline versus build scenario in which both scenarios use the same random number seed, to reduce Monte Carlo simulation variance<sup>2</sup> between the two runs. These random number seeds are specific to households and persons, so Monte Carlo variance is significantly reduced in the comparison of model results; if the probability distributions between two model runs are the same, the chosen alternatives will be exactly the same. In the model system, Monte Carlo variance occurs because model choices made in the upper level of the model system affect lower-level choices. For example, auto ownership affects tour generation, which affects tour mode, etc. So, if the auto ownership choice in the build alternative is different for a subset of households, people in those households may generate different numbers of tours, with different destinations, modes, etc. To some extent these changes are consistent with the change in auto ownership, but the overall outcome may not be immediately obvious.

Furthermore, the feedback process, in which the entire model system is run iteratively, results in travel time changes between iterations. Due to imperfect convergence, the travel time changes can lead to changes in travel patterns that also may not be obviously traced back to the change in model inputs. In such cases we refer to the 'signal-to-noise' ratio in the model; we expect that the signal (the changes that are directly related to changes in inputs) is higher than the noise (Monte Carlo simulation variance) but this may not always be the case; particularly with respect to changes in inputs that affect only a very small subset of decision-makers. In such cases it may be necessary to run the model multiple times, varying the random number seed in each run, and averaging the results, to decrease the Monte Carlo simulation variance and achieve something closer to an 'expected' or average model outcome.

In support of model calibration and validation, SANDAG implemented a reporting and visualization tool to compare model outputs for each scenario. The tool creates a PowerBI notebook. Many of the graphics in this document are taken from this tool.

---

<sup>2</sup> Monte Carlo simulation variance relates to the different outcomes that one obtains from a probabilistic simulation model due to the use of random number sequences to draw discrete alternatives from probability distributions.

**Table 1: Descriptions of ABM3 Sensitivity Tests**

CARB Category Of Scenario	Type of Scenario	Scenario ID	Description	Scenario Year
Base	Base Model		Base Model	2035
Transit network	Transit Headways	26	All headways increased by 50%	2035
		21	All headways decreased by 50%	2035
Local/ Regional Pricing	Transit Fare	23	All fares decreased by 50%	2035
		19	All fares decreased by 100% or free	2035
	Parking Costs	32	Updated 2035 parking constrained areas and rates - Sensitivity test base	2035
		29	50% more parking costs over parking baseline scenario	2035
		30	50% less parking costs over parking baseline scenario	2035
	Managed Lane Pricing	38	50% decrease in managed lane cost	2035
		42	50% increase in managed lane cost	2035
	New Mobilities	EV Charging Infrastructure	36	Increase in per capita charging stations by 50%
35			Decrease in per capita charging stations by 50%	2035
EV Rebates		197	Apply rebates for low- and middle-income households to purchase EVs	2035
Self-owned E-Bike ownership		27	E-Bike ownership changes from 0.008 to 0.211	2035
Microtransit		39	Microtransit services present	2035

CARB Category Of Scenario	Type of Scenario	Scenario ID	Description	Scenario Year	
		40	Average microtransit wait time decreased by 50%	2035	
	Micromobility Access Time	31	Expanded Micromobility services	2035	
	Micromobility Costs	44	Increased micromobility cost by 50%	2035	
		45	Decreased micromobility cost by 50%	2035	
Exogeneous Variables	Auto Operating Cost (AOC)	22	Auto Operating Cost increased by 50%	2035	
		24	Auto Operating Cost Decreased by 50%	2035	
	Land Use	62	Future growth within ½ mile of premium transit stops	2050	
		203	Job/housing balance	2035	
	Household Income	192	Household Income decreased by 1/3	2035	
		191	Household Income increased by 1/3	2035	
	Regional Employment	201	High Employment (10% less unemployed)	2035	
		194	Low Employment (10% more unemployed)	2035	
	Telework	More Telework	198	Increased Telework coefficient by 50%	2035
		Less Telework	199	Decreased Telework coefficient by 50%	2035

# 3.0 Sensitivity Testing Results

## 3.1 Transit Headway

The transit route attribute table which has headways by route, was modified for these tests. For one scenario, headways for all time periods were increased by 50% while they were decreased by 50% for the other scenario (relative to corresponding values in the base 2035 model).

A priori expectations for this scenario test include:

- An increase in frequency of transit services would likely cause an increase in transit use and a decrease in drive modes and active modes, and vice versa with an increase in headway.
- A decrease in headway to increase the number of transit boardings, and an increase in headway to decrease the number of transit boardings.
- Vehicle Miles of Travel (VMT) trends could be seen in either direction, as a decreased headway might lead to fewer drive trips, but those drive trips could be replaced by transit miles.

An examination of person trips by mode (Table 2) shows expected results, with transit modes<sup>3</sup> increasing and non-transit modes<sup>4</sup> decreasing when headway is decreased, and vice-versa when headway is increased. The magnitude of the percentage of change is again largely a function of the number of person trips for each mode, as the smaller the number of person trips for a mode, the larger the apparent change in percent difference. Overall, a decrease in headway results in a 0.1% decrease in trips across all private auto modes, and a 7% increase in trips across all transit modes. Conversely, an increase in headway results in a 0.2% increase in trips across all private auto uses, and a 6.8% decrease in trips across all transit modes. Note that we see very little change in total tours generated, which is expected given the relatively low share of transit in San Diego County, with only +0.1%/-0.1% change for a decrease/increase in headway, though the direction of change in total tours is logical.

---

<sup>3</sup> There are twelve transit sub-modes considered in ABM3 mode choice models. These are differentiated by four access modes (walk, park-and-ride, kiss-and-ride, and tnc-and-ride) and three combinations of transit paths (local-only, premium-only, and mixed which must include a transfer between local and premium transit).

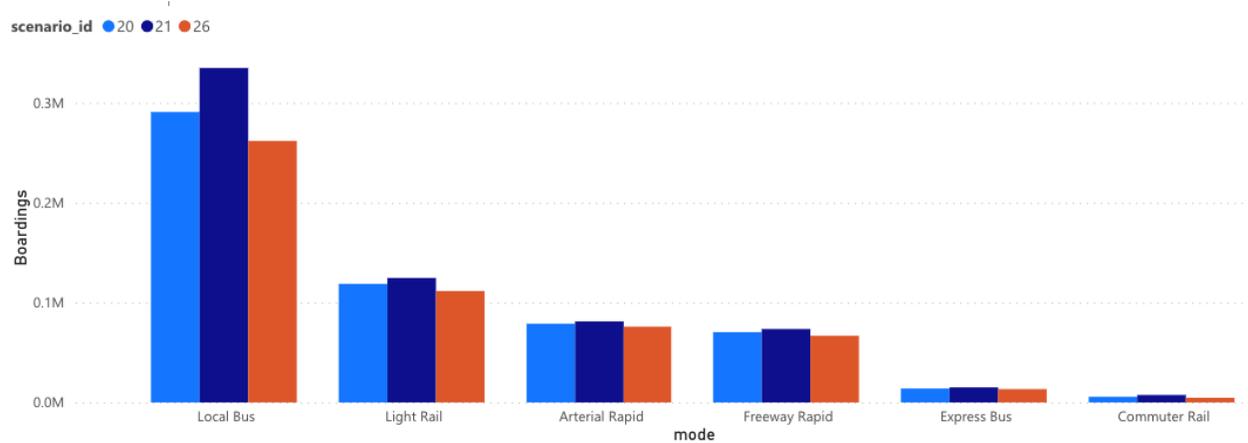
<sup>4</sup> The other modes considered in ABM3 mode choice models are mostly self-explanatory: auto is differentiated by three occupancy levels (drive-alone, shared-ride 2, and shared-ride 3+); there are two active transport modes (walk and bike) and two micromobility modes (e-scooter and e-bike); three ride-hail modes (taxi, single-pay TNC, and shared or pooled TNC) and school bus which is only available for school tours.

**Table 2: Person Trips by Mode- Resident Model, Headway Scenarios**

Mode	Baseline	50% Decrease	%Diff	50% Increase	%Diff
DA	5,566,105	5,556,067	-0.2%	5,580,334	0.3%
S2	2,466,891	2,467,143	0.0%	2,469,591	0.1%
S3	2,464,999	2,462,949	-0.1%	2,463,858	0.0%
WALK	1,868,207	1,868,028	0.0%	1,870,150	0.1%
BIKE	373,368	372,397	-0.3%	374,056	0.2%
WLK-LOC	97,533	107,515	10.2%	89,795	-7.9%
WLK-PRM	54,333	53,440	-1.6%	53,191	-2.1%
WLK-MIX	60,564	64,610	6.7%	56,529	-6.7%
PNR-LOC	893	1,110	24.3%	731	-18.1%
PNR-PRM	1,919	1,831	-4.6%	2,106	9.7%
PNR-MIX	656	677	3.2%	513	-21.8%
KNR-LOC	3,226	3,993	23.8%	2,555	-20.8%
KNR-PRM	9,252	11,079	19.7%	7,782	-15.9%
KNR-MIX	1,968	1,960	-0.4%	1,729	-12.1%
TNC-LOC	906	1,282	41.5%	701	-22.6%
TNC-PRM	5,210	5,743	10.2%	4,723	-9.3%
TNC-MIX	1,776	1,559	-12.2%	1,708	-3.8%
E-Scooter	2,645	2,734	3.4%	2,753	4.1%
E-Bike	231,974	230,629	-0.6%	231,905	0.0%
Sch bus	41,470	41,861	0.9%	41,902	1.0%
TAXI	34,748	34,395	-1.0%	35,217	1.3%
TNC Single	127,867	126,540	-1.0%	129,238	1.1%
Total person trips	13,416,510	13,417,542	0.0%	13,421,067	0.0%
All Private Auto Trips	10,497,995	10,486,159	-0.1%	10,513,783	0.2%
All Active	2,476,194	2,473,788	-0.1%	2,478,864	0.1%
All transit	238,236	254,799	7.0%	222,063	-6.8%

As seen in Figure 1 and Table 3, an increase in headway by 50% (scenario 26) resulted in an 8% decrease in transit boardings for all types of transit. Similarly, a decrease in headway by 50% (scenario 21) leads to a 10% increase in transit boardings. Local bus is changed most drastically in absolute number of increased or decreased boardings from 290,800 to 334,935 (15% increase) for 50% decreased headway and 261,825.63 (9% decrease) for 50% increase in headway. Commuter rail experiences the most dramatic change in percent of boardings (from 5,690 up to 7,512 for a decreased headway, or 32% increase, and down to 4,719 or down 17% for a decreased headway). This makes sense since local bus has the most boardings of any transit submode, while commuter rail has the smallest transit sub-mode share (see elasticity formula).

**Figure 1: Transit Boardings by Transit Sub-Mode and Scenario- Headway Scenarios (20 Baseline, 21-50% Decrease, 26-50% Increase)**



**Table 3: Transit Boardings by Transit Sub-Mode- Headway Scenarios**

	Baseline	50% Decrease	change	%diff	50% Increase	change	%diff
Local Bus	290,800	334,935	44,135	15%	261,826	-28,974	-10%
Light Rail	118,754	124,680	5,926	5%	111,595	-7,158	-6%
Arterial Rapid	78,865	81,220	2,355	3%	75,859	-3,007	-4%
Freeway Rapid	70,354	73,543	3,189	5%	66,787	-3,568	-5%
Express Bus	13,991	15,136	1,145	8%	13,396	-595	-4%
Commuter Rail	5,690	7,512	1,822	32%	4,719	-971	-17%
Total	578,454	637,026	58,573	10%	534,180	-44,273	-8%

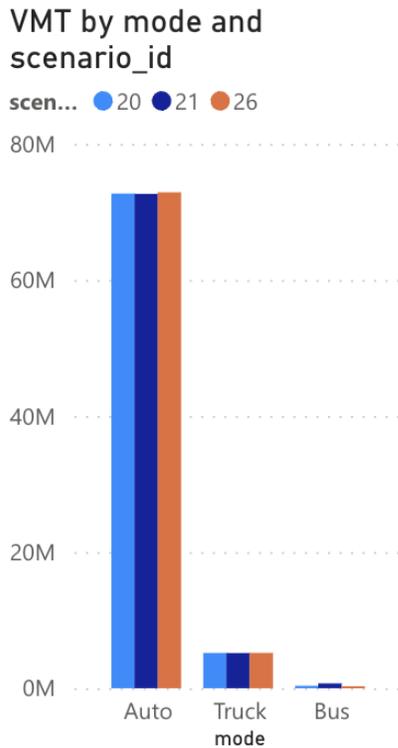
Analysis of the ActivitySim Trip VMT (Table 4) shows a decrease in the overall VMT from the resident and visitor models, and a 0.6% increase in VMT from Commercial vehicles for the scenario in which headway is decreased. An increase in headway leads to an increase by 0.3% in the trip VMT in the resident model. Moreover, the overall VMT decreases by 0.1% with a decrease in headway, and a 0.2% increase with an increase in headway.

**Table 4: ActivitySim Trip VMT by Market- Headway Scenarios**

	Baseline	50% Decrease	%diff	50% Increase	%diff
Resident	48,540,976	48,452,320	-0.2%	48,666,564	0.3%
Visitor	664,322	642,043	-3.4%	662,068	-0.3%
Airport-CBX	448,663	440,768	-1.8%	450,106	0.3%
Airport-SAN	1,091,015	1,091,746	0.1%	1,096,256	0.5%
Commercial Vehicle	11,024,111	11,088,157	0.6%	11,067,643	0.4%
Crossborder	2,321,494	2,308,628	-0.6%	2,328,390	0.3%
External-External	977,824	976,321	-0.2%	977,855	0.0%
External-Internal	8,751,515	8,752,750	0.0%	8,751,815	0.0%
Truck	1,903,239	1,903,165	0.0%	1,903,249	0.0%
Total	75,723,159	75,655,898	-0.1%	75,903,946	0.2%

As shown in Figure 2 and Table 5, when loaded onto the network, both scenarios result in a small increase in total VMT, with a 0.4% increase in total VMT for the decreased headways scenario, and a 0.1% increase for the increased headways scenario. By mode, an increase in headways most notably caused an increase in VMT by auto (181,763 miles), and a decrease in VMT by bus (113,937 miles), while a decrease in headway caused a much smaller decrease in auto VMT (33,796 miles) and a much larger increase in bus VMT (341,810 miles). The difference between the ActivitySim produced trip VMT and the loaded network VMT indicates that although VMT generated should be lower with a decrease in headway, when loaded on the network, perhaps the additional trips bus VMT is impacting the route choice of other vehicles, therefore adding to longer trips than would be expected.

**Figure 2: VMT by Mode and Scenario- Headway Scenarios (20-Baseline, 21-50% Decrease, 26-50% Increase)**



**Table 5: Loaded Network VMT by Mode and Scenario- Headway Scenarios**

	baseline	50% decrease	VMT Base %Diff	50% increase	VMT Base %Diff
Auto VMT	72,691,512	72,657,716	0.0%	72,873,275	0.3%
Bus VMT	341,811	683,621	100.0%	227,874	-33.3%
Truck VMT	5,163,160	5,153,516	-0.2%	5,172,750	0.2%
Total VMT	78,196,483	78,494,854	0.4%	78,273,899	0.1%
% Diff in Total VMT		0.40%		0.10%	

### 3.2 Transit Fare

The transit route table also contains fare information by route. For one scenario, all fares were decreased by 50% while they were decreased by 100% (free) for the other scenario. The fares were modified relative to corresponding values in the base 2035 model. The zone-based fare for commuter rail was updated in the same manner as the route-based fare assumption.

A priori expectations for both scenarios include:

- Increase in transit use for tour mode and trip mode choice and a corresponding decrease in auto and active modes of transportation.
- Higher transit boardings
- Lower VMT/VHT

Changes in person trips by mode for the resident model are shown in Table 6. Results indicate that trip share for auto modes decreases for both scenarios (0.2% or (7,776 trips) for a 50% decrease in transit cost and by 0.4% (or 15,023) for a free fare). Similarly, active modes also experienced a decrease in number of person trips by a similar magnitude with a 0.3% decrease in trips for the 50% reduced fare, and a 0.7% decrease in trips for the free fare scenario. Conversely, an increase in total number of person trips by transit is observed, with an increase by 12.4% in trips by all transit types with a 50% fare reduction, and a 26.1% increase in trips in the free fare scenario.

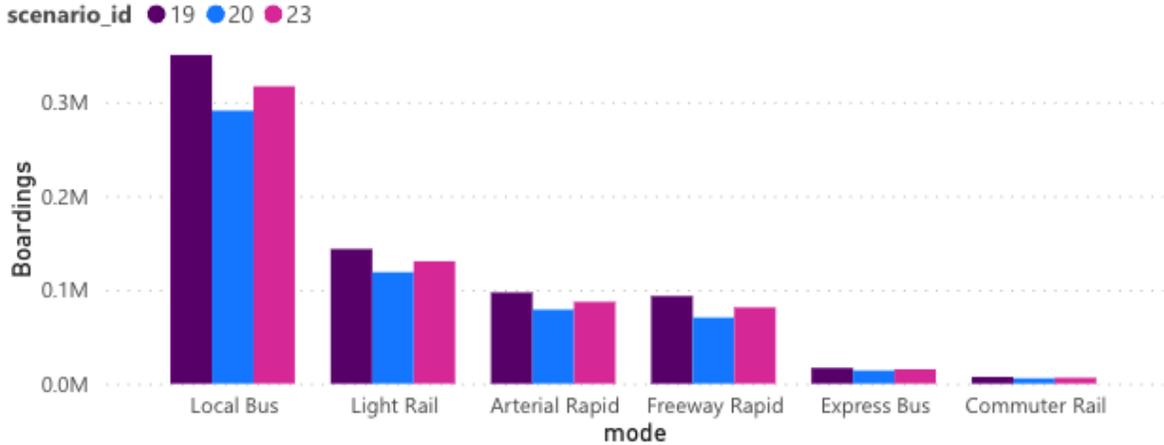
**Table 6: Person trips by Mode: Transit Fare Scenarios**

Mode	Base (scenario 20)	50% decrease (scenario 23)	%Diff	Free fare (scenario 19)	%Diff
DA	5,566,105	5,553,190	-0.2%	5,540,589	-0.5%
S2	2,466,891	2,461,524	-0.2%	2,459,022	-0.3%
S3	2,464,999	2,462,587	-0.1%	2,457,846	-0.3%
WALK	1,868,207	1,867,085	-0.1%	1,860,680	-0.4%
BIKE	373,368	370,704	-0.7%	368,701	-1.2%
WLK-LOC	97,533	109,791	12.6%	122,643	25.7%
WLK-PRM	54,333	61,023	12.3%	68,406	25.9%
WLK-MIX	60,564	69,329	14.5%	79,817	31.8%
PNR-LOC	893	952	6.6%	1,036	16.0%
PNR-PRM	1,919	2,050	6.8%	2,226	16.0%
PNR-MIX	656	658	0.3%	742	13.1%
KNR-LOC	3,226	3,372	4.5%	3,615	12.1%
KNR-PRM	9,252	9,793	5.8%	10,074	8.9%
KNR-MIX	1,968	2,093	6.4%	2,269	15.3%
TNC-LOC	906	981	8.3%	1,147	26.6%
TNC-PRM	5,210	5,654	8.5%	6,219	19.4%
TNC-MIX	1,776	1,999	12.6%	2,248	26.6%
E-Scooter	2,645	2,743	3.7%	2,716	2.7%
E-Bike	231,974	229,443	-1.1%	227,830	-1.8%

Mode	Base (scenario 20)	50% decrease (scenario 23)	%Diff	Free fare (scenario 19)	%Diff
Sch bus	41,470	41,475	0.0%	41,846	0.9%
TAXI	34,748	34,486	-0.8%	34,227	-1.5%
TNC Single	127,867	126,574	-1.0%	124,566	-2.6%
<b>Total Person Trips</b>	13,416,510	13,417,506	0.0%	13,418,465	0.0%
<b>All Private Auto Trips</b>	10,497,995	10,477,301	-0.2%	10,457,457	-0.4%
<b>All Active Trips</b>	2,476,194	2,469,975	-0.3%	2,459,927	-0.7%
<b>All Transit Trips</b>	238,236	267,695	12.4%	300,442	26.1%

A comparison between scenarios of boardings by mode is provided in Figure 3 and Table 7. The 50% fare reduction scenario resulted in an increase in boardings by 10.2%, and the free fare resulted in a 22.4% increase in transit boardings. One must use caution in evaluating the changes in boardings, as smaller numbers can experience greater changes in percentage than larger numbers due to the way elasticities are calculated. However, it is notable that Freeway Rapid Transit in both scenarios surpasses Arterial Rapid Transit in number of additional boardings, despite Arterial Rapid Transits larger share of overall boardings in the baseline scenario.

**Figure 3: Boardings by Mode- Transit Fare Scenarios (20: Baseline, 19: 100% Decrease, 23: 50% Decrease)**



**Table 7: Transit Boardings by Mode and Percent Change by Scenario- Transit Fare Scenarios**

	Baseline	50% Decrease	change	%diff	100% Decrease	change	%diff
Local Bus	290,800	316,751	25,951	8.9%	349,999	59,199	20.4%
Light Rail	118,754	130,391	11,637	9.8%	143,419	24,665	20.8%
Arterial Rapid	78,865	87,162	8,297	10.5%	97,100	18,235	23.1%
Freeway Rapid	70,354	81,195	10,841	15.4%	93,303	22,948	32.6%
Express Bus	13,991	15,372	1,381	9.9%	16,725	2,734	19.5%
Commuter Rail	5,690	6,320	630	11.1%	7,204	1,514	26.6%
<b>Total</b>	<b>578,454</b>	<b>637,190</b>	<b>58,737</b>	<b>10.2%</b>	<b>707,750</b>	<b>129,296</b>	<b>22.4%</b>

Lastly, a decrease in fare by 50% resulted in a 0.1% decrease in total trip VMT across all models reported in Table 8, and a reduction to a free fare resulted in a 0.3% decrease in total trip VMT across models. Changes in VMT by mode on the loaded network using EMME are provided in Table 9. As seen in the table, most of the change in VMT occurs in auto modes.

**Table 8: ActivitySim Trip VMT by Market- Headway Scenarios**

	Baseline	50% Decrease	%diff	Free Fare	%diff
Resident	48,540,976	48,432,352	-0.2%	48,358,836	-0.4%
Visitor	664,322	655,452	-1.3%	647,657	-2.5%
Airport-CBX	448,663	446,069	-0.6%	446,677	-0.4%
Airport-SAN	1,091,015	1,097,049	0.6%	1,093,242	0.2%
Commercial Vehicle	11,024,111	11,088,157	0.6%	11,067,643	0.4%
Crossborder	2,321,494	2,266,930	-2.4%	2,211,713	-4.7%
External-External	977,824	977,830	0.0%	977,824	0.0%
External-Internal	8,751,515	8,751,910	0.0%	8,751,586	0.0%
Truck	1,903,239	1,903,095	0.0%	1,903,346	0.0%
Total	75,723,159	75,618,844	-0.1%	75,458,524	-0.3%

**Table 9: Loaded Network VMT by Mode- Transit Fare Scenarios**

Scenario	Auto	Bus	Truck	Total	VMT Base Diff	VMT Base %Diff
Baseline	72,691,512	341,811	5,163,160	78,196,483	0	0.00%
50% decrease	72,615,357	341,811	5,173,213	78,130,380	-66,103	-0.1%
Free Fare	72,426,859	341,811	5,172,815	77,941,485	-254,998	-0.3%

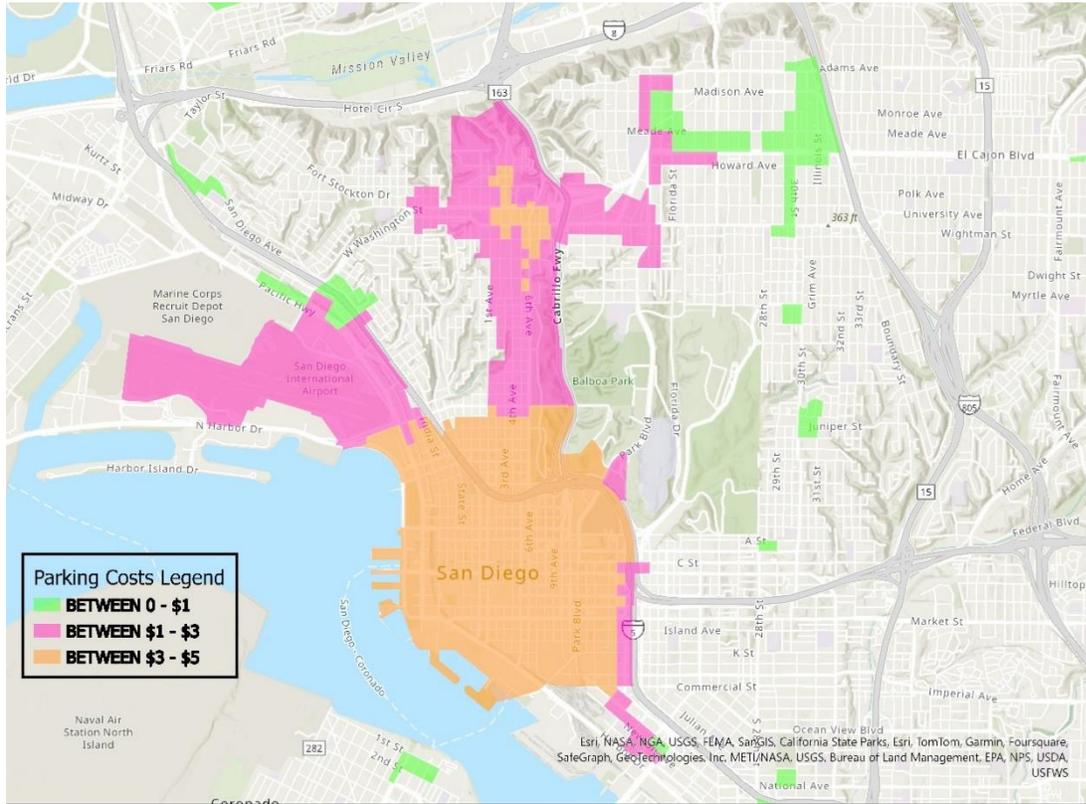
### 3.3 Parking Costs

A new baseline scenario (scenario 32) was created with an updated inventory of parking constrained areas and parking costs. Downtown Parking Constrained Areas are provided in Figure 4, Figure 5, and Figure 6. The scenarios updated parking costs in 887 MGRAs (out of over 23,000). The impacted MGRAs have about 4.5% of the regional population in 2035. In the baseline 2035 case, the average costs for parking are \$3.5/hour, \$23/day and \$318/month all in 2022\$.

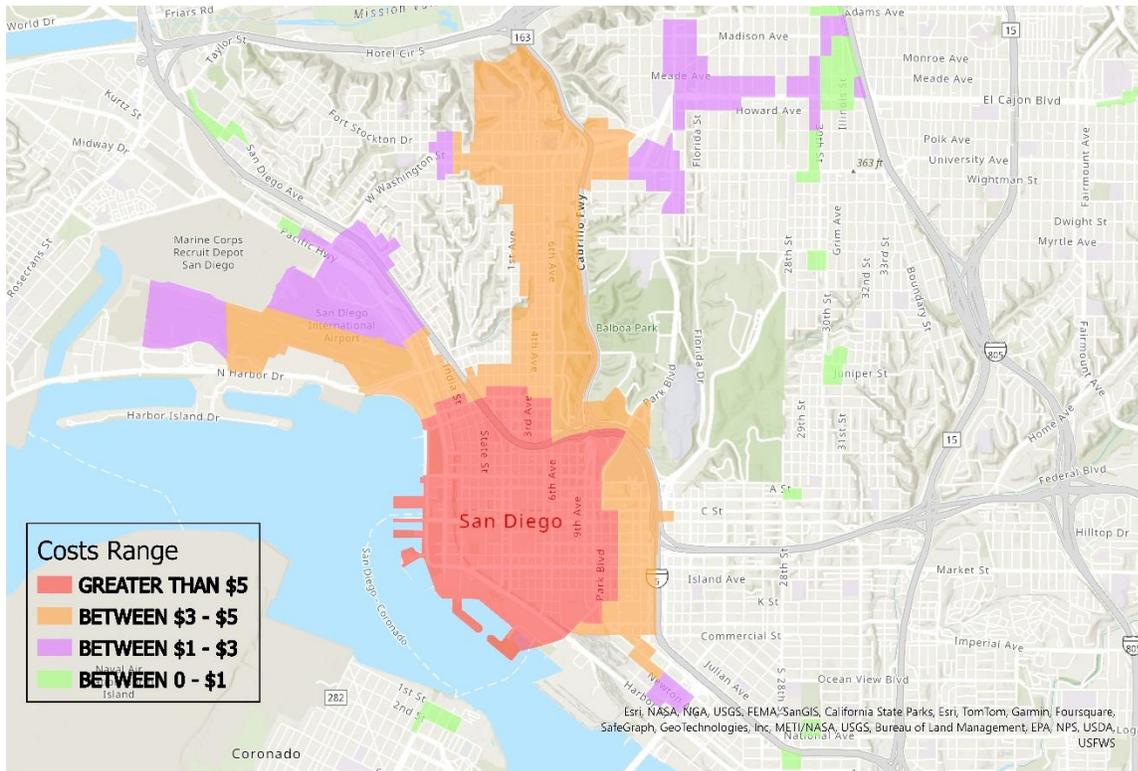
Two new scenarios were built on this new baseline scenario:

- Increase in parking costs by 50% (scenario 29)
- Decrease in parking costs by 50% (scenario 30)

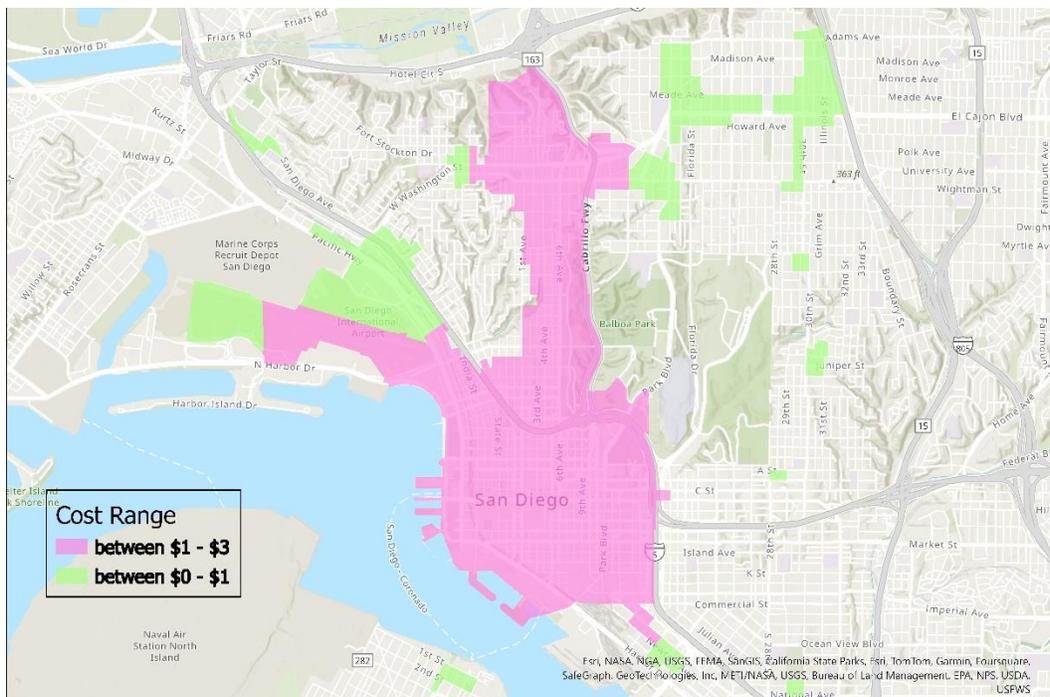
Figure 4: Hourly Costs – Downtown Parking Constrained Areas



**Figure 5: Hourly Parking with 50% Increase**



**Figure 6: Hourly Parking with 50% Decrease**



We expect the following changes in response to the parking cost tests:

- A reduction in mode share for auto modes for an increase in parking costs, and an increase in mode share for auto modes for a decrease in parking costs,
- An increase in transit, and active modes corresponding to an increase in parking costs, and a decrease in these modes corresponding to a decrease in parking costs.
- An increase in transit boardings consistent with an increase in transit mode share.
- A decrease in VMT with an increase in parking costs, and an increase in VMT with a decrease in parking cost.

Results of the scenario test indicates that an increase in parking costs by 50% results in a 1.7% increase in transit pass ownership, and a decrease in parking costs results in a 1.9% decrease in transit pass ownership, as shown in Table 10.

**Table 10: Transit Pass Ownership – Parking Cost Scenarios**

Baseline	50% Increase	% Diff	50% Decrease	% Diff
596872	607,226	1.7%	585520	-1.9%

The mode share results for these scenarios are provided in Table 11. Drive alone trends are as expected, with a decrease in drive alone mode with an increase in parking, and an increase in drive alone with a lower parking cost. However, Shared2 and Shared3+ do not have the same trends. A decrease in parking cost results in a 0.1% reduction of person trips by Shared2. Additionally, a 50% increase in parking results in a 0.2% increase of Shared3+ trips, and a decrease in parking cost results in a 0.1% decrease in Shared3+ trips. This is likely a result of the cost sharing for shared ride trips; as parking costs increase, the decrease in utility for drive-alone is much higher than the decrease in utility for shared-ride 2 and more so for shared ride 3.

All active modes of transportation increase when parking costs increase, and all active modes decrease when parking costs decrease. Additionally, with the exception of TNC access to premium transit, all transit modes decrease with a decrease in parking costs. There is no evident trend in transit across all modes with an increase in parking costs, some modes increase in person trips, and some decrease. This perhaps is due to the small number of transit trips in the elasticity calculation and therefore the inability to make strong conclusions regarding the impact of parking increases on transit ridership.

**Table 11: Person trips by Mode: Resident Model, Parking Scenarios**

Mode	Baseline	50% increase	%Diff	50% decrease	%Diff
DA	5,691,677	5,677,827	-0.2%	5,712,630	0.4%
S2	2,485,639	2,485,844	0.0%	2,482,358	-0.1%
S3	2,472,504	2,477,119	0.2%	2,470,021	-0.1%
WALK	1,882,998	1,887,852	0.3%	1,879,450	-0.2%
BIKE	383,013	385,245	0.6%	379,969	-0.8%

Mode	Baseline	50% increase	%Diff	50% decrease	%Diff
WLK-LOC	99,789	100,667	0.9%	98,429	-1.4%
WLK-PRM	54,925	55,958	1.9%	54,220	-1.3%
WLK-MIX	62,315	62,947	1.0%	60,932	-2.2%
PNR-LOC	899	920	2.3%	866	-3.7%
PNR-PRM	2,089	2,157	3.3%	1,960	-6.2%
PNR-MIX	642	633	-1.4%	616	-4.0%
KNR-LOC	3,282	3,281	0.0%	3,138	-4.4%
KNR-PRM	9,595	9,823	2.4%	9,501	-1.0%
KNR-MIX	2,145	2,110	-1.6%	2,057	-4.1%
TNC-LOC	926	973	5.1%	941	1.6%
TNC-PRM	5,438	5,530	1.7%	5,490	1.0%
TNC-MIX	1,892	1,973	4.3%	1,831	-3.2%
E-Scooter	517	571	10.4%	539	4.3%
E-Bike	36,055	36,251	0.5%	35,537	-1.4%
Sch bus	42,079	41,437	-1.5%	41,892	-0.4%
TAXI	37,541	37,175	-1.0%	36,858	-1.8%
TNC Single	130,737	131,557	0.6%	130,269	-0.4%
<b>Total Person Trips</b>	13,406,697	13,407,850	0.0%	13,407,850	0.0%
<b>All Private Auto Trips</b>	10,649,820	10,640,790	-0.1%	10,665,009	0.1%
<b>All Active Trips</b>	2,302,583	2,309,919	0.3%	2,295,495	-0.3%
<b>All Transit Trips</b>	243,984	246,925	1.2%	239,981	-1.6%

Transit boardings are however shown to increase overall in the increased parking cost scenario and decrease in a very similar magnitude for the scenario with a decrease in parking cost as shown in Table 12.

**Table 12: Transit Boardings- Parking Scenarios**

	Parking Baseline	50% Increase	% Diff	50% Decrease	% Diff
Arterial Rapid	79,192	81,065	0.6%	78,713	-2.4%
Commuter Rail	5,765	5,719	1.0%	5,706	0.8%
Express Bus	14,248	14,687	0.7%	14,153	-3.1%

	Parking Baseline	50% Increase	% Diff	50% Decrease	% Diff
Freeway Rapid	71,152	72,666	0.9%	70,481	-2.1%
Light Rail	120,073	121,688	1.1%	118,704	-1.3%
Local Bus	295,120	296,650	1.4%	291,019	-0.5%
<b>All</b>	<b>585,550</b>	<b>592,475</b>	<b>1.2%</b>	<b>578,776</b>	<b>-1.2%</b>

The ActivitySim trip VMT by model is provided in Table 13. Results indicate that an increase in parking costs show a 0.3% decrease in trip VMT, and a decrease in parking costs results in a 0.1% increase in Trip VMT for the resident model. The visitor model however indicates an opposite impact, with an increase in VMT with an increase in parking costs, and a decrease in VMT with a decrease in parking costs. Perhaps the small changes in the visitor model reflects the fact that some visitors are selecting accommodations or parking in locations that are further from their destinations with an increase in parking costs and vice versa for a decrease in parking.

**Table 13: ActivitySim Trip VMT by Travel Segment- Parking Scenarios**

	Baseline	Increase 50%	% Diff	Decrease 50%	% Diff
Resident	49,246,324	49,119,172	-0.3%	49,311,884	0.1%
Visitor	650,914	655,960	0.8%	647,606	-0.5%
Airport-CBX	445,467	447,527	0.5%	447,523	0.5%
Airport-SAN	1,095,562	1,093,122	-0.2%	1,099,466	0.4%
Commercial Vehicle	11,103,494	11,046,663	-0.5%	11,030,302	-0.7%
Crossborder	2,358,264	2,348,930	-0.4%	2,376,042	0.8%
External-External	976,958	976,958	0.0%	976,982	0.0%
External-Internal	8,752,650	8,752,203	0.0%	8,752,521	0.0%
Truck	1,903,799	1,903,778	0.0%	1,903,288	0.0%
<b>Total</b>	<b>76,533,432</b>	<b>76,344,313</b>	<b>-0.2%</b>	<b>76,545,614</b>	<b>0.0%</b>

Table 14 and Table 15 provide residential model VMT and vehicle trips from MGRAs in which parking costs have been applied and to MGRAs in which parking costs have been applied. Results indicate that there is a decrease in trips and VMT with an increase in costs, and an increase in trips and VMT with a decrease in parking costs.

**Table 14: VMT from and to Impacted MGRAs- Parking Scenarios, Residential Model**

	From Parking MGRAs	%Diff	To Parking MGRAs	%Diff
Baseline	2,486,741		2,553,614	
50% Increase	2,398,421	-3.6%	2,465,099	-3.5%
50% Decrease	2,564,860	3.1%	2,633,046	3.1%

**Table 15: Vehicle Trips from and to Impacted MGRAs- Parking Scenarios, Residential Model**

	From Parking MGRAs	%Diff	To Parking MGRAs	%Diff
Baseline	914,861		916,389	
50% Increase	904,447	-1.1%	906,052	-1.1%
50% Decrease	926,577	1.3%	928,162	1.3%

### 3.4 Managed Lane Pricing

SANDAG currently operates managed lane facilities on I-15, though these are planned to expand. One major policy dial that could affect travel behavior is the price on these managed lane facilities. By default, the 2035 network has a 30 cent per mile charge on managed lanes, with a 12 cent per mile charge on the following low-volume corridors:

- SR-163: from I-805 to SR-52
- I-8: from SR-125 to Greenfield Dr
- SR-125: From SR-54 to SR-94
- I-5: From SR-905 to Palomar St

Two sensitivity tests were conducted: One with the managed lane price decreased by 50% and the other with it increased by 50%. It was expected that increasing the price would decrease the VMT on managed lanes, and the opposite would happen if the price were decreased. This was observed, as shown in Table 16. There was no significant change in regional VMT.

**Table 16: Managed Lane VMT- Managed Lane Scenarios**

	VMT	%Diff
Base	3,233,284	
Managed lane price decrease 50%	3,824,106	18.27%
Managed lane price increase 50%	2,867,301	-11.32%

### 3.5 EV Charging Infrastructure

The number of per-capita electric vehicle chargers is an input to the vehicle type choice model in ABM3, which predicts the vehicle fleet mix of owned vehicles by age, body type, and fuel type. In the 2035 baseline, the number of chargers per capita was assumed to be the same as that in 2022 base year, a value of 0.00034592 (over 1,100 chargers in a region with a population of 3.2 million persons). Sensitivity test scenarios include an increase in chargers per capita by 50% and a decrease in chargers per capita by 50% for the year 2035.

A priori expectations from this set of scenarios include:

- A decrease in the number of gas-powered vehicles and an increase in Electric Vehicles in the fleet composition with an increase in charging infrastructure.

- Little change in mode, trip distance or VMT, as most of the impact will be experienced in the type of auto rather than the existence of and distance of the auto trip.

Fleet composition results seen in Table 17 of the scenario tests reveal that for the fleet of vehicles within the year 2003-2035, a decrease in charging infrastructure results in an increase in gas and hybrid powered vehicles, and a decrease in Battery Electric Vehicles (BEVs) and Plug-in Electric Hybrid Vehicles (PEVs). With an increase in charging stations, BEV and PEV ownership increases, and gas, hybrid and diesel vehicle ownership decrease.

**Table 17: Fleet Composition- Electric Vehicle Charging Station Scenarios**

	Gas	Hybrid	BEV	PEV	Diesel
Baseline	80.9%	8.5%	6.0%	2.8%	1.8%
Infrastructure Decreased 50%	82.7%	8.6%	4.7%	2.2%	1.8%
Infrastructure Increased 50%	78.6%	8.4%	7.7%	3.6%	1.7%

Trip length, mode share and VMT were examined and were found to have no significant changes.

### 3.6 E-Bike Ownership

A scenario was also considered in which the rate of privately owned E-bikes by households was increased from 0.008 to 0.211. Planners had requested that modelers assume that 36% of bikes would be E-bikes in 2035, so this number was multiplied by the percentage of households that owned a bike in the 2022 household travel survey (58.5%) to estimate that 21.1% of households would own an E-bike in 2035.

A priori expectations from this scenario test include:

- An increase in E-bike trips and a corresponding decrease in other active modes, as well as some transit modes.
- Changes in VMT by mode, with an increase in E-bike VMT and a decrease in the other active and transit modes
- Very little to no change in trip length by mode

The number of person trips by mode are provided in **Error! Reference source not found.**

The results show as expected that with a 26x increase in E-bike trips, e-bike trips increase by nearly 12%, and both walk and bike trips experience a decline in share<sup>5</sup>. E-scooter trips did not change significantly. All private auto modes decrease in number of trips as well. There was not an overall change in trips from the base year scenario to the increased e-bike ownership scenario, indicating that the e-bike ownership replaced other modes, but did not have a high impact on the generation of trips.

<sup>5</sup> E-bike mode share includes both privately owned e-bikes and publicly available e-bikes. For owners of e-bikes, we assume that usage of these modes is free and available with no access time. Other travelers use of e-bikes are subject to availability constraints and access times that vary by origin of tour/trip and the cost of using the bike. Base-year data was insufficient to calibrate separate e-bike tour and trip mode share constants for owners of e-bikes but we expect to revisit this with the availability of another wave of survey data.

**Table 18: Person Trips by Mode- E-Bike Scenarios**

Mode	Baseline	Increase E-Bike	%Diff
DA	5,566,105	5,548,629	-0.3%
S2	2,466,891	2,461,839	-0.2%
S3	2,464,999	2,464,917	0.0%
WALK	1,868,207	1,864,996	-0.2%
BIKE	373,368	372,280	-0.3%
WLK-LOC	97,533	97,488	0.0%
WLK-PRM	54,333	54,160	-0.3%
WLK-MIX	60,564	60,568	0.0%
PNR-LOC	893	881	-1.3%
PNR-PRM	1,919	1,966	2.4%
PNR-MIX	656	611	-6.9%
KNR-LOC	3,226	3,121	-3.3%
KNR-PRM	9,252	9,378	1.4%
KNR-MIX	1,968	2,005	1.9%
TNC-LOC	906	886	-2.2%
TNC-PRM	5,210	5,085	-2.4%
TNC-MIX	1,776	1,705	-4.0%
E-Scooter	2,645	2,651	0.2%
E-Bike	231,974	259,425	11.8%
Sch bus	41,470	42,340	2.1%
TAXI	34,748	34,619	-0.4%
TNC Single	127,867	127,533	-0.3%
<b>Total Person Trips</b>	<b>13,416,510</b>	<b>13,417,083</b>	<b>0.0%</b>
<b>All Private Auto Trips</b>	<b>10,497,995</b>	<b>10,475,385</b>	<b>-0.2%</b>
<b>All Active Trips</b>	<b>2,476,194</b>	<b>2,499,352</b>	<b>0.9%</b>
<b>All Transit Trips</b>	<b>238,236</b>	<b>237,854</b>	<b>-0.2%</b>

Table 19 provides the ActivitySim derived Person Trip VMT by model for the two scenarios. The total VMT for the resident model decreases by nearly 40,000 miles or 0.1%. Changes in the loaded network VMT observed in other models and reported in Table 19 could be either due to interactions with the resident model in which e-bike ownership is specific to, or could be due to simulation variance. Most changes, with the exception of the commercial vehicle model, are small in comparison to the resident model. It may be worthwhile to investigate why the commercial vehicle model VMT is changing with an increase in e-bike ownership. Table 20 indicates that when the trips are loaded onto the network, there is a resulting 0.1% increase in VMT. Further investigation into why this might be occurring is necessary.

**Table 19: ActivitySim Person Trip VMT by Market- E-bike Scenarios**

	Baseline	Increased E-bike	% Diff
Resident	48,540,976	48,501,280	-0.1%
Visitor	664,322	659,662	-0.7%
Airport-CBX	448,663	448,535	0.0%
Airport-SAN	1,091,015	1,088,827	-0.2%
Commercial Vehicle	11,024,111	11,096,575	0.7%
Crossborder	2,321,494	2,315,308	-0.3%
External-External	977,824	977,824	0.0%
External-Internal	8,751,515	8,751,660	0.0%
Truck	1,903,239	1,903,245	0.0%
<b>Total</b>	<b>75,723,159</b>	<b>75,742,916</b>	<b>0.0%</b>

**Table 20: Loaded Network VMT- E-Bike Scenarios**

	Auto	Bus	Truck	Total	VMT Base Diff	VMT Base %Diff
Baseline	72,691,512	341,811	5,163,160	78,196,483	0	
Increased E-Bike	72,742,486	341,811	5,181,824	78,266,121	69,638	0.1%

### 3.7 Microtransit

Two types of microtransit that are a part of the 2025 Regional Plan were incorporated into ABM3 for testing:

- Standard microtransit: Small buses that serve a relatively larger area
- Neighborhood electric vehicles (NEVs): Small electric vans that serve a relatively smaller area

For each of these services, a trip on a microtransit or NEV vehicle must be within a specified service area, which are often focused on premium transit stops. Three types of microtransit travel were accounted for in the mode choice models: Full microtransit trips, first-mile transit access, and last-mile transit access.

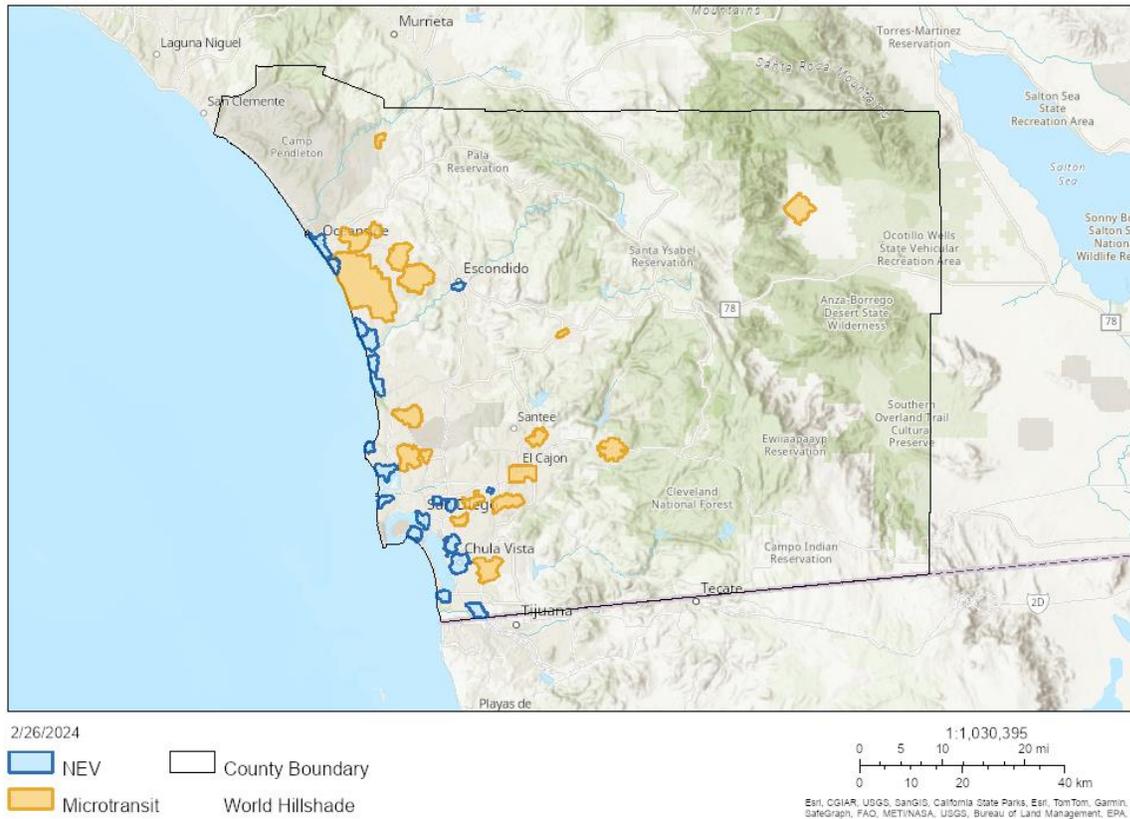
For the full microtransit trips, the pooled TNC mode was utilized. A choice hierarchy was enforced, where if an origin and destination were both within a NEV service area, NEV values for wait time, travel time, and cost were used. If the origin and destination were not within a NEV service area, it was then checked if they were within a microtransit service area, in which case microtransit travel times, wait times, and costs were used. If not, then standard pooled TNC values were used.

For the first-mile microtransit access, the TNC to transit mode was used for premium stops only. If a trip origin (or destination on the return leg) was within a NEV or microtransit service area, an appropriate access time and additional transfer was assumed. The microtransit and NEV fares were assumed to be zero when accessing a premium transit stop, as that is what is planned for these services. The hierarchy of services applied in the same way as with the full microtransit trips, where if an origin was within a NEV service area, that was assumed to be used, and if not microtransit was assumed to be used if within one of those service areas. Otherwise, standard TNC was used. If microtransit or NEV were used to access a transit stop, an additional transfer was added.

For the last-mile microtransit access, the walk egress (or access time on return trips) time was edited so that if the distance from the destination to a premium stop was more than a half mile and within a NEV service area, the NEV travel and wait times were used as the egress times, along with the addition of a transfer. If the destination was within a microtransit service area, a similar way of calculating an egress time was used. In both cases an additional transfer was added. No additional cost was added for using microtransit or NEV for egress as that is planned to be free.

In addition to the resident model, these were added to the visitor and crossborder model as these services are available to those markets (though TNC Access to transit isn't available for those markets, so it was excluded). Two sensitivity tests were run, one with a standard microtransit setup, and another with lowered microtransit and NEV wait times. These changes were made by editing the `microtransitWaitTime` and `nevWaitTime` parameters set in `constants.yaml` in `common\configs` and `crossborder\configs`.

**Figure 7: Microtransit & NEV Service Areas**



The standard sensitivity test for 2035 had all of the microtransit and NEV services as planned, including operating speeds, wait times, and costs. The other reduced the average wait time for a service from 12 minutes to 6 minutes. The expectation was that decreasing the wait times would increase the microtransit and NEV boardings. These boardings are shown in Table 21. An increase in microtransit and NEV boardings was indeed observed, particularly at the attraction end of the trip. It should be noted that these results are preliminary and light calibration to match observed boardings in microtransit pilots are to be done.

**Table 21: Number of Microtransit/NEV Trips**

Mode	Baseline	Reduced Wait Time	%Diff
Full Microtransit Trips	1,778	2,169	22.0%
Outbound Microtransit Access to Transit	516	552	7.0%
Outbound Microtransit Egress from Transit	396	624	57.6%
Inbound Microtransit Access to Transit	691	991	43.4%
Inbound Microtransit Egress from Transit	516	552	7.0%
<b>Total Microtransit Trips</b>	<b>2,119</b>	<b>2,719</b>	<b>28.3%</b>

Mode	Baseline	Reduced Wait Time	%Diff
Full NEV Trips	3,856	4,217	9.4%
Outbound NEV Access to Transit	1,687	1,855	10.0%
Outbound NEV Egress from Transit	375	527	40.5%
Inbound NEV Access to Transit	523	796	52.2%
Inbound NEV Egress from Transit	1687	1,855	10.0%
<b>Total NEV Trips</b>	<b>4,272</b>	<b>5,033</b>	<b>17.8%</b>

Person trips by mode for the resident model in the microtransit scenarios are shown in Table 22. There were increases in TNC Shared and TNC-PRM, which are the two modes that most benefit from reducing the microtransit wait time. The increase in the use of TNC Shared was higher when microtransit or NEV were available.

**Table 22: Person Trips by Mode- Microtransit Scenarios**

Mode	Baseline	Reduced Wait Time	%Diff
DA	5,659,594	5,660,213	0.0%
S2	2,482,700	2,482,741	0.0%
S3	2,470,875	2,470,486	0.0%
WALK	1,871,111	1,872,524	0.1%
BIKE	381,679	380,194	-0.4%
WLK-LOC	86,150	85,932	-0.3%
WLK-PRM	33,160	33,987	2.5%
WLK-MIX	50,208	50,075	-0.3%
PNR-LOC	3,176	3,152	-0.8%
PNR-PRM	5,266	5,500	4.4%
PNR-MIX	2,352	2,342	-0.4%
KNR-LOC	11,480	11,344	-1.2%
KNR-PRM	33,304	33,147	-0.5%
KNR-MIX	9,814	9,899	0.9%
TNC-LOC	589	582	-1.2%
TNC-PRM	3,003	3,122	4.0%
TNC-MIX	1,344	1,317	-2.0%
E-Scooter	491	531	8.1%

Mode	Baseline	Reduced Wait Time	%Diff
E-Bike	35,924	35,833	-0.3%
Sch bus	41,521	41,808	0.7%
TAXI	33,294	32,943	-1.1%
TNC Single	105,556	104,888	-0.6%
TNC Shared (NEV)	1,209	1,572	30.0%
TNC Shared (Microtransit)	1,702	2,106	23.7%
TNC Shared (Other)	53,910	54,071	0.3%
<b>Total Person Trips</b>	<b>13,379,437</b>	<b>13,380,336</b>	<b>0.0%</b>

The loaded network VMT for the microtransit scenarios is shown in Table 23. Decreasing the wait time for microtransit did not have a significant impact on regional VMT.

**Table 23: Loaded Network VMT- Microtransit Scenarios**

	Auto	Bus	Truck	Total	VMT Base Diff	VMT Base %Diff
Baseline	73,189,110	341,811	5,173,710	78,704,631		
Reduced Wait Time	73,201,840	341,811	5,160,565	78,704,216	-415	-0.0%

### 3.8 Auto Operating Cost

Model sensitivity to Auto Operating Cost (AOC) was tested using the 2035 baseline scenario. The scenarios include an increase in AOC by 50% and a decrease in AOC by 50%. The ABM3 resident model includes a vehicle type choice model, in which auto operating cost varies by vehicle age, body type, and fuel type. An average AOC is specified in a global properties file, and used in assignment. A procedure was added after the vehicle type choice model is run so that the average AOC of the region’s owned vehicle fleet is scaled to match the global value set in the properties file. This allows for lower AOC values for households that use more fuel-efficient vehicles. If a non-household vehicle is selected to be used in the vehicle allocation model, the global AOC value is used. Overnight visitors, Mexico residents, and airport passengers also use the global AOC.

Expected observations to a change in auto operating cost include

- Decrease in auto mode use and VMT with an increase in AOC, and an increase in auto mode use and VMT with a decrease in AOC.
- Increase in active modes with an increase in AOC and a decrease in active modes with a decrease in AOC
- Increase in transit boardings with an increase in AOC, and a decrease in transit boardings with a decrease in AOC

- Decrease in trip distance with an increase in AOC and an increase in trip distance with a decrease in AOC

Analysis of transit pass ownership shows that with an increase in AOC, there is a 0.1% increase in transit pass ownership, and with a decrease in AOC, there is a 0.1% decrease in transit pass ownership as seen in Table 24.

**Table 24: Transit Pass Ownership- AOC Scenarios**

	<b>Owns Transit Pass</b>	<b>% Diff</b>
Base	599,436	
Increase 50%	600,140	0.1%
Decrease 50%	599,078	-0.1%

Average person trip distance is provided in Table 25, and as expected shows an increase in the average distance for all transit and active transportation modes, and a decrease in auto dependent modes (drive alone, shared 2 and shared 3+ as well as single TNC trips) when there is an increase in AOC. The only exception to this is trip distance by taxi, which shows a positive but insignificant change. Most changes are small, however school bus average distance increases more compared to increases experienced by other modes (over 2 miles longer). Conversely, there is a decrease in average trip distance for all transit and active modes and an increase in trip distance for auto modes when the AOC is decreased. Except for TNC access for local transit trips, all modes including TNC for all or a portion of the trip experience some of the largest decreases (over 1 mile) in average distance. School bus trips also show a larger decrease, perhaps pointing to the lower threshold for switching between auto or active and bus mode choice for school related trips.

**Table 25: Person Trip Average Distance by Mode- AOC Scenarios**

	<b>Baseline</b>	<b>50% increase</b>	<b>change</b>	<b>%diff</b>	<b>50% Decrease</b>	<b>change</b>	<b>%diff</b>
DA	6.67	6.44	-0.23	-3.4%	6.93	0.26	3.9%
S2	6	5.85	-0.15	-2.5%	6.19	0.19	3.2%
S3	6.88	6.61	-0.27	-3.9%	7.22	0.34	4.9%
WALK	0.78	0.8	0.02	2.6%	0.77	-0.01	-1.3%
BIKE	3.17	3.21	0.04	1.3%	3.1	-0.07	-2.2%
WLK-LOC	5.28	5.38	0.1	1.9%	5.09	-0.19	-3.6%
WLK-PRM	9.03	9.22	0.19	2.1%	8.7	-0.33	-3.7%
WLK-MIX	14.76	15.41	0.65	4.4%	14.09	-0.67	-4.5%
PNR-LOC	6.41	6.98	0.57	8.9%	6.09	-0.32	-5.0%
PNR-PRM	12.31	13.2	0.89	7.2%	12.32	0.01	0.1%
PNR-MIX	16.01	15.55	-0.46	-2.9%	15.43	-0.58	-3.6%

	Baseline	50% increase	change	%diff	50% Decrease	change	%diff
KNR-LOC	6.06	6.31	0.25	4.1%	5.67	-0.39	-6.4%
KNR-PRM	11.58	11.85	0.27	2.3%	10.96	-0.62	-5.4%
KNR-MIX	13.46	13.26	-0.2	-1.5%	13.12	-0.34	-2.5%
TNC-LOC	7.94	8.52	0.58	7.3%	7.36	-0.58	-7.3%
TNC-PRM	15.22	15.4	0.18	1.2%	14.37	-0.85	-5.6%
TNC-MIX	20.08	21.15	1.07	5.3%	18.71	-1.37	-6.8%
E-Scooter	4.48	4.55	0.07	1.6%	4.75	0.27	6.0%
E-Bike	5.01	5.04	0.03	0.6%	4.97	-0.04	-0.8%
Sch bus	15.17	17.95	2.78	18.3%	13.5	-1.67	11.0%
TAXI	2.64	2.69	0.05	1.9%	2.58	-0.06	-2.3%
TNC Single	6.74	7	0.26	3.9%	6.42	-0.32	-4.7%

Person trips by mode share results (provided in Table 26) for the three scenarios show that a decrease in AOC results in a 0.1% increase in overall trips and a 0.1% decrease when AOC increases. Private auto modes experience an increase in person trips with a decrease in AOC, and a decline in private auto trips with an increase in AOC. Conversely, active modes and transit that do not involve an auto for access (Kiss and Ride- KNR and Park and Ride- PNR) behaves as expected, with decreases in AOC leading to a decrease in person trips by those modes, and increases in AOC resulting in an increase. Transit trips involving KNR and PNR access behave similarly to private auto, in that a decrease in AOC results in an increase in trips using auto access, and vice versa.

**Table 26: Person Trips by Mode-AOC Scenarios**

Mode	Baseline	50% Decrease	%Diff	50% Increase	%Diff
DA	5,566,105	5,612,047	0.8%	5,504,191	-1.1%
S2	2,466,891	2,490,263	0.9%	2,441,177	-1.0%
S3	2,464,999	2,508,328	1.8%	2,424,920	-1.6%
WALK	1,868,207	1,824,168	-2.4%	1,906,871	2.1%
BIKE	373,368	359,651	-3.7%	386,034	3.4%
WLK-LOC	97,533	83,479	-14.4%	109,158	11.9%
WLK-PRM	54,333	45,837	-15.6%	60,457	11.3%
WLK-MIX	60,564	47,345	-21.8%	73,424	21.2%
PNR-LOC	893	2,002	124.2%	427	-52.2%

Mode	Baseline	50% Decrease	%Diff	50% Increase	%Diff
PNR-PRM	1,919	4,848	152.6%	949	-50.5%
PNR-MIX	656	1,480	125.6%	338	-48.5%
KNR-LOC	3,226	7,529	133.4%	1,508	-53.3%
KNR-PRM	9,252	25,332	173.8%	4,194	-54.7%
KNR-MIX	1,968	5,677	188.5%	936	-52.4%
TNC-LOC	617	906	46.8%	1,192	93.2%
TNC-PRM	5,210	2,808	-46.1%	6,879	32.0%
TNC-MIX	1,776	973	-45.2%	2,505	41.0%
E-Scooter	2,645	2,736	3.4%	2,717	2.7%
E-Bike	231,974	215,966	-6.9%	247,833	6.8%
Sch bus	41,470	35,770	-13.7%	48,199	16.2%
TAXI	34,748	32,437	-6.7%	37,112	6.8%
TNC Single	127,867	117,266	-8.3%	138,981	8.7%
<b>Total Person Trips</b>	<b>13,416,221</b>	<b>13,426,848</b>	<b>0.1%</b>	<b>13,400,002</b>	<b>-0.1%</b>
<b>All Private Auto Trips</b>	<b>10,497,995</b>	<b>10,610,638</b>	<b>1.1%</b>	<b>10,370,288</b>	<b>-1.2%</b>
<b>All Active</b>	<b>2,476,194</b>	<b>2,402,521</b>	<b>-3.0%</b>	<b>2,543,455</b>	<b>2.7%</b>
<b>All transit</b>	<b>237,947</b>	<b>228,216</b>	<b>-4.1%</b>	<b>261,967</b>	<b>10.1%</b>

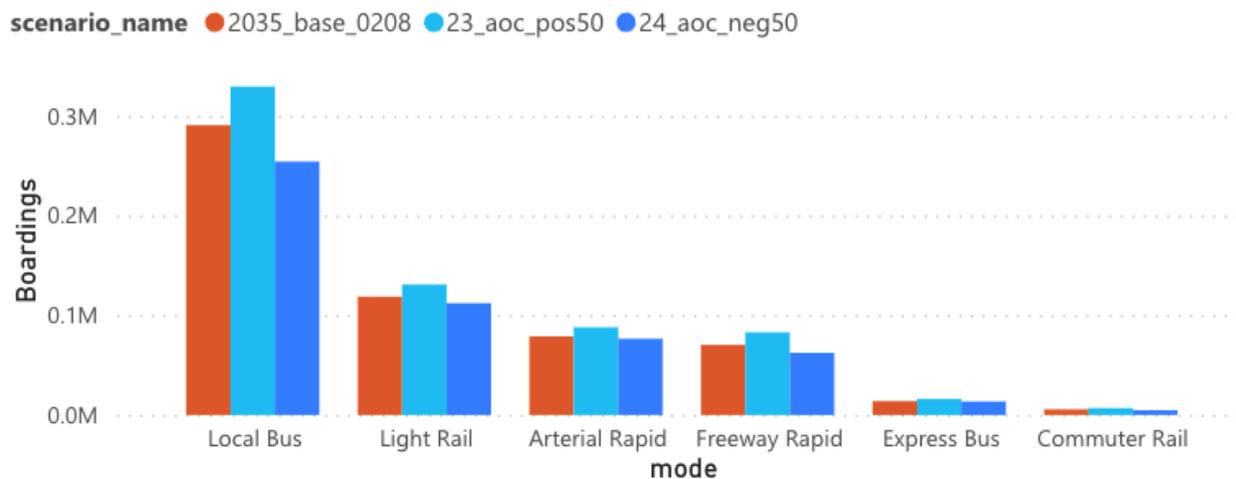
As expected, an increase in transit boardings across all types of transit is observed with an increase in the AOC, ranging from a 10% increase for light rail to a 21% increase for commuter rail as seen in Table 27 and Figure 8. With a decrease in AOC, all types of transit experience a decrease in boardings, however many are not as extreme in magnitude than in the increased AOC scenario. Express bus, arterial rapid transit, and light rail all experience a lower change in boardings. Customers utilizing these transit types may be less affected by changes in auto operating costs, either due to ownership of vehicles, household use of vehicles, the trip purpose, or additional factors influencing the utility of mode choice.

**Table 27: Transit Boardings by Transit Type for AOC Scenarios**

	Baseline	50% Decrease	change	%diff	50% Increase	change	%diff
Local Bus	290,800	329,473	38,673.00	13.3%	254,212	-36,588.00	-12.6%
Light Rail	118,754	130,925	12,171.00	10.2%	112,207	-6,547.00	-5.5%
Arterial Rapid	78,865	87,913	9,048.00	11.5%	76,505	-2,360.00	-3.0%

	Baseline	50% Decrease	change	%diff	50% Increase	change	%diff
Freeway Rapid	70,354	82,857	12,503.00	17.8%	62,361	-7,993.00	-11.4%
Express Bus	13,991	16,044	2,053.00	14.7%	13,562	-429.00	-3.1%
Commuter Rail	5,690	6,895	1,205.00	21.2%	4,839	-851.00	-15.0%

**Figure 8: Boardings by Transit Mode for AOC Scenarios (20: Baseline, 22: 50% Increase, 24: 50% Decrease)**



Scenario run results (seen in Table 28) indicate that the loaded network VMT, and specifically VMT by Auto and Truck is reduced when AOC is increased by 50%, and increased when AOC is reduced by 50%. The magnitude of the percent change in total VMT is very similar for each scenario, with a 3.93% reduction in VMT with an increase in AOC, and a 4.06% increase in VMT with a decrease in AOC.

**Table 28: Loaded Network VMT by Mode- AOC Scenarios**

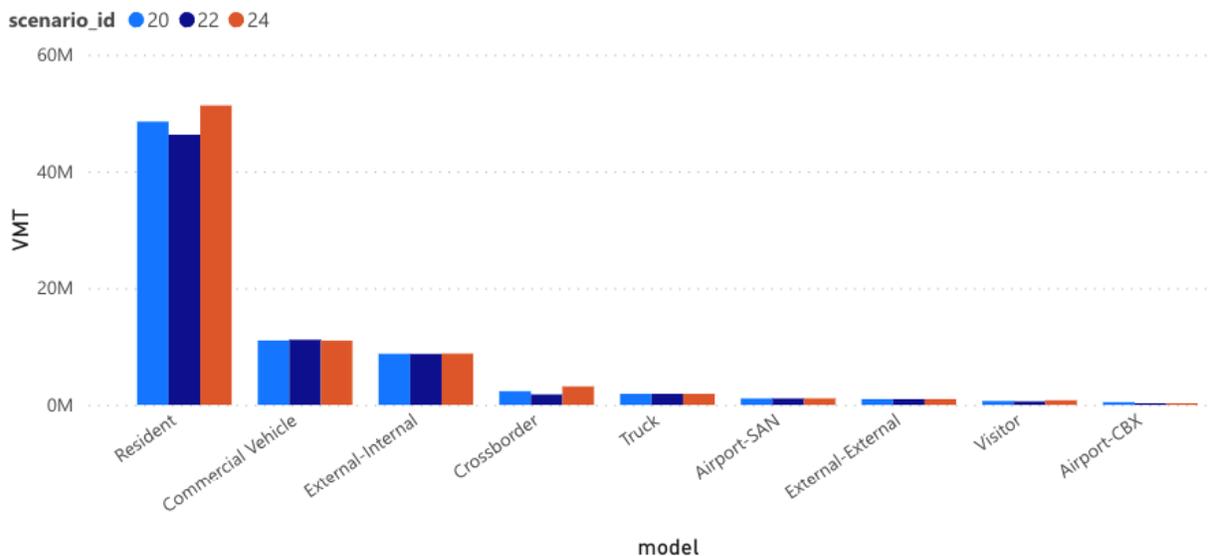
	Auto	Bus	Truck	Total	VMT Base Diff	VMT Base %Diff
Base (20)	72,691,512	341,811	5,163,160	78,196,483	0	0.00%
Increase AOC 50% (22)	69,995,635	341,811	5,152,988	75,490,435	-2,706,048	-3.5%
Decrease AOC 50% (24)	76,136,056	341,811	5,179,219	81,657,085	3,460,602	4.4%

For trip VMT by model seen in Table 29 and Figure 9, much of the overall percent change in VMT is a result of changes in the resident model, as expected. However, when examining the percent change in each of the models, significant changes in individual models can be seen. The Crossborder model experiences significant changes in VMT with changes in AOC. The crossborder model experiences a 35.4% increase in VMT with the decrease in operating costs, and a 23.4% decrease in VMT with an increase in operating costs, due to relatively high cost sensitivity of Mexico residents. Additionally, trip VMT in the visitor model increases by over 15% with a decrease in operating cost, likely due to the higher competitive advantages of auto modes in the choice utility.

**Table 29: ActivitySim Trip VMT by Market- AOC Scenarios**

	Baseline	Increase 50%	% Diff	Decrease 50%	% Diff
Resident	48,540,976	46,242,264	-4.7%	51,196,516	5.5%
Visitor	664,322	582,993	-12.2%	765,816	15.3%
Commercial Vehicle	11,024,111	11,108,637	0.8%	10,989,989	-0.3%
Crossborder	2,321,494	1,777,728	-23.4%	3,142,752	35.4%
External-External	977,824	975,605	-0.2%	984,124	0.6%
External-Internal	8,751,515	8,729,910	-0.2%	8,792,337	0.5%
Truck	1,903,239	1,900,708	-0.1%	1,905,972	0.1%
Airport-CBX	448,663	427,881	-4.6%	459,418	2.4%
Airport-SAN	1,091,015	1,085,175	-0.5%	1,101,780	1.0%
<b>Total</b>	<b>75,723,159</b>	<b>71,317,845</b>	<b>-5.8%</b>	<b>77,777,506</b>	<b>2.7%</b>

**Figure 9: VMT by Model- AOC Scenarios (20: Baseline, 22: 50% Increase, 24: 50% Decrease)**



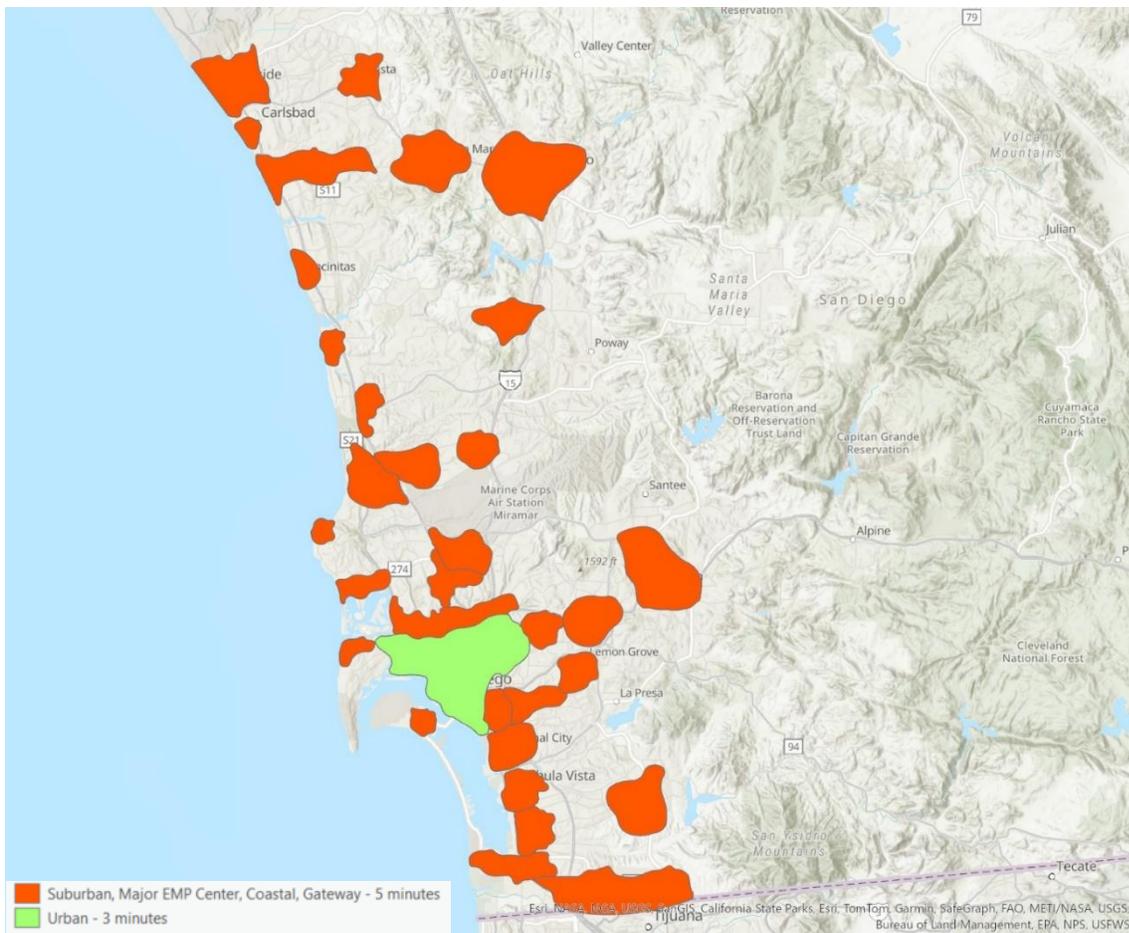
### 3.9 Micromobility Access Time

In this test, we expanded shared micromobility (e-bike and e-scooter) access to all high density hubs from just Urban, College area, La Jolla, Pacific Beach, Ocean Beach, Mission Valley, Southeast San Diego, Encinitas. The micromobility costs are not changed from the baseline model.

We changed the micromobility access time for following hubs:

- 3 minutes – Urban mobility hub (densely populated)
- 5 minutes – Suburban, Major employment centers, Coastal, Gateway hubs
- All other areas are considered inaccessible for micromobility.

Figure 10: All Mobility Hubs with Micromobility Access



We observe the following in comparison to the baseline model:

- A decrease in VMT (0.58%)
- A significant increase in Ebike & Scooter usage (**Error! Reference source not found.**) – 455%
- Slight decrease in TNC and Transit usage.
- Increase in share of micromobility trips with respect to walking.

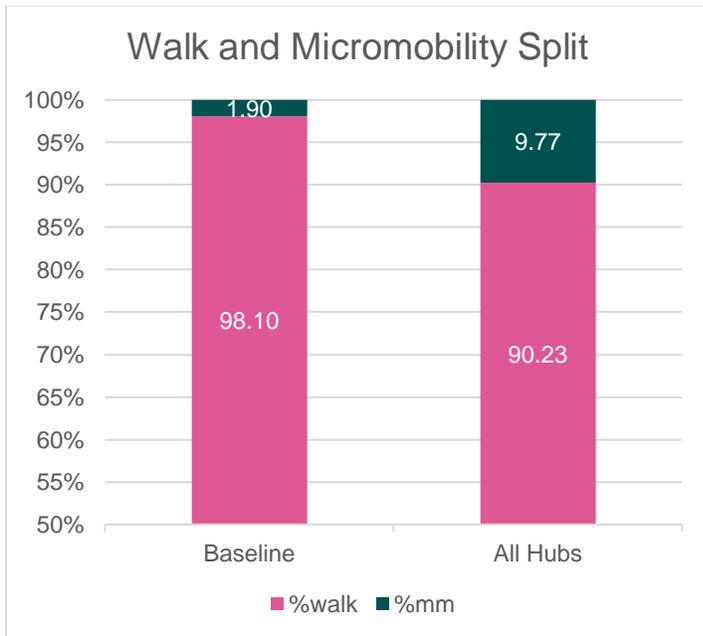
**Table 30: Person Trips by Mode- Micromobility Scenarios**

Mode	All Mobility Hub			
	Baseline	Access	Change	% Diff
DA	7,148,023	7,051,419	-96,604	-1.35%
S2	2,715,651	2,700,525	-15,126	-0.56%
S3	2,888,749	2,882,809	-5,940	-0.21%
WALK	2,094,940	2,072,468	-22,472	-1.07%
BIKE	383,325	374,187	-9,138	-2.38%
E-Scooter/E-bike	36,627	202,691	166,064	453.39%
LOC	215,776	212,200	-3,576	-1.66%
MIX	86,076	84,485	-1,591	-1.85%
PRM	140,828	138,825	-2,003	-1.42%
TNC	276,433	271,502	-4,931	-1.78%
Taxi	87,520	85,089	-2,431	-2.78%
Sch Bus	41,351	41,952	601	1.45%
Truck	437,434	437,909	475	0.11%

The results suggest micromobility access time had significant impact on micromobility trips and the share of micromobility trips, but limited impact on VMT and mode shares.

This is likely due to the low share of micromobility and the relatively short trip length of micromobility trips.

**Figure 11: Walk & Micromobility Split for Micromobility Access Time Test**



### 3.10 Micromobility Costs

In this test, we increased and decreased the cost of Micromobility by 50%. This includes the fixed cost and variable cost for the year 2035. Following results for 50% increased costs test:

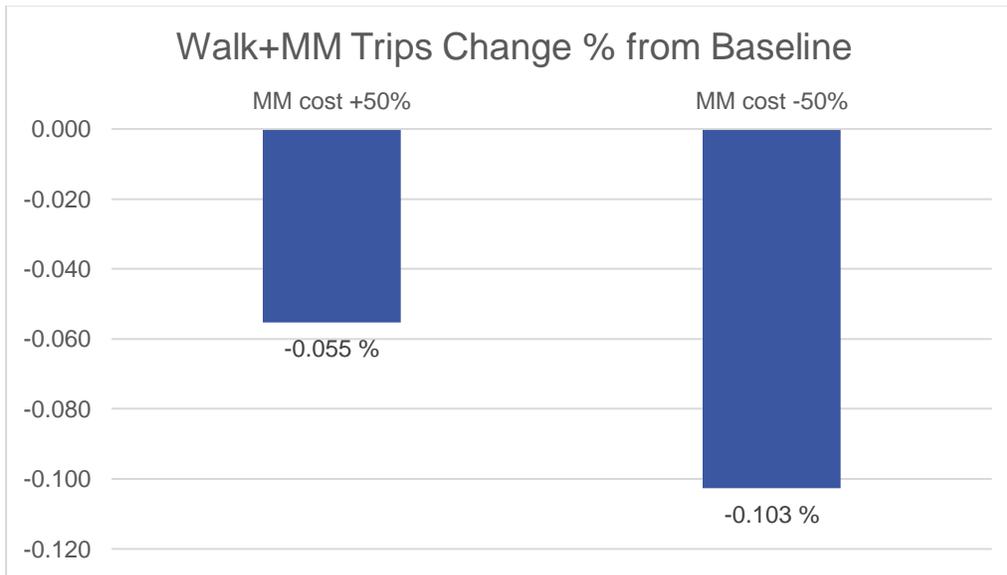
- Insignificant VMT change.
- Insignificant mode share change
- A small decrease in total micromobility trips
- The share of micromobility trips for the total walk and micromobility trips decreased from 1.93% to 1.9%.

In comparison with the 2035 baseline, a test decreasing micromobility cost by 50% had the following results:

- Insignificant VMT change.
- Insignificant mode share change
- A small increase in total micromobility trips
- The share of micromobility trips for the total walk and micromobility trips increased from 1.93% to 1.96%.

The results suggest micromobility cost had limited impact on micromobility trips, share of micromobility trips, VMT or total walk and micromobility trip share. However, the total share of walk and micromobility trips predicted by the model was not sensitive to these cost changes. This is in part due to the way that the model is formulated, where most of the model competition is between micromobility and walk mode. Simply increasing or decreasing the cost of the mode was not enough to change the generalized walk time and subsequently impact the competition between walk\micromobility and other modes in the model.

**Figure 12: Walk & Micromobility Trips Change for Micromobility Costs Test**



### 3.11 Increased Growth Near Premium Transit

In order to test the effect of land use changes on transportation, a sensitivity test where growth from 2022 to 2050 was entirely within a half mile of premium transit stops was conducted. To do this, a script was written that read in the base 2022 and forecast 2050 demographics. If an MGRA was further than a half mile from a premium transit stop and had an increase in households from 2022 to 2050, the excess households (excluding group quarters) were randomly assigned to a new MGRA within a half mile of a premium transit stop. The process was repeated with employment so that population and job growth would only be in locations close to premium transit. The change in the number of households, population, and employment within and further than a half mile of a premium transit stop is shown in Table 31, Table 32, and Table 33, respectively.

**Table 31: Households Within and Outside of a Half Mile of a Premium Transit Stop for Proximity to Transit Sensitivity Test**

	Baseline 2022	Future 2050	Adjusted 2050	% Change
Within ½ mile of premium transit stop	361,842	455,134	554,595	21.9%
Outside ½ mile of premium transit stop	798,630	879,409	779,948	-11.3%

**Table 32: Population Within and Outside of a Half Mile of a Premium Transit Stop for Proximity to Transit Sensitivity Test**

	Baseline 2022	Future 2050	Adjusted 2050	% Change
Within ½ mile of premium transit stop	956,950	1,078,355	1,335,678	23.9%
Outside ½ mile of premium transit stop	2,330,356	2,321,895	2,067,011	-11.0%

**Table 33: Employment Within and Outside of a Half Mile of a Premium Transit Stop for Proximity to Transit Sensitivity Test**

	Baseline 2022	Future 2050	Adjusted 2050	% Change
Within ½ mile of premium transit stop	954,506	1,065,715	1,188,475	11.5%
Outside ½ mile of premium transit stop	1,184,577	1,307,337	1,184,577	-9.4%

It was a priori hypothesized that focusing growth in areas close to premium transit would reduce VMT and increase transit boardings. As can be seen in Table 34, the auto VMT decreased by over 1%.

**Table 34: Proximity to Transit Scenarios**

	Baseline	Growth Near Premium Transit	Change %
Auto VMT	78,113,823	77,037,210	-1.4%
Bus VMT	285,035	285,035	0.0%
Total VMT	84,234,567	83,494,187	-0.9%

As shown in **Error! Reference source not found.**, transit boardings increased when growth was focused on areas near premium transit stops, particularly for premium transit submodes. Local bus has some increase as well.

**Table 35: Transit Boardings-Proximity to Transit Scenarios**

	Baseline	Growth Near Premium Transit	% Diff
Arterial Rapid	55,273	60,936	10.2%
Commuter Rail	5,239	5,901	12.7%
Express Bus	2,756	3,211	16.5%
Freeway Rapid	44,058	47,433	7.7%
Light Rail	121,403	132,298	9.0%
Local Bus	111,180	117,054	5.3%

	Baseline	Growth Near Premium Transit	% Diff
<b>All</b>	<b>339,908</b>	<b>366,834</b>	<b>7.9%</b>

Table 36 shows the effect of focusing growth on areas close to premium transit on the number of person trips by mode within the resident model. There was a 1.7% decrease in the number of private auto trips, consistent with the VMT reduction. The 6.4% increase in the number of transit trips was also consistent with the 7.9% increase in transit boardings. Further, there was a 6.7% increase in trips made by active modes. This could be due to more people living close to a higher diversity of land uses as employment was moved close to premium transit stops in addition to households, though further analysis would be needed to conclude this.

**Table 36: Person Trips by Mode- Proximity to Transit Scenarios**

Mode	Baseline	Growth Near Premium Transit	%Diff
DA	6,335,988	6,220,725	-1.8%
S2	2,557,242	2,522,830	-1.3%
S3	1,745,014	1,711,335	-1.9%
WALK	2,134,404	2,276,722	6.7%
BIKE	288,725	308,549	6.9%
WLK-LOC	32,578	33,671	3.4%
WLK-PRM	53,485	58,085	8.6%
WLK-MIX	24,857	25,611	3.0%
PNR-LOC	1,474	1,466	-0.5%
PNR-PRM	4,991	5,320	6.6%
PNR-MIX	829	826	-0.4%
KNR-LOC	6,048	6,318	4.5%
KNR-PRM	16,379	18,332	11.9%
KNR-MIX	2,644	3,036	14.8%
TNC-LOC	65	38	-41.5%
TNC-PRM	501	449	-10.4%
TNC-MIX	223	204	-8.5%
E-Scooter	3,468	3,994	15.2%
E-Bike	11,523	12,412	7.7%
Sch bus	17,939	18,266	1.8%
TAXI	14,424	14,907	3.3%

Mode	Baseline	Growth Near Premium Transit	%Diff
TNC Single	68,728	72,881	6.0%
TNC Shared	96,297	101,619	5.5%
<b>Total Person Trips</b>	<b>13,417,826</b>	<b>13,417,596</b>	<b>0.0%</b>
<b>All Private Auto Trips</b>	<b>10,638,244</b>	<b>10,454,890</b>	<b>-1.7%</b>
<b>All Active</b>	<b>2,438,120</b>	<b>2,601,677</b>	<b>6.7%</b>

### 3.12 Exogenous Variables: Household Income

These tests evaluated exogenous factors through household income. Household income was set to be one-third less or one-third more than the corresponding values in the 2035 baseline. CARB recommended that MPOs should conduct sensitivity tests on some of the most common exogenous variables in the travel demand model such as income distribution and auto operating cost. Auto operating cost tests are included in the section 3.8.

Expected observations due to a change in household income include:

- Increase in auto mode use and VMT with an increase in household income, and a decrease in auto mode use and VMT with a decrease in household income.
- Increase in active modes with a decrease in household income and a decrease in active modes with an increase in household income
- Increase in transit boardings with a decrease in household income, and a decrease in transit boardings with an increase in household income
- Decrease in trips with a decrease in household income and an increase in trips with an increase in household income

Analysis of transit pass ownership shows that with an increase in household income, there is a 1% increase in transit pass ownership, and with a decrease in household income, there is a 1% decrease in transit pass ownership as seen in Table 37.

Analysis of transponder ownership shows that with an increase in household income, there is a 4% increase in transponder ownership, and with a decrease in household income, there is a 7% decrease in transponder ownership as seen in Table 37.

**Table 37: Transit Pass and Transponder Ownership- Household Income Scenarios**

	Owns Transit Pass	% Diff	Owns Transponder	% Diff
Base	21%		51%	
Increase 1/3	22%	1%	55%	4%
Decrease 1/3	20%	-1%	44%	-7%

Person trips by mode share results (provided in Table 38) for the three scenarios show that a decrease in household income results in a 1.5% decrease in overall trips and a 0.9% decrease when household income increases. Private auto modes and ride hailing (TNC single, TNC shared and Taxi) experience an increase in person trips with an increase in household income, and a decline with a decrease in household income. Transit trips increase about 14% with a decrease in household income and decrease 7.4% with an increase in household income.

**Table 38: Person Trips by Mode-Household Income Scenarios**

Mode	Baseline	1/3 Decrease	%Diff	1/3 Increase	%Diff
DA	6,425,001	6,212,240	-3.3%	6,549,020	1.9%
S2	2,531,738	2,509,289	-0.9%	2,541,498	0.4%
S3	2,005,393	1,982,490	-1.1%	2,016,858	0.6%
WALK	2,069,930	2,096,260	1.3%	2,053,534	-0.8%
BIKE	295,665	276,829	-6.4%	304,472	3.0%
WLK-LOC	66,248	75,421	13.8%	61,761	-6.8%
WLK-PRM	60,407	71,009	17.6%	55,588	-8.0%
WLK-MIX	129,794	146,786	13.1%	119,917	-7.6%
PNR-LOC	718	783	9.1%	736	2.5%
PNR-PRM	779	823	5.6%	680	-12.7%
PNR-MIX	11,145	11,950	7.2%	10,498	-5.8%
KNR-LOC	5,574	6,383	14.5%	5,145	-7.7%
KNR-PRM	4,909	5,669	15.5%	4,344	-11.5%
KNR-MIX	42,327	47,562	12.4%	39,167	-7.5%
TNC-LOC	116	129	11.2%	141	21.6%
TNC-PRM	50	54	8.0%	67	34.0%
TNC-MIX	540	415	-23.1%	538	-0.4%
E-Scooter	9,963	9,698	-2.7%	9,799	-1.6%
E-Bike	34,018	39,499	16.1%	31,256	-8.1%
Sch bus	18,596	22,968	23.5%	16,717	-10.1%
TAXI	28,862	23,205	-19.6%	33,895	17.4%
TNC Shared	19,750	18,980	-3.9%	20,881	5.7%
TNC Single	48,947	44,143	-9.8%	52,677	7.6%
<b>Total Person Trips</b>	13,810,470	13,602,585	-1.5%	13,929,189	0.9%

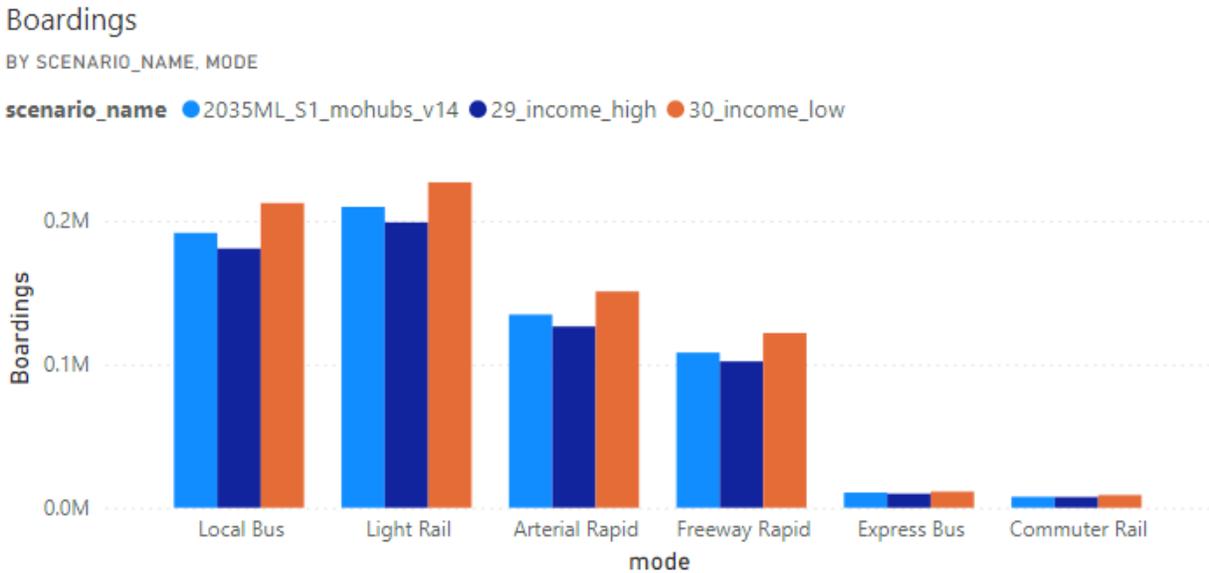
Mode	Baseline	1/3 Decrease	%Diff	1/3 Increase	%Diff
<b>All Private Auto Trips</b>	10,962,132	10,704,019	-2.4%	11,107,376	1.3%
<b>All Active</b>	2,365,595	2,373,089	0.3%	2,358,006	-0.3%
<b>All transit</b>	322,607	366,984	13.8%	298,582	-7.4%

As expected, an increase in transit boardings across all types of transit is observed with a decrease in the household income, ranging from a 6% increase for Express Bus to a 16% increase for commuter rail as seen in Table 39 and Figure 13. With an increase in household income, all types of transit experience a decrease in boardings. Commuter Rail experiences a lower change 2% in boardings.

**Table 39: Transit Boardings by Transit Type for Household Income Scenarios**

	Baseline	1/3 Decrease	change	%diff	1/3 Increase	change	%diff
Local Bus	191,596	212,395	20,799	11%	180,703	-10,893	-6%
Light Rail	209,720	226,836	17,116	8%	198,933	-10,787	-5%
Arterial Rapid	134,673	150,792	16,119	12%	126,339	-8,334	-6%
Freeway Rapid	108,154	121,829	13,675	13%	101,992	-6,162	-6%
Express Bus	10,575	11,253	678	6%	9,775	-800	-8%
Commuter Rail	7,628	8,853	1,225	16%	7,472	-156	-2%

**Figure 13: Boardings by Transit Mode for Household Income Scenarios**



Scenario run results (seen in Table 40) indicate that the loaded network VMT, and specifically VMT by Auto and Truck is reduced when household income is decreased by 1/3 and increased when household income is increased by 1/3. The magnitude of the percentage change in total VMT is very similar for each scenario, with a 3.43% reduction in VMT with a decrease in household income, and a 2.43% increase in VMT with an increase in household income.

**Table 40: Loaded Network VMT by Mode- Household Income Scenarios**

	Auto	Bus	Truck	Total	VMT Base Diff	VMT Base %Diff
Base	74,124,114	264,273	6,813,416	81,201,802		
Increase Household Income	76,065,263	264,273	6,846,850	83,176,386	1,974,584	2.4%
Decrease Household Income	71,391,135	264,273	6,760,946	78,416,354	-2,785,448	-3.4%

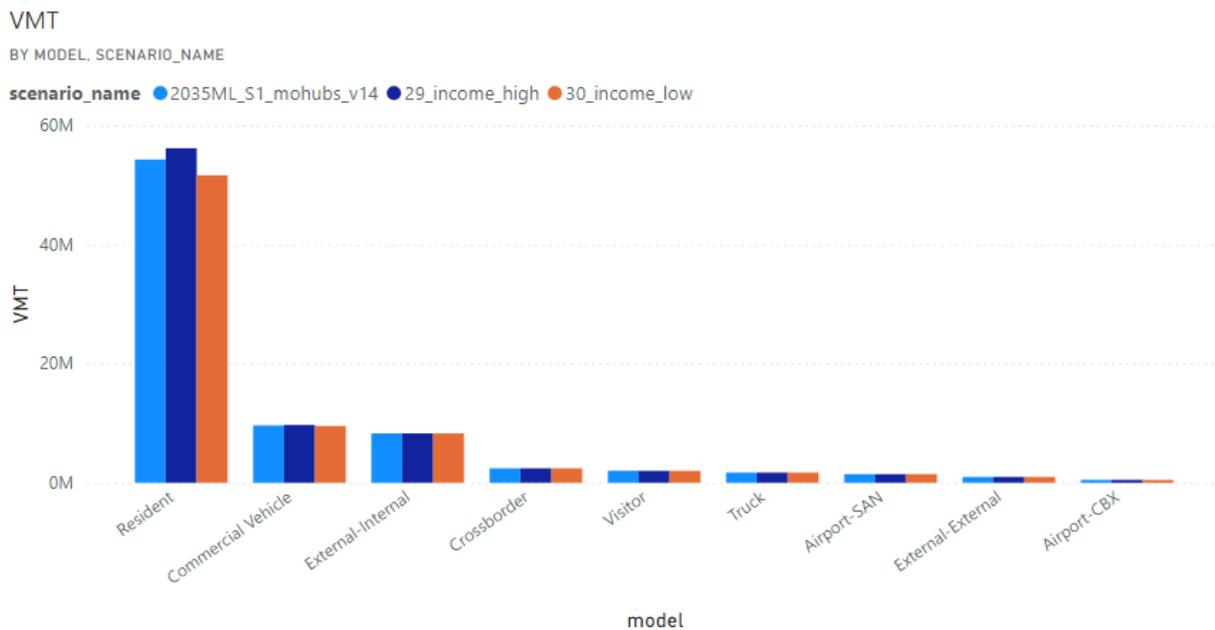
For trip VMT by model seen in Table 41 and Figure 14, much of the overall percent change in VMT is a result of changes in the resident model, as expected.

**Table 41: ActivitySim Trip VMT by Market- Household Income Scenarios**

	Baseline	1/3 decrease	% Diff	1/3 Increase	% Diff
Resident	54,296,524	51,645,972	-4.9%	56,194,380	3.5%
Visitor	2,013,846	1,993,368	-1.0%	1,988,509	-1.3%

	Baseline	1/3 decrease	% Diff	1/3 Increase	% Diff
Commercial Vehicle	9,620,689	9,530,496	-0.9%	9,694,394	0.8%
Crossborder	2,418,786	2,425,750	0.3%	2,416,017	-0.1%
External-External	976,610	978,120	0.2%	976,603	0.0%
External-Internal	8,288,153	8,288,838	0.0%	8,286,550	0.0%
Truck	1,710,398	1,710,398	0.0%	1,710,398	0.0%
Airport-CBX	488,657	480,340	-1.7%	486,745	-0.4%
Airport-SAN	1,436,470	1,449,990	0.9%	1,432,647	-0.3%
<b>Total</b>	<b>81,250,132</b>	<b>78,503,271</b>	<b>-3.4%</b>	<b>83,186,242</b>	<b>2.4%</b>

Figure 14: VMT by Model- Household Income Scenarios



### 3.13 Exogenous Variables: Regional Employment

These tests evaluated exogenous factors through regional employment. In the persons file, the number of unemployed was set to be 10% less or 10% more than the corresponding values in the 2035 baseline, as shown in Table 42.

Table 42: Number of Employment – Regional Employment Scenarios

Employment Status	Baseline	%	Employment High	%	Employment Low	%
Employed Full-Time	1,288,210	38%	1,546,601	45%	984,201	29%

Employment Status	Baseline	%	Employment High	%	Employment Low	%
Employed Part-Time	341,241	10%	421,800	12%	281,200	8%
Unemployed or Not in Labor Force	1,182,551	35%	843,601	25%	1,546,601	45%
Less than 16 Years Old	587,209	17%	587,209	17%	587,209	17%

In the MGRA input file, employment change at each MGRA was implied and the total employment change comparing with the corresponding values in the 2035 baseline was shown in Table 43.

**Table 43: Number of Jobs Change – Regional Employment Scenarios**

Scenarios	Total Number of Jobs	Diff	Diff%
Baseline	2,231,573		
Employment Low	1,870,915	-360,658	-16%
Employment High	2,690,938	459,365	25%

In comparison with the 2035 baseline, a test with high employment has the following results:

- VMT increased by 5.5% (Figure 15)
- San Diego resident mode share (Figure 16):
  - Drive Alone increased from 46.5% to 47.5%
  - Shared Ride 2 decreased from 18.3% to 17.6%
  - Shared Ride 3 decreased from 14.5% to 14.0%
  - TNC increased from 0.44% to 0.49%
- Transit boardings increased by 3%
- Total person trips of San Diego residents increased by 2.9%

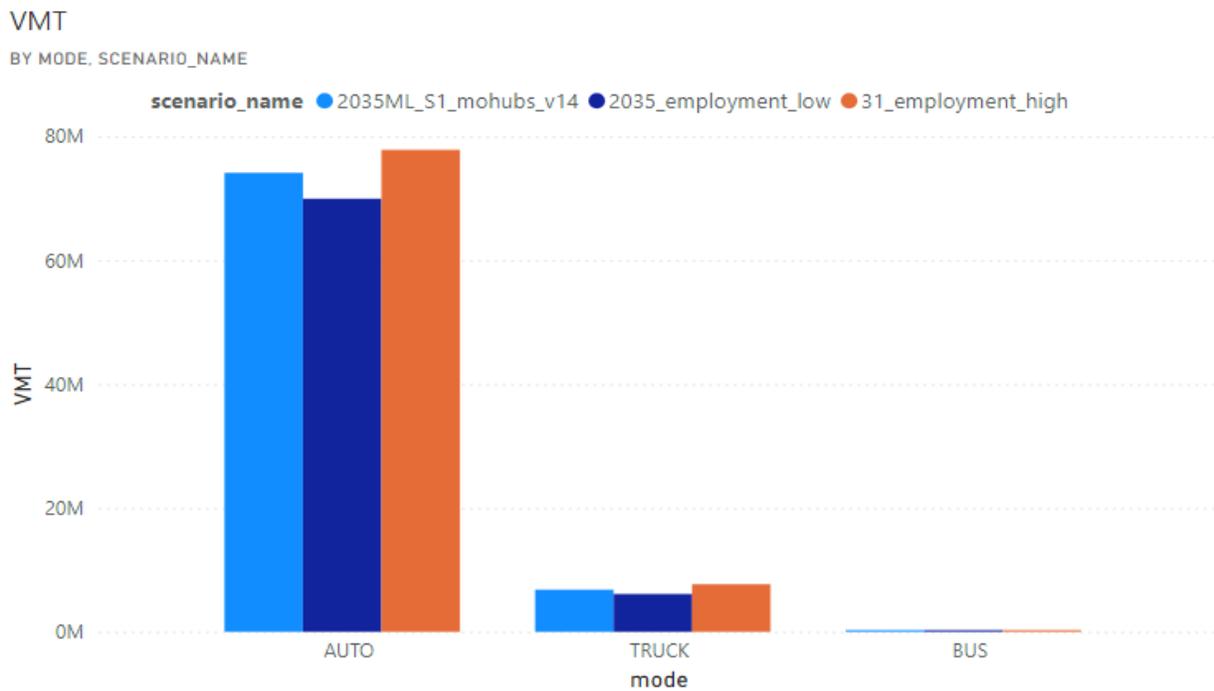
In comparison with the 2035 baseline, a test with low employment has the following results:

- VMT decreased by 6% (Figure 15)
- San Diego resident mode share (Figure 16):

- Drive Alone decreased from 46.5% to 45.0%
- Shared Ride 2 increased from 18.3% to 19.2%
- Shared Ride 3 increased from 14.5% to 15.1%
- TNC decreased from 0.44% to 0.41%
- Transit boardings increased by 0.1% insignificantly
- Total person trips of San Diego residents decreased by 2.7%

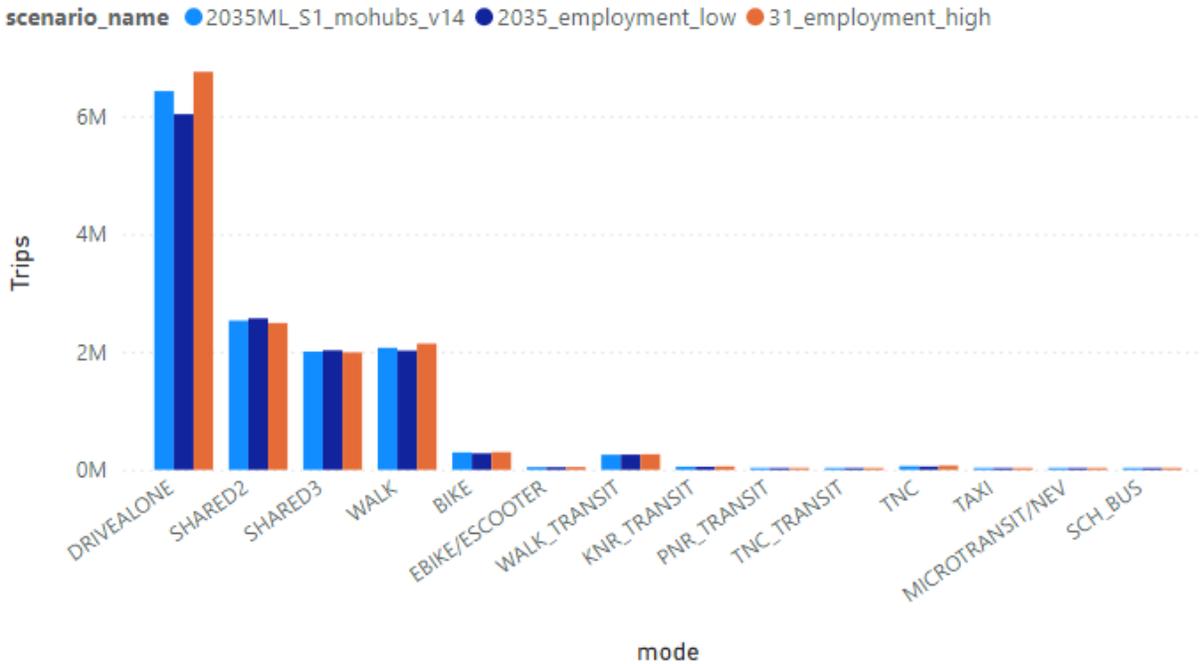
The tests suggest that ABM3 is sensitive to regional employment. When regional employment increased, the model indicated higher VMT, high travel demand, higher DA mode share, and lower shared ride auto mode shares. When regional employment decreased, the opposite effects were observed. It should be noted that these are simply hypothesis tests which hold all other variables constant, neglecting the supply-demand interaction between inter-dependent variables. The test results should not be interpreted as the effects of +/-10% regional employment changes in San Diego.

**Figure 15: VMT by Mode- Regional Employment Scenarios**



**Figure 16: Trips by Mode by San Diego Residents- Regional Employment Scenarios**

Trips by mode and scenario\_id



### 3.14: New Mobilities: EV Rebates

In order to mitigate the increases of greenhouse gases (GHGs) in the San Diego Region in the future, SANDAG planners want to test giving rebates to low- and middle-income households in order to purchase an EV. A sensitivity test comparing a 2035 run without any rebates to one that had the rebates with all other inputs being the same. Separate rebate values were given for BEVs and PHEVs, and low-income households were given a higher rebate than middle-income households. The rebate eligibility was determined by the household income relative to the federal poverty guidelines. The rebate values are shown in Table 44:

**Table 44: EV Rebate Scheme**

	300-400% Federal Poverty Level	0-300% Federal Poverty Level
Average BEV rebate amount	\$2,000	\$6,750
Average PHEV rebate amount	\$1,000	\$3,375

Table 45 shows the change in the BEV and PEV ownership rates between the scenarios without and with rebates. As expected, there was an increase in the ownership rates of both BEVs and PHEVs.

**Table 45: Effect of EV Rebates on BEV and PHEV ownership rates**

	No Rebates	Rebates	Change
BEV OwnershipRate	17.42%	18.03%	0.61%
PHEV Ownership Rate	7.50%	8.35%	0.85%

The increase in EV ownership rates consequentially resulted in a 5% increase in eVMT, despite the fact that the VMT stayed relatively constant. These results are shown in Table 46.

**Table 46: Effect of EV Rebates on total VMT and eVMT**

	No Rebates	Rebates	Change
Total VMT	52,738,644	52,645,760	-0.18%
eVMT	14,873,637	15,620,518	5.02%

No other significant differences in model results were observed, which was expected from this test.

### 3.15: Telework

SANDAG staff conducted telework sensitivity tests to evaluate the responsiveness of ABM3 to various telework scenarios. In ABM3, there are two types of telework, permanent and occasional telework. Permanent telework is modeled in the work from home (WFH) model, while the impact of occasional telework is reflected in daily activity pattern, telework frequency, non-mandatory tour frequency, and non-mandatory tour stop frequency models. Two telework alternatives were tested: +50% and -50% of WFH and telecommuting coefficients respectively.

In comparison with the existing telework pattern, the increased telework scenario (+50%) had the following results:

- VMT from resident model decreased by 1.8% and the total regional wide VMT decreased by 1.2% (see Table 47)
- Transit boardings decreased by 0.3% (Table 48). Among all transit types, express bus boardings dropped significantly to 1.5%
- Vehicle hours traveled (VHD) decreased by 4% (Figure 15)

In comparison with the existing telework pattern, the decreased telework scenario (-50%) had the following results:

- VMT from resident model increased by 1.6% and the total regional wide VMT increased by 1.1% (See Table 48)

- Transit boardings increased by 1.1% (Table 48). Among all transit types, commuter rail boardings increased significantly by 4.8%
- Vehicle hours traveled (VHD) increased by 4% (Figure 15)

**Table 47: ActivitySim Trip VMT by Telework Scenarios**

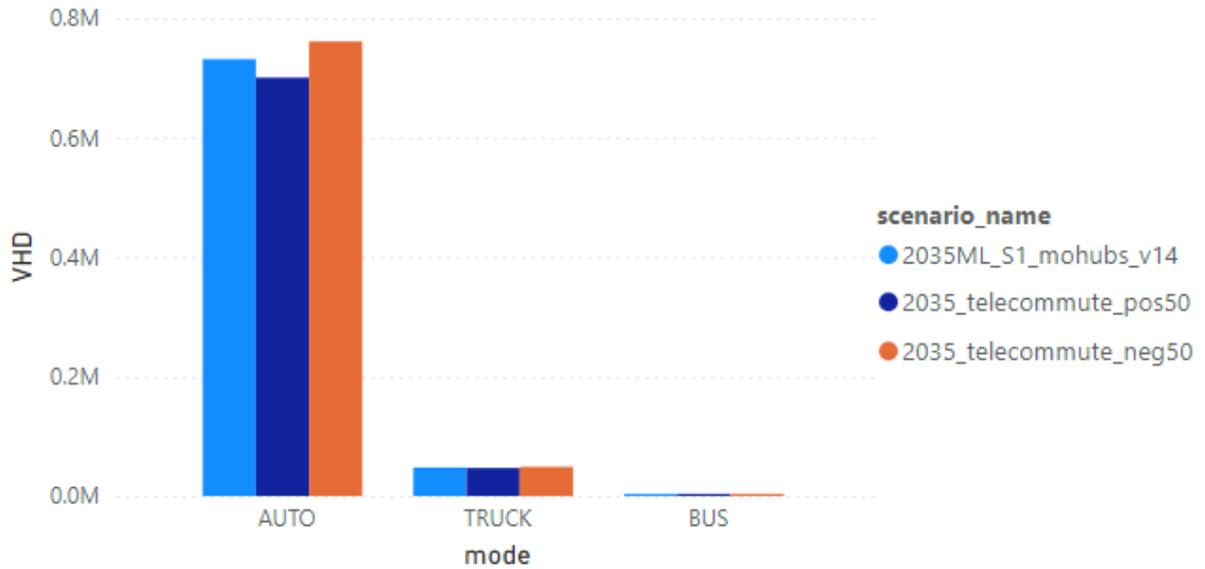
	Baseline	50% decrease	% Diff	50% Increase	% Diff
Resident	54,296,524	55,174,524	1.6%	53,311,160	-1.8%
<b>Total</b>	<b>81,201,802</b>	<b>82,069,775</b>	<b>1.1%</b>	<b>80,246,870</b>	<b>-1.2%</b>

**Table 48: Transit Boardings by Transit Type for Telework Scenarios**

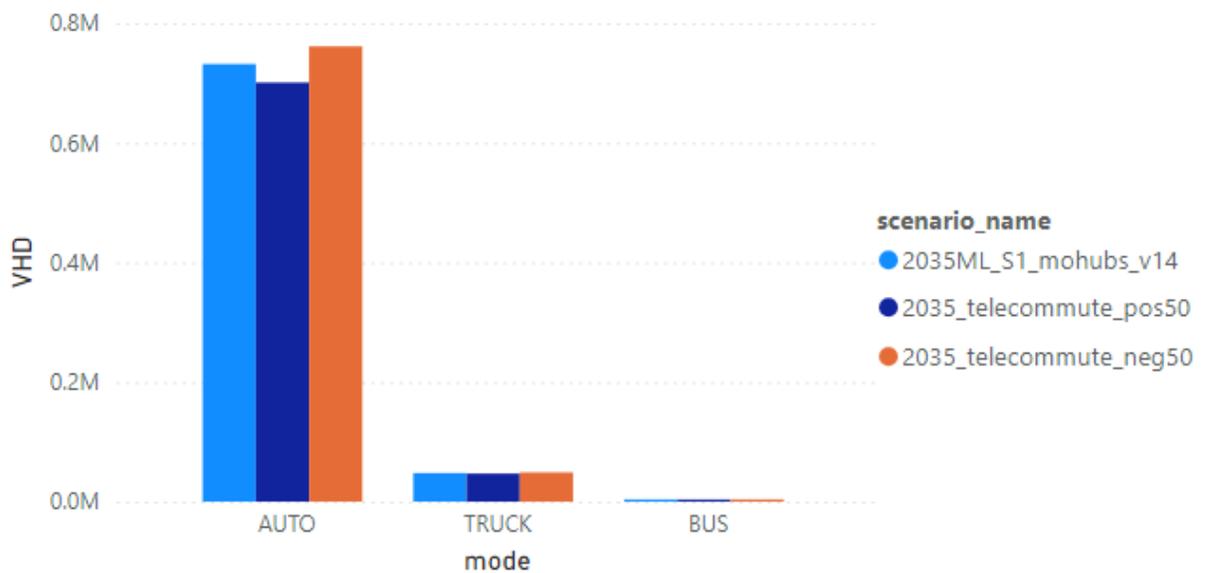
	Baseline	50% Decrease	change	%diff	50% Increase	change	%diff
Local Bus	191,596	192,684	1,088	0.6%	191,089	-507	-0.3%
Light Rail	209,720	211,628	1,908	0.9%	208,763	-957	-0.5%
Arterial Rapid	134,673	136,217	1,544	1.1%	134,738	65	0.0%
Freeway Rapid	108,154	110,199	2,045	1.9%	107,960	-194	-0.2%
Express Bus	10,575	10,768	193	1.8%	10,390	-185	-1.7%
Commuter Rail	7,628	7,991	363	4.8%	7,743	115	1.5%
<b>Total</b>	<b>662,346</b>	<b>669,487</b>	<b>7,141</b>	<b>1.1%</b>	<b>660,683</b>	<b>-1,663</b>	<b>-0.3%</b>

Figure 15: VHD by Mode- Telework Scenarios

VHD by Mode



VHD by Mode



### 3.16: Job-Housing Balance

This alternative represents a job/housing balance scenario with population growth concentrated in San Diego's job centers: Carlsbad Palomar, Kearny Mesa, La Mesa, Linda Vista/Serra Mesa, Mission Valley, National City, San Marcos, Sorrento Valley, University Community and West Bernado.

Compared with the 2035 baseline, the job housing alternative test had the following results:

- VMT by San Deigo Residents decreased by 0.95% (Table 49)
- Households without cars decreased by 2.3%. Households with 1 and 2 cars increased by 1.3%. Households with 3+ cars decreased by 1.3% (Table 50)
- Transit Boardings increased by 2.0% (Table 51)
- San Deigo resident mode shares (Table 52)
  - Auto mode (Drive Alone, Shared2 and Shared3) decreased from 79.4% to 79.3%
  - Transit increased from 2.34% to 2.39%
  - Active modes (walk, bike and Ebike/Escooter) increased from 17.45% to 17.52%
- Average San Diego resident trip distance decreased from 5.72 miles to 5.68 miles. Work and university trip distances decreased. Trip distance of non-mandatory trips such as recreational, maintenance, and shopping also decreased (Figure 15).

**Table 49: ActivitySim Trip VMT by Market- Job-Housing Balance scenario**

	Baseline	Job-Housing Balance	% Diff
Resident	54,296,524	53,779,788	-0.95%
<b>Total</b>	<b>81,201,802</b>	<b>80,786,838</b>	<b>-0.51%</b>

**Table 50: Household Count with autos for Job-Housing Balance Scenario**

Number of Autos	Baseline	Job-Housing Balance	change	%diff
0	163,603	159,810	-3,793	-2.3%
1	408,364	413,425	5,061	1.2%
2	504,862	505,292	430	0.1%
3	203,998	203,428	-570	-0.3%
4	112,247	111,119	-1,128	-1.0%

**Table 51: Transit Boardings by Transit Type for Job-Housing Balance Scenario**

	Baseline	Job-Housing Balance	change	%diff
Local Bus	191,596	194,022	2,426	1.3%
Light Rail	209,720	220,738	11,018	5.3%

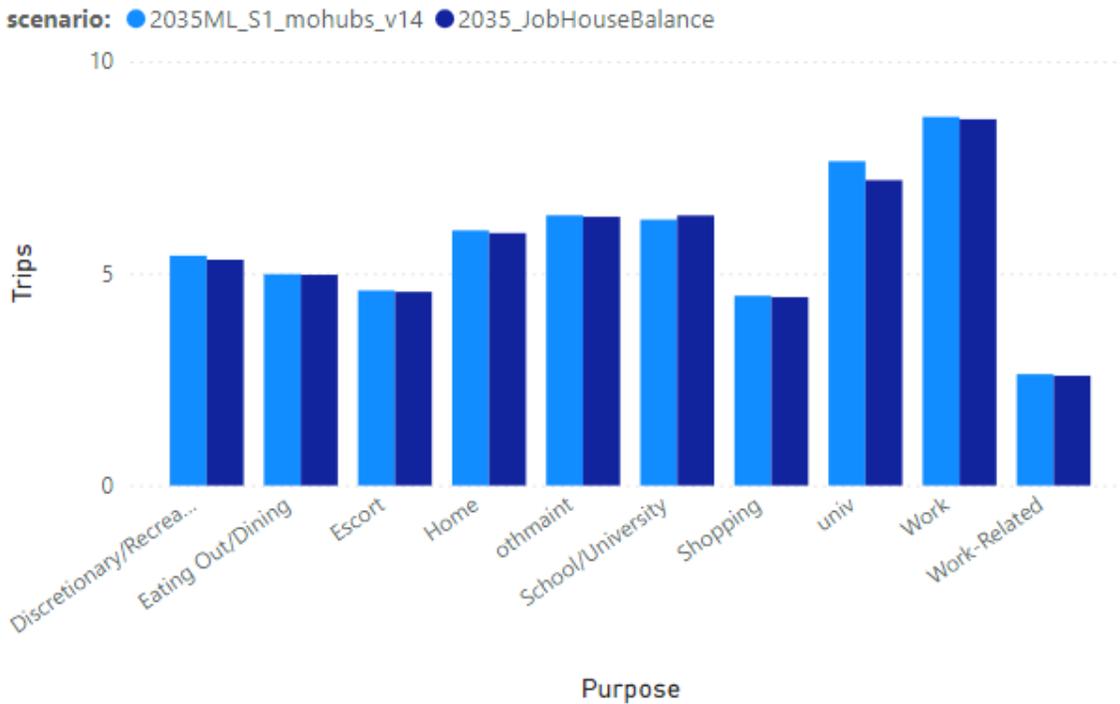
	Baseline	Job-Housing Balance	change	%diff
Arterial Rapid	134,673	134,114	-559	-0.4%
Freeway Rapid	108,154	109,077	923	0.9%
Express Bus	10,575	10,476	-99	-0.9%
Commuter Rail	7,628	7,172	-456	-6.0%
<b>Total</b>	<b>662,346</b>	<b>675,599</b>	<b>13,253</b>	<b>2.0%</b>

**Table 52: Mode Share by San Diego Resident -Job-Housing Balance Scenario**

Mode	Baseline	Job-Housing Balance	%Diff
DA	46.52%	46.55%	0.03%
S2	18.33%	18.28%	-0.05%
S3	14.52%	14.42%	-0.10%
WALK	14.99%	15.04%	0.05%
BIKE	2.14%	2.14%	0.00%
E-Bike/ E-Scooter	0.32%	0.34%	0.02%
LOC	0.53%	0.53%	0.00%
MIX	0.48%	0.49%	0.01%
PRM	1.33%	1.37%	0.04%
TNC	0.44%	0.44%	0.00%
TAXI	0.21%	0.21%	0.00%
MICROTRANSIT/NEV	0.05%	0.06%	0.01%
School Bus	0.13%	0.14%	0.01%

**Figure 15: San Diego Resident Trip Length by Purpose- Job-Housing Balance**

Trip Length by Purpose -



The above results confirm that ABM3 is sensitive to land use alternative. When households and population growth are close to major employment centers, the model indicated lower VMT, lower auto mode shares, higher active transportation and transit shares, and shorter trip distances. The total number of person trips slightly increased by 0.02%, which may be caused by decreased household numbers with 0 cars. It should be noted that the test alternative did not include employment growth.

## 4.0 Testing Conclusions

Analysis of the sensitivity results shows expected results in accordance to a priori assumptions of the model performance for most of the scenario tests. Changes and directions of change are largely consistent with accepted understanding of policy implementation and resulting impacts. Most of the scenarios are targeted towards mode choice and we have found the model to respond in the expected direction for each test. In the case that we summarized trip length, results seem mostly logical, though school bus trip length seems affected by certain sensitivity tests which may require further analysis. Auto and transit assignment results logically follow mode choice changes, though in some cases feedback of congested skims causes 'bounce-back' effects which cause changes in VMT in markets that were initially unaffected by the test.

Some of the sensitivity tests only affect a portion of the region (e.g. parking costs) so regional results are muted for those tests. Some of the results, for example trip length, are quite small and therefore difficult to interpret, especially due to simulation variance. It may be helpful in such cases to run the model multiple times, with varying random number seeds, to determine the signal to noise ratio on certain model outcomes.

One finding worth mentioning is that the telecommute frequency model is not sensitive to auto operating cost; this results in the unintuitive behavior of the model to predict less telecommuting with respect to auto operating cost increases. This is because the increase in cost leads to shorter work tour lengths, which the telecommute model responds to by decreasing the probability of telecommuting. In future, we plan on modifying the work tour length variable in telecommute frequency to consider auto operating cost, and scaling the coefficient accordingly, to address this issue.

We also note that the monthly transit fare variable which is used in transit pass ownership was not changed in the transit fare scenarios. We would expect transit pass ownership to be affected by the cost of transit, but the scenario does not reflect this expectation, so future sensitivity tests may require changing this variable.