

9 Auto Operating Costs, Pricing and Transit Fares

9.1 Auto Operating Costs

SACSIM19 uses consumer full “out-of-pocket” auto operating costs as a key concept and input for driving mode choice and usage. Cost include gasoline, maintenance and tires, and federal and state taxes; computed on a per mile basis (Table 9-1). Gasoline costs are the largest share of per-mile out-of-pocket operating costs for most vehicles. Within SACSIM19 Cube® scripts, the auto operating cost is split into the portion related to direct costs (fuel, tires, and maintenance) and the portion related to fuel tax (for base year model, and future scenarios with no Pay-as-You-Go or mileage-based fees), or for representing a PAYGO fee for future scenarios assuming transition from fuel tax to PAYGO fees.

Table 9-1 Calculation of SACSIM9 Auto Operating Costs

Variable	2016
Fuel Price Per Gal. (Yr. 2017 \$) [†]	\$2.81
Avg. Auto Miles / Gal ^{††}	23.2
Gas Cost Per Mile (Yr. 2017 \$)	\$0.12
Tire+Maint Cost Per Mile (Yr. 2017 \$) ^{††}	\$0.065
Total Auto Ops Cost Per Mile (Yr. 2017 \$)	\$0.186
Total Auto Ops Cost Per Mile (Yr. 2000 \$)	\$0.128
Fuel tax shares of Auto Ops Cost	
Federal + State Fuel Tax per Mile (Yr. 2017 \$)	\$0.023
Non-fuel-tax Auto Ops Cost per Mile (Yr. 2017 \$)	\$0.164

Source: SACOG 2020.

[†]Based on California Energy Commission spot prices

[†]Inflation adjustments based on Bureau of Labor Statistics “Western States Urban” CPI.

^{††} From EMFAC2014 passenger car vehicle fleet miles per gallon

^{††}From CSAA “Your Cost of Driving” reports.

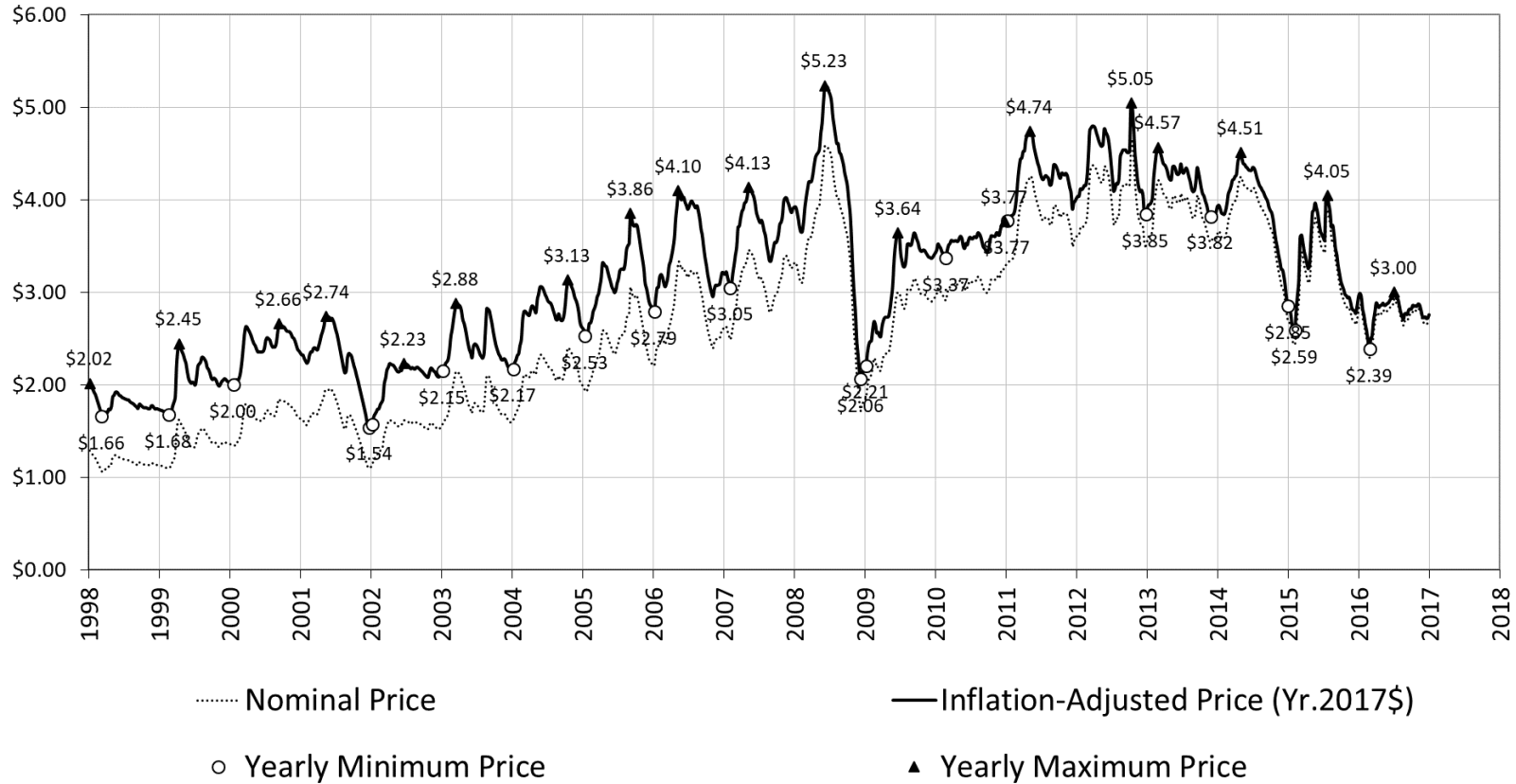
For future scenarios analyzed as part of the 2020 MTP/SCS, a similar approach used in the 2012 and 2016 MTP/SCS was used to represent future auto operating costs within SACSIM. The approach used:

- recent federal Energy Information Administration “Low” and “High” forecasts of gasoline prices;
- average passenger vehicle fleet MPG forecasts using the EMFAC emissions model;
- non-fuel costs projected based on AAA “Your Cost of Driving” data; and
- update the CA/US price differential using most recent data.

The approach to forecast auto operating costs were detailed in documents submitted to the California Air Resources Board *SACOG Technical Methodology for Greenhouse Gas Calculations for the 2020 MTP/SCS” and associated addendums.*

SACSIM and other MPO Travel Demand models have shifted to average cost per mile as standard practice (integrated as part of SACSIM since 2009). Use of average variable cost per mile have been shown to be more predictive of trip-making behavior than average “full” costs (which include vehicle ownership costs like finance charges, depreciation, insurance, etc.). The behavioral theory underpinning this is that for most households, vehicle ownership is a necessity, and choices of use of a vehicle (number of trips, length of trip, etc.) do not factor in auto ownership costs.

Figure 9-1 California Gasoline Prices, 1998 to 2017



Source: SACOG 2020.

Based on gasoline price data from the California Energy Commission, with inflation adjustments calculated using the Western States Urban consumer price index.

9.2 Facility and Mileage Based Pricing

One of the major changes from SACSIM15 to SACSIM19 was the implementation of facility and user fee-based pricing. In order to integrate pricing, major SACSIM overhauls include:

- DAYSIM calibration
- DAYSIM distribution of value-of-time (VOT)
- VOT bins during highway assignment
- Network Skimming
- Dynamic tolling adjustment algorithm during highway assignment
- Reconfiguration of Path loading by mode
- New Mileage Based User Fee spatial and temporal inputs
- New priced roadway network identification attributes and cost inputs
- Model equilibrium, population sampling, and global iterations

This section will not discuss calibration or model structure details for all topics above and instead focuses on SACSIM19's user fee or roadway pricing functionality. For model structure adjustments, see Chapter 3 on Model Structure and Chapter 12 on Calibration and Validation.

9.2.1 Facility Pricing

To incorporate effects of roadway pricing, travel choice components must be considered such as trip generation, distribution, time-of-day, congestion, mode choice, and routing. The concept is based off the *Strategic Highway Research program C04: Improving Our Understand of How Highway Congestion and Pricing Affect Travel Demand, 2012*. Consistent with the SHRP2 C04 report, SACSIM19 implements the utility-based function in Equation 9-1 to model the effects of pricing and congestion to travel.

Equation 9-1 Utility-based function to model the effects of pricing on travel¹²

$$U = \Delta + a_1 Time \times (1 + a_2 Dist + a_3 Dist^2) + b [Cost / (Inc^e \times Occ^f)] + c STD / Dist$$

(1)

Where:

- Δ = Alternative-specific "bias" constant for priced facilities
- a_1 = Travel time coefficient, estimated as a random parameter to capture unobserved user heterogeneity
- $Time$ = Average travel time
- a_2, a_3 = Coefficients reflecting the impact of travel distance on perception of travel time
- $Dist$ = Average travel distance
- b = Coefficient on travel cost
- $Cost$ = Cost of travel including tolls, parking, and auto operating costs
- Inc = Household income of traveler
- e = Coefficient reflecting the impact of income on the perception of cost
- Occ = Occupancy of vehicle
- f = Coefficient reflecting the impact of auto occupancy on the perception of cost
- c = Coefficient reflecting the impact of travel time (un-)reliability
- STD = Day-to-day standard deviation

SACSIM19 does not implement all congestion pricing recommendations from the SHRP CO4, but builds off the key concepts for functionality of SACSIM's existing modules and structure. SACSIM does incorporate congestion as its primary proxy for reliability, a difficult input for Demand modeling, with time factors that range from 10.05 to 1.80 based on traffic conditions. Table 9-2 compares key concepts from SHRP CO4 pricing recommendations and how they are implemented into SACSIM19.

Table 9-2 SACSIM19 Implementation of SHRP C04 Concepts

ID	Recommendations	Built into SACSIM19
1	Random coefficient on travel time to reflect unobserved user, such as a truncated lognormal distribution curve constrained as negative ensuring logical negative utility with respect to travel time.	Adjusted distributed travel time sensitivities based from a lognormal distribution with standard deviation of 0.85. Higher standard deviation shifting majority trips to lower initial VOT bin.
2	Travel time sensitivity should be a function of distance with short distances and longer distance decreasing sensitivity factors to travel time.	Not implemented due to contradictory findings from other studies.
3	Scaling travel cost coefficient by a function of household income and auto occupancy.	Already built into previous versions of SACSIM
4	Utility function include standard deviation of travel time, scaled by distance as a measure of reliability. Suggest congestion a proxy for reliability with time factors that range from 1.05 to 1.80 traffic conditions.	Cost of delays built in with time factors from 1.05 to 1.80 during highway assignment.

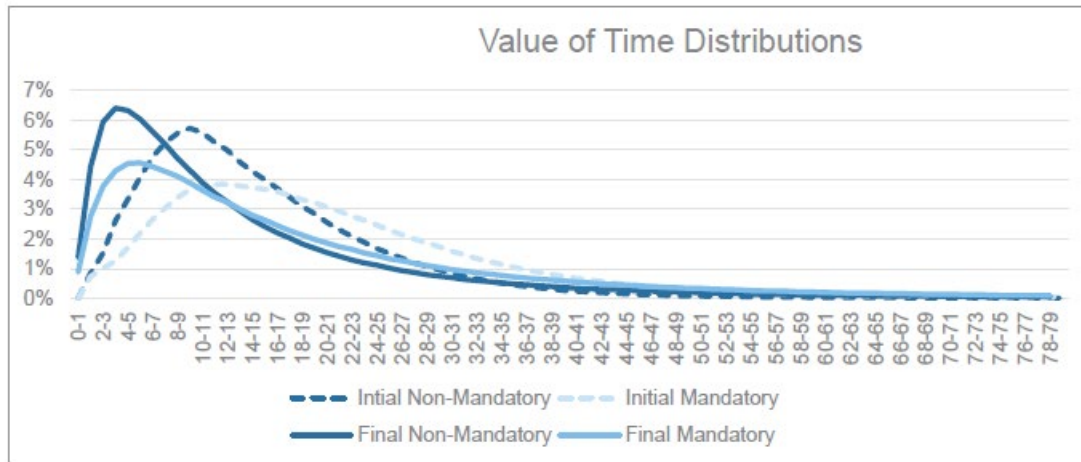
Source: SACOG 2020

9.2.1.1 Valuation of Time

Per RSG Travel demand Model Toll Enhancements¹², SACSIM uses distributed travel time sensitivities that are drawn from a lognormal distribution whose shape is controlled by the user. In the initial model, the values-of-time (VOT) for mandatory and non-mandatory SACSIM trips were drawn from log normal distributions with standard deviations equal to 0.24 and 0.15 respectively. Comparison of the resulting distributions of value-of-time with that of other regions collected by RSG indicated the need for increasing the standard deviation for SACSIM trips. Several trials were run with different values of standard deviation and compared against the other regions’ distributions. A standard deviation of 0.85 was selected for both mandatory and non-mandatory trips in the current version. Figure 9-2 shows the initial and final value-of-time distributions for trips by tour type (mandatory versus non-mandatory). As shown in the plot, the new distributions use a higher standard deviation and therefore shift trips to the left (more trips with lower value-of-time than the initial distributions). These plots more closely match the results of several Stated Preference surveys conducted by RSG over the past several years¹.

¹² RSG *Travel Demand Model Toll Enhancements Technical Memorandum* for SACOG, September 20, 2018

Figure 9-2 Initial Versus Final Value of Time Distributions



Source: Research Systems Group (RSG) 2018

9.2.1.2 Auto Value-of-Time Bins

Per RSG’s toll modeling enhancements memo¹², the initial model setup used one value-of-time to determine path choice for all trips in the model. In the new model setup, three VOT bins were created for highway skimming and assignment. The bins were created using 33rd, 66th and 90th percentile values of the values-of-time for all trips. The corresponding dollar amount of the percentiles were \$7.25, \$16.85 and \$38.80 respectively. These bins were used to group all trips into three VOT classes; low (1), medium (2) and high (3). The resulting cube script skims time, distance, and toll cost for three occupancy groups (drive alone, shared ride-2 and shared ride 3+) and 9 time periods for each of the three VOT classes. The total number of skim matrices thus produced is 243. A generalized cost function, shown below in Equation 9-2, was used to find the shortest path that considers both time and cost.

Equation 9-2 Generalized cost roadway utilization function with VOT and toll pricing¹²

$$\text{cost} = \text{time} + (\text{AOC} + \text{toll}) * \text{VOT}_i$$

Where:

- cost is the generalized cost on the link in minutes
- time is the congested time on the link returned by the volume-delay function
- AOC is the auto operating cost on the link, in dollars
- VOT_i is the value-of-time on the link, in minutes per dollar.
- The VOTs used for the three classes are:
 - Low VOT bin: 60/7.25 = 8.28 min/\$
 - Medium VOT bin: 60/16.85 = 3.56 min/\$
 - High VOT bin: 60/38.80 = 1.55 min/\$

9.2.1.3 Dynamic Roadway Pricing Loop

The toll optimization algorithm was incorporated to allow dynamic roadway pricing in SACSIM19. In order to maximize travel time savings from a priced facility, the priced facility volume must continue to flow. Therefore, the price must increase or decrease based on demand to maintain the facility at an optimal level of service. The toll optimization algorithm does this at link level by comparing the travel time savings of a toll segment to the adjacent “free” or general-purpose lane. The toll price is then calculated by multiplying the time savings by the average value-of-time the highway assignment takes place. This toll value is then applied to the vehicle pathloading impedance function represented as part of the cost as describe above in Equation 9-2 to determine the demand and person who will use the priced facility. If the V/C ratio of any link in a defined toll segment exceed the optimal level of service, currently set to 0.8, or LOS D, the toll increase reducing the attractiveness, by increase the value in the impedance function. Ideally, this process continues until the facility has converged to an optimal price based on demand. In practice, this process of running the optimization loop is rather time consuming and is set to beak each toll loop when the maximum toll changes (new toll - previous toll) for any segment is less than \$0.05 or 5 toll optimization loops have been run.

9.2.1.3.1 Sequential Steps of Toll Optimization Algorithm:

1. Start the toll optimization loop.
2. Read initial tolls for each segment from the tolls.csv file.
3. Calculate the travel time on the toll segments and the corresponding gp segments.
4. Calculate the time savings in the toll segment ($\text{tollseg_time} - \text{gpseg_time}$)
5. Multiply the time savings by the average VOT to get the current toll.
6. If the v/c ratio in any link of the toll segment is greater than 0.8, multiply the current toll by 2 (or any other factor).
7. Calculate new toll by taking an average of the previous toll and the current toll.
8. Apportion the segment toll to each link in the segment.
9. If the maximum change in tolls from the previous step is less than 50 cents, break the loop.

9.2.2 Mileage Based User Fee

A mileage-based fee, known as a pay-as-you-go, or PAYGO fee, was added into SACSIM19 path building utilization cost function. The fee is defined as:

- Combination of state and federal fuel tax per mile traveled, based on the inflation-adjusted cost of fuel taxes on a per mile basis; or
- PAYGO or mileage-based fees assumed to replace part or all of the fuel taxes in future scenarios

Within the Cube® script used to run SACSIM19, a user would set the “direct” costs of fuel, maintenance and tires on a per-mile basis for the “AOC” variable described below, and the fuel tax or PAYGO fee per mile for the “mileagefee” variable as described below.

This allows SACSIM19 new functionalities described above for travel time sensitivity distribution curves and three VOT bins for highway skimming to also be sensitive to a dynamic mileage-based fees. The fee can also vary by defined geography and time periods to represent potential fee increases based on congestion around denser land use areas or peak commute travel times. Similarly, allow fee reductions for non-congestion areas, due to off peak travel times or locations requiring longer mandatory trips to job and service areas such as rural and agricultural areas.

The generalized cost function described in Equation 9-2 for shortest path during skimming and assignment is now updated to consider not only time, costs outlined above but also, mileage-based user fees. Equation 9-3 and Equation 9-4 show the mileage-based fee integration into the cost equation.

Equation 9-3 Generalized Cost Function with Mileage Based User Fee (Equation 2 update)

$$\text{cost} = \text{time} + (\text{AOC} + \text{toll} + \text{mileagefee}) * \text{VOT}_i$$

Where:

- cost is the generalized cost on the link in minutes
- mileagefee is the mileage-based fee applied on the link, in dollars

Equation 9-4 Mileage Based User Fee

$$\text{mileagefee} = (\text{imilagefee} * \text{spatialfactor}) + \text{congestionfee} + \text{feediscount}$$

Where:

- imilagefee is the initial mileage-based fee applied on the link, in 2000 dollars (typically as a fraction of cents)
- spatialfactor is a multiplicative factor spatial adjustment by regional analysis zone (RAD) applied on the link level, in 2000 dollars, for “flat fee” spatial factor is set to one.
- congestionfee is a mileage-based fee increase applied on the link based on time period, in 2000 dollars, for “flat fee” congestionfee is set to zero.
- feediscount is a mileage-based fee decrease (negative value) applied on the link based on time period, in 2000 dollars, for “flat fee” feediscount is set to zero.

9.3 Auto Operating Costs and Pricing User Guide Setup

9.3.1 Auto Operating Cost User Guide Setup

9.3.1.1 Step 1: Determine AOC for scenario year

Auto Operating Cost must be determined as a SACSIM19 user input. See section Auto Operating Costs section above on how to compute AOC based on scenario year.

9.3.1.2 Step 2: Set AOC in SACSIM19 Script (.s) file

Open SACSIM19 model run script to update the auto cost input variable *auto_cost_per_mile* as shown in Figure 9-3.

Figure 9-3 SACSIM19 Auto Cost and User Fee Inputs

```
9 ;=====
10
11 ;Set per-mile auto operating cost here
12 auto_cost_per_mile = 0.162
13 userfee_per_mile = 0.014
```

9.3.2 Mileage Based User Fee User Guide Setup

9.3.2.1 Step 1: Determine Scenario Mileage Based User Fee

Determine mileage-based user fee for scenario. See Appendix D Fuel Tax and Mileage Fee Report for further description and examples. Must convert mileage-based fees back to 2000 dollars for SACSIM19 use.

9.3.2.2 Step 2: Set User fee in SACSIM19 (.s) file

Open SACSIM19 model run script to update the initial mileage-based user fee input variable *userfee_per_mile*. If not user fee is desired for the scenario, *userfee_per_mile* should be set to 0.00. For a flat user fee per mile, *userfee_per_mile* is the only input required. If time period or spatial adjustments are need additional inputs are required. Regardless, it is important to review other user fee inputs to confirm they are set on or off properly.

9.3.2.3 Step 3: Spatial and Time Period Fee Adjustments

Spatial and temporal components can be set using the *RAD_Userfee.csv* input file in the Scenario run folder. Table 9-3 describes the four inputs in the *RAD_Userfee.csv* required and an example with and without the mileage based fee adjustments. Figure 9-4 shows an example of the *RAD_Userfee.csv*.

Table 9-3 Spatial and Temporal Mileage-Based Fee Adjustment

Header (Not in actual file)	RAD	Multiplicative Factor	Peak Adjustment	Off Peak Adjustment
Required input description	Regional Analysis Distract Spatial Geography where factor will apply to roadways. Default is all RAD Zones within region.	Factor used to multiple userfee_per_mile input. Default is 1.	Peak congestion rate adjustment factor applied to AM (7am-10am) and (4PM – 6PM) peak hours. Default is 0.	Off Peak period discount rate during non-congested times applied to Evenings (7-9), Nighttime (10-5am) and Midday. Default is 0
Example Spatial Adjustment Turned On	1	2	0.007	-0.007
Example Spatial Adjustment Turned Off	1	1	0	0

Figure 9-4 RAD_Userfee.csv Example

26	26	1	0.007	-0.007
27	27	2	0.007	-0.007
28	28	1	0.007	-0.007

9.3.3 Facility Pricing User Guide Setup

SACSIM19 requires two facility pricing inputs:

- Network Segment Identification
- Toll Input Cost
- Model Run Script (*only for adjusting all-lane toll facility*)

9.3.3.1 Step 1: Network Segment Identification

Open the base network, typically named <scenario year>_base.net. Every priced facility must have a TOLLID number associated. For parallel general purpose and auxiliary lanes. The same ID number must be assigned to GPID (general purpose lanes) and AUXID (auxiliary lanes). This is used to determine the cost of the managed facility relative to the congestion on the parallel “free” facilities. Depending on the type of managed lane, USECLASS must also be set with a value of 0, 2, or 3 to

determine the allowed vehicle type on the managed facility. Zero allows all users to drive on the facility being priced. Note, USECLASS does not determine which vehicles are priced, the prices are set in the Toll Input File described below. Two refers to vehicle occupancy of 2+ and 3 allows vehicle with 3 or more passengers only to enter the facility. Figure 9-5Figure 2-8 shows an example of a managed lane facility coding on the base network. In this example all vehicle types are allowed on the managed lane facility. For more information on other network attributes that may influence the network toll segment see chapter 4 on Highway Network.

9.3.3.1.1 Define Network Toll Segment

Defining toll segment distance and extents is an important input to determine the cost and utilization of the priced facility. Each toll segment has multiple links, but only one TOLLID identifier, one GPID identifier, and one AUXID identifier (if auxiliary lane exists along segment). Travel time savings is taken as the total toll segment time minus the total general-purpose segment time, and if any V/C ratio link is greater than the level of service threshold, cost increases. Taking into consideration distance, number of lanes, interchanges, ramps, and speeds is important for a priced facility to work properly. Figure 9-6 shows an example where the number of lanes and demand of the highway facility changed for different toll segments were defined before and after the ramps.

Figure 9-5 Base Network Toll ID Coding

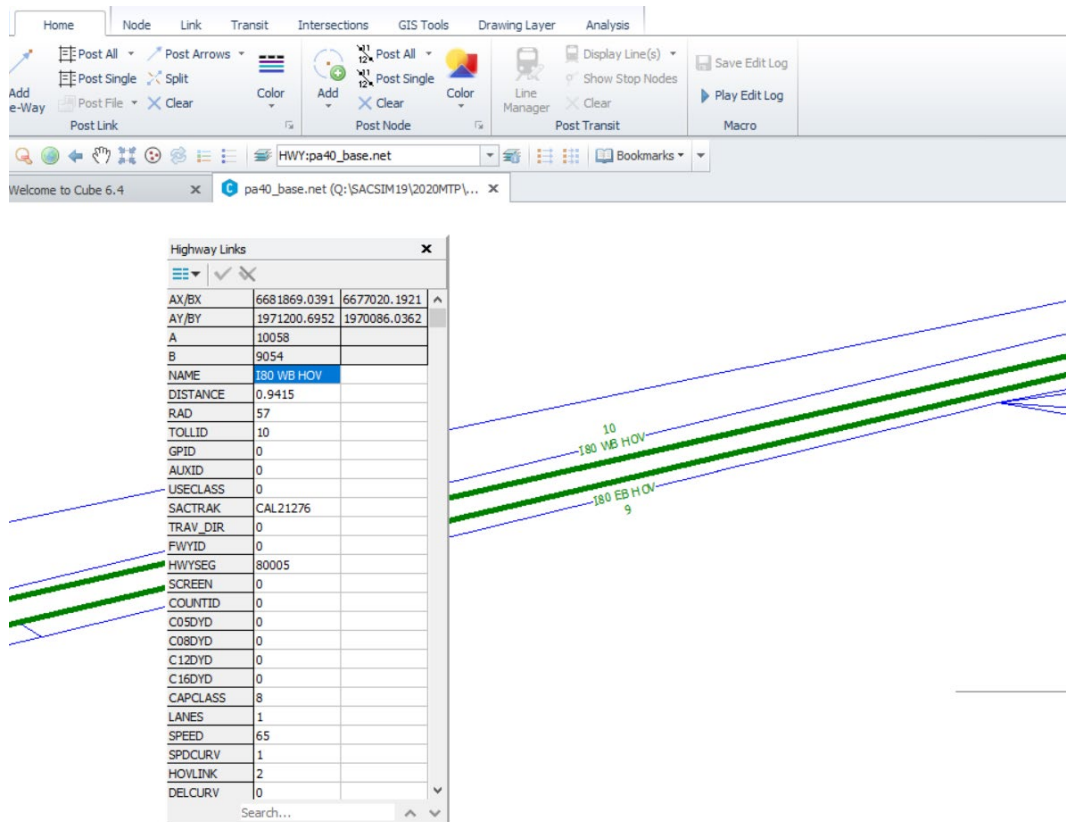
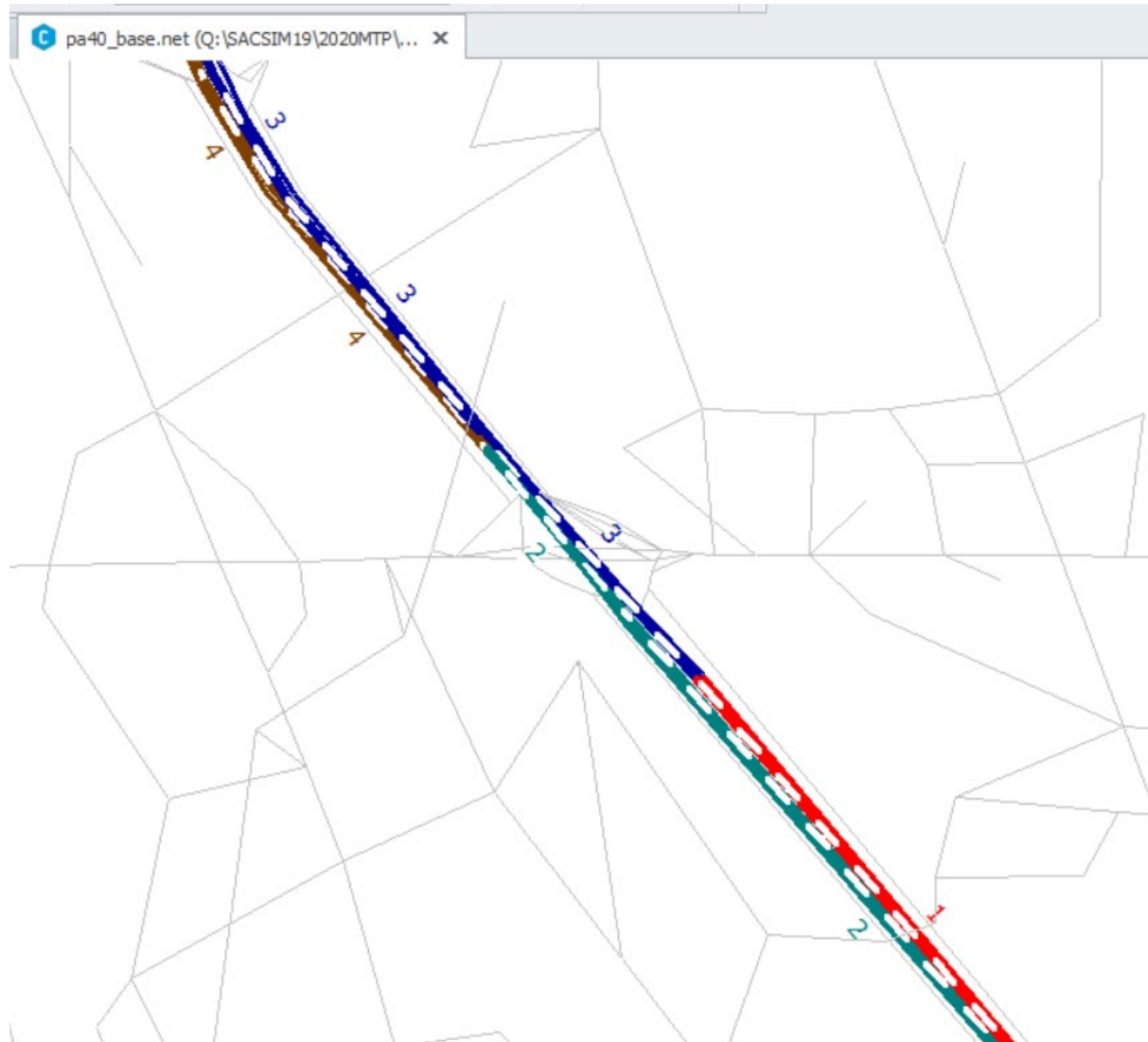


Figure 9-6 Multiple Toll Segments Identified on Network



9.3.3.1.2 Define Network General Purpose and Auxiliary Segment

Since the travel time from the general-purpose lane is needed to compare savings to the priced facility, the general purpose segment length must be the same distance as the priced facility distance. If these distances are too far off this will affect the travel time savings function. For this reason, if the total general-purpose distances less or greater than 0.25 miles different from the priced facility, SACSIM will immediately error out. These lengths can be checked in the tollseg_length.csv file created during SACSIM initial setup. Auxiliary lanes are not used in the pricing optimization algorithm and therefore do not require and maximum or minimum lengths. Auxiliary lanes need to be coded to ensure the vehicles do not skip the facility all together and allow the total volume across all lanes to be accounted for.

9.3.3.1.3 Define Network Segments for All-Lane Toll Facility

To define an all-lane toll facility. The TOLLID must be identified for all lanes, including what may have been previously coded as general-purpose lanes or auxiliary lanes. Additionally, the model run script input variable *AllLaneToll* must be set from 0 (default) to 1, as shown in Figure 9-7. Since the toll optimization loop is based off the travel time savings from the parallel free option, the dynamic pricing is not available for all toll facilities, instead users will have to specify the cost of the toll as an input in the toll cost file *toll.csv*.

Figure 9-7 SACSIM19 All-lane Toll Facility Input

```

90 ; this block of code calculates the total length of each toll segments, which will later be used to apportion tolls to each link
91   AllLaneToll = 0 ; 1 True, 0 False. Turn true if all lane toll facilities exist.
92   run pgm = hwynt MSG='step 0 Calculate toll segment length'
```

9.3.3.2 Step 2: Toll Cost File

The TOLLID coded on the network identifies the toll segments. The costs by vehicle types then need to be associated and defined to the network toll segments. This is done in the Toll Input Cost File *tolls.csv*. Each row represents a unique TOLLID segment by time period. For every tolled there will be nine additional rows added to the input file (1 tollid X 9 SACSIM time periods). Table 9-4 describes the columns required for the toll cost file. Table 9-5 Toll Cost Input Example shows an example of the Toll Input Cost File with one toll segment. The actual csv file does not have column headers and must be written in the same order as Table 9-4.

Table 9-4 Toll Cost Inputs

Input Order	Columns	Description	Value Type
1	Facility Index	unique ID for a link during a time period: toll_gp_id*100 + period	Unique Integer >100 (based on Segment Number and period)
2	Segment #	corresponds to TOLLID, GPID, and AUXID in model network	Unique Integer
3	period	SACSIM time period	1-9
4	adjustment	1/0 indicating if toll optimization algorithm is applied	Binary (0-1)
5	toll_da	starting toll value for drive-alone	2000 dollar
6	toll_s2	starting toll value for HOV2	2000 dollar
7	toll_s3	starting toll value for HOV3	2000 dollar
8	toll_cv	starting toll value for commercial vehicles	2000 dollar
9	mintoll_da	minimum toll value for drive-alone	2000 dollar
10	mintoll_s2	minimum toll value for HOV2	2000 dollar
11	mintoll_s3	minimum toll value for HOV3	2000 dollar
12	mintoll_cv	minimum toll value for commercial vehicles	2000 dollar
13	maxtoll_da	maximum toll value for drive-alone	2000 dollar
14	maxtoll_s2	maximum toll value for HOV2	2000 dollar
15	maxtoll_s3	maximum toll value for HOV3	2000 dollar
16	maxtoll_cv	maximum toll value for commercial vehicles	2000 dollar
17	Reversible Lane AM	add managed lane(s), remove opposite flow general purpose lane, during AM peak period (7-10am), general purpose removal should be on different toll segment ID.	positive integer to add managed lane(s), negative integer to remove general purpose lane(s)
18	Reversible Lane PM	add managed lane(s), remove opposite flow general purpose lane, during PM peak period (3-6pm), general purpose removal should be on different toll segment ID.	positive integer to add managed lane(s), negative integer to remove general purpose lane(s)

Input Order	Columns	Description	Value Type
19	Shoulder lane AM	add managed lane(s) during AM peak period (7-10am), assumption is shoulder space is converted to a managed or general purpose along the facility adding width for an additional managed lane.	positive integer to add managed lane(s)
20	Shoulder lane PM	add managed lane(s), during PM peak period (3-6pm)	positive integer to add managed lane(s)
21	Take a Lane AM	add managed lane(s), remove adjacent general-purpose lane, during AM peak period (7-10am)	positive integer to add managed lane(s), (will subtract value from general purpose lane(s))
22	Take a Lane PM	add managed lane(s), remove adjacent general-purpose lane, during PM peak period (3-6pm)	positive integer to add managed lane(s), (will subtract value from general purpose lane(s))

Table 9-5 Toll Cost Input Example

Fac. Index	Seg	Per.	Fac. Type	Adjust	Toll DA	Toll S2	Toll S3	Toll CV	Min DA	Min S2	Min S3	Min CV	Max DA	Max S2	Max S3	Max CV	Reversible Lane AM	Reversible Lane PM	Shoulder lane AM	Shoulder lane PM	Take a Lane AM	Take a Lane PM
101	1	1	2	1	1	0	0	2	0.1	0	0	0.2	30	0	0	30	0	0	0	0	0	0
102	1	2	2	1	1	0	0	2	0.1	0	0	0.2	30	0	0	30	0	0	0	0	0	0
103	1	3	2	1	1	0	0	2	0.1	0	0	0.2	30	0	0	30	0	0	0	0	0	0
104	1	4	2	1	1	0	0	2	0.1	0	0	0.2	30	0	0	30	0	0	0	0	0	0
105	1	5	2	1	1	0	0	2	0.1	0	0	0.2	30	0	0	30	0	0	0	0	0	0
106	1	6	2	1	1	0	0	2	0.1	0	0	0.2	30	0	0	30	0	0	0	0	0	0
107	1	7	2	1	1	0	0	2	0.1	0	0	0.2	30	0	0	30	0	0	0	0	0	0
108	1	8	2	1	1	0	0	2	0.1	0	0	0.2	30	0	0	30	0	0	0	0	0	0
109	1	9	2	1	1	0	0	2	0.1	0	0	0.2	30	0	0	30	0	0	0	0	0	0

Referring to the Input Order Column of Table 9-4:

Inputs 1-3 are used to tie the network toll links identified to the cost per time period. Input 1 should be calculated by $\text{input 2} * 100 + \text{input 3}$. If additional time periods or toll segments are added, these rows will need to be expanded on in the same format for every new toll segment added to the network.

If a scenario requires no toll pricing, Inputs 4-22 should all be set to zero.

Input 4 adjustment if the toll optimization algorithm is turned on or off. This must be turned on to use the dynamic pricing. There are a few reasons to turn off:

- User want toll prices fixed, may have already determined the optimal cost or running post processing assignments.
- All toll lane scenario or facility is being applied
- For testing purpose, user wants to reduce model run time.

Inputs 5-8 are user specified initial toll prices by four mode vehicle classifications. These values are put into model as part of the initial cost function and then adjusted during the toll optimization loop. If a fixed or all lane toll scenario is being ran, the initial inputs will also be the final cost. Based on default settings, the toll optimization loop is set to run a maximum of five iterations. If toll price curve results seem too high or too low based on no osculation occurring or not enough convergence in price, it is recommended to start the next run with a higher or lower initial toll to help convergence to occur within the 5 iterations.

- DA = drive alone or single occupancy vehicle
- S2 = Shared Occupancy Vehicle with two persons (SOV2)
- S3+ = Shared Occupancy Vehicle with three or more persons (SOV3+)
- CV = Commercial Vehicles, currently defined as SACSIM category CV 2 axle, 3+ axle CVs are not allowed access to managed lanes. This can be adjusted in the model run script.

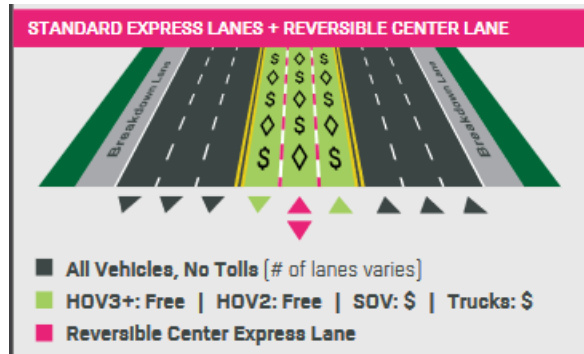
Inputs 9-16 are user specified toll prices constraints. Inputs 9-12 are the minimum by set price by mode. Input 13-16 are the maximum price by mode. For example, if a minimum toll price was set to \$1.00 and a maximum to \$10.00, the final price must be at or between these upper and lower bounded constraints regardless of demand, or lack thereof, along the facility. Since the toll optimization loop sets the price based on the vehicle demand, the more constraints added the less likely the algorithm can find the optimal price to set.

Inputs 17-22 are user specified lane configuration adjustments on both the general purpose or “free” lanes and the managed lanes or “priced” lanes.

Inputs 17 and 18 add reversable lanes to the priced facility to the peak period: 17: 3 AM peak hours 7-8, 8-9, 8-10 am, 18: 3 PM peak hour 3-4,4-5,5-6 pm. If positive value is entered to a toll segment, a priced lane(s) will be added. If a negative value is added a general-purpose lane(s) will be added.

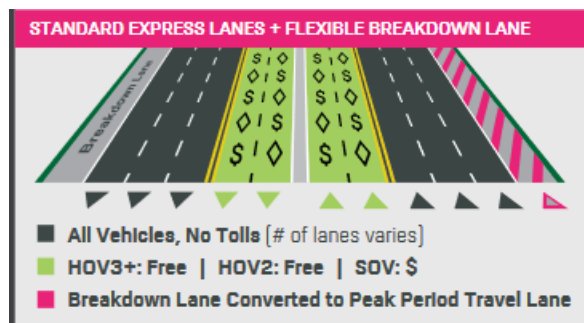
Using this logic, to maintain the number of lanes defined in the scenario base network file, a negative value should always be assigned to the parallel opposite direction toll segment ID. If no negative number is specified, an additional lane is added to the network. Figure 9-8 shows an example of a reversible lane as an additional middle lane that can reverse directions based on the peak period traffic flow directional demand of travel.

Figure 9-8 Express Lane Configuration: Reversible Center Lane



Inputs 19 and 20 add a managed lane(s) during AM peak period (7-10am) and PM peak periods (3-6pm) respectively. SACSIM19 assumption is shoulder space is converted to a managed or general purpose along the facility adding width for an additional managed lane. Since SACSIM19 assignment is a “stick and ball” network, land configuration curvature and geometry is not accounted for at the demand level software. Nor is type of pricing facility implementation infrastructure design. Microsimulation or CAD software’s may be used to determine if adding a shoulder lane scenario is realistic based on a roadway geometry. SACSIM19 simple provides the capability to add or remove the lane during assignment. Figure 9-9 shows an example of a shoulder or breakdown lane converted into an additional lane during peak periods.

Figure 9-9 Express Lane Configuration: Flexible Breakdown Lane



Inputs 21 and 22 add an additional managed during AM peak period (7-10am) and PM peak periods (3-6pm) respectively by removing a general-purpose lane during the defined time period. This allows scenarios with multilane express lanes during times of high demand to manage congestion, and “free” or general-purpose lanes during lower demand. An facility example of could be a highway with high morning peak congestion into downtown in the mornings, however, during the PM the traffic may be more evenly dispersed throughout the duration of the afternoon evening and not

require as many managed lanes available. Figure 9-10 shows an example of a multi-lane express lane configuration where a “Take A Lane” may be applied.

Figure 9-10: Multilane Express Lane



9.4 Transit Fares

Zone-to-zone transit fares are required as inputs to the mode choice model, reflecting boarding fares, transfer discounts, and (where applicable) zonal fares along the transit paths.

9.4.1 Transit Pass and Discount Models

By default, SACSIM assumes a potential transit user will pay the [single-ride adult cash fare](#) for each transit trip and pay the price, if applicable, for any transfers. However, significant shares of transit users either use a transit pass or receive a significantly discounted fare.

DAYSIM's transit pass model predicts whether a person would own a transit pass based on his/her age, type, access to transit from his/her home, employment status, and student status. If a person owns a transit pass, then the fare cost of taking a trip by transit is zero. Model users can adjust the coefficients for predicting transit pass ownership or turn the pass ownership model off if desired.

DAYSIM also predicts whether a person will pay a discounted fare, as well as how much that discount is, by applying a percentage discount to the adult cash fare based on the person's age (e.g. for a senior/child discount) and student status (e.g. students ride for free or pay a discounted fare).

Both fare discounts and the transit pass model are configurable in the DAYSIM configuration file, though there is a separate coefficient file for adjusting the transit pass model coefficients.

9.4.2 Limits of Transit Fare Estimation

While SACSIM captures the bulk of transit fare types, it cannot capture all of them. Examples of fare types not estimated by SACSIM include day passes and week passes that, respectively, allow unlimited boardings during a 24-hour day or 7-day week. Also, even within the discount factors applied above, SACSIM does not capture the full variation of discounts that apply across different operators, e.g., while one operator allows students to ride for free, another operator may just give them a discounted fare. Ideally, SACSIM would capture all fare policies and variations, but doing so would add considerable complexity to the model while only very marginally improving model accuracy.

9.4.3 SACOG Transit Operator Base Fares and Transfer Policies

Table 9-6 lists the undiscounted adult cash fares for operators included in SACSIM. Boardings and transfer fares are defined for each group of transit services.

Note that although fares in Table 9-6 are stated in year 2016 dollars, for the model fare input table, "ptfare.txt", all fares are converted to year 2000 dollars. This is consistent with other dollar cost model inputs such as auto operating cost.

Table 9-6 Year 2016 Transit Fares (in 2016 Dollars)

Fare Group	Transit Service	2016 Adult Cash Fare, in 2016 Dollars	Discount(s)	Monthly Passes
1,2	RT LRT & Bus	\$2.75	Seniors, youth	Yes
3	Yolobus Express	\$3.25	Seniors, youth	Yes
4	Yolobus Local / Intercity	\$2.25	Seniors, youth	Yes
5	Roseville Commuter	\$3.25	Seniors, youth	Yes
6	Roseville Local	\$1.50	Seniors, youth	Yes
7	Yuba-Sutter Commuter	\$4.00	Seniors, youth	Yes
8	Yuba-Sutter Local	\$1.00	Seniors, youth	Yes
9	El Dorado Transit Commuter	\$5.00	Seniors, youth	Yes
10	El Dorado Transit Local	\$1.50	Seniors, youth	Yes
11	Placer County Transit Commuter	\$4.25-\$5.75	Seniors, youth	Yes
12	Placer County Transit Local	\$1.25	Seniors, youth	Yes
13	Unitrans	\$1.00	Seniors, UCD goClub members	Yes
14	Heavy Rail	Varies	Seniors	Yes
15	South County Link (Galt)	\$3.25	Seniors, youth	Yes
16	E-Tran Commuter	\$2.25	Seniors, youth	Yes
17	E-Tran Local	\$2.25	Seniors, youth	Yes
20	Folsom Local	\$2.50	Seniors, youth	Discount groups only

Source: SACOG 2020.