



Photo Credit: History of Food Delivery, Milk Delivery India

SCAG Heavy Duty Truck (HDT) Model Update

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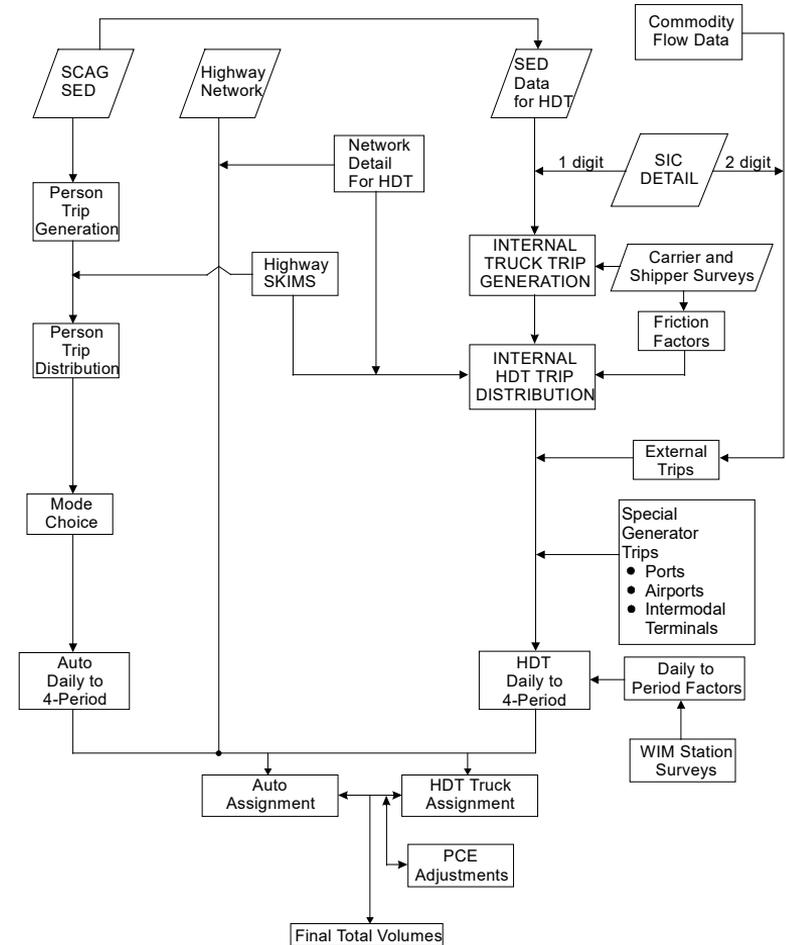
MODELING TASK FORCE
January 24, 2024

Why HDT Model needs Comprehensive Update?

- Last comprehensive update was in 2008 – there is a new whole world out there!
- E-commerce has drastically changed the dynamics of urban freight distribution
- The population and activity of each HDT truck class has evolved with different patterns
- Need for more accurate estimation of Light Heavy Truck activities
- Need for more accurate estimation of trucks' *VMT* for emission calculation, electrification goals, impact analysis, and more
- New data is available to support model improvements

HDT Model Structure

- Gross Vehicle Weight Rating (GVWR) classes:
 - Light-heavy (8,500 to 14,000 lbs.)
 - Medium-heavy (14,001 to 33,000 lbs.);
 - Heavy-heavy (>33,000 lbs.)
- Internal HDT Model: all HDT trips that have both origin and destination within the 6-county modeling area.
- Port Model Development: HDT trips coming out of and going into the POLB and POLA.
- External HDT Model: HDT trips that come into, go out of, or pass through the region.
- HDT trip tables get integrated in ABM multi-Class assignment



Major Updates

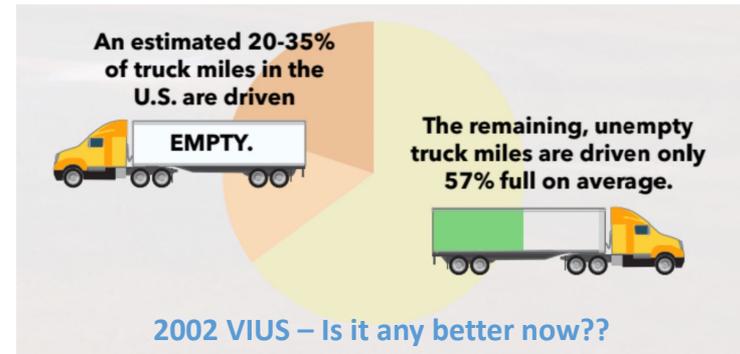
- Data preparation (FHWA-13 Class 3 trucks)
- Trip rates by truck class (“freight” and “non-freight” trucks)
- Distribution (friction factors)
- External trips (existing and future projection)
- Calibration and Validation process

Data Preparation

- Commodity flow Data
 - FAF 5.5 , Transearch 2019
- GPS Data
 - Streetlight 2019 sample, Geotab April 2019 sample
- Traffic count
 - 403 location from Streetlight data base
 - 176 location from Caltrans data base
 - 645 locations for Screenline (PeMS, Tube Counts)
- Research and literature review

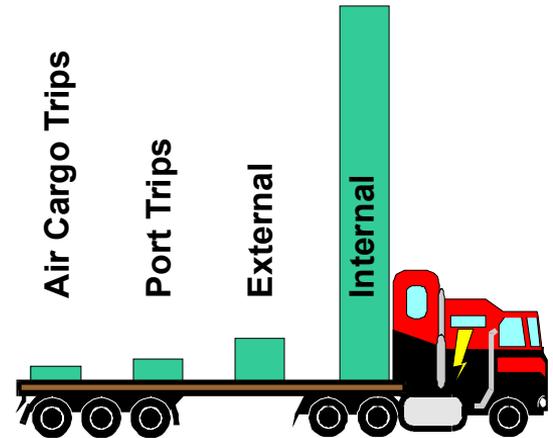
Trip Definition

- What is the practical way to define **A TRUCK TRIP** in traditional *4-step models* to best represent the truck movement activities in the region?
 - Trucks that do **not** carry commodity for paid bill of lading: Municipality, landscaping, utility maintenance, construction, last mile delivery
 - Hours of Service (HOS) Regulation
 - Less-Than-Truckload (LTL) Operation
 - Empty miles



HDT Trips Preview

- 1,695,612 Total Trips
- 1,498,129 Internal Trips
- 97,437 External
- 87,768 Port Trips
- 12,277 Air Cargo Trips



Internal Trips – Daily Summary - 2019

Land Use	Daily Rates	LHDT	MHDT	HHDT	HDT	Percent
Households	0.069	329,035	94,010	4,273	427,318	28.7%
Mining and Construction	0.054	11,041	9,626	7,644	28,311	1.9%
Retail	0.149	50,304	37,728	37,728	125,761	8.4%
agriculture	0.017	527	422	105	1,054	0.1%
Manufacturing	0.098	19,852	21,270	29,778	70,900	4.8%
Transportation	0.148	16,971	19,800	33,943	70,714	4.7%
Wholesale	0.328	42,122	43,575	59,552	145,250	9.7%
LC Warehouse	0.890	36,834	18,417	36,834	92,085	6.2%
HC Warehouse	2.475	81,871	27,836	54,035	163,741	11.0%
Other	0.030	219,573	73,191	73,191	365,956	24.5%
Sum	-	808,131	345,875	337,083	1,491,089	100.0%
Percent	-	54.2%	23.2%	22.6%	100%	-

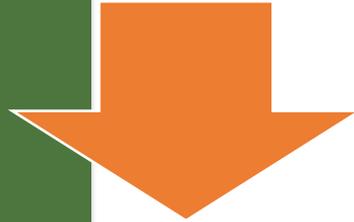
Truck Activity

Commodity flow data (FAF or Transearch)

- Widely used for freight planning and modeling projects across the U.S.
- Primary data source to study truck activity across regions
- Particularly covers long-haul commodity-moving trucks
- No/low coverage of non-freight trucks, e.g e-commerce, last-mile delivery

Expanded truck GPS data and classification counts

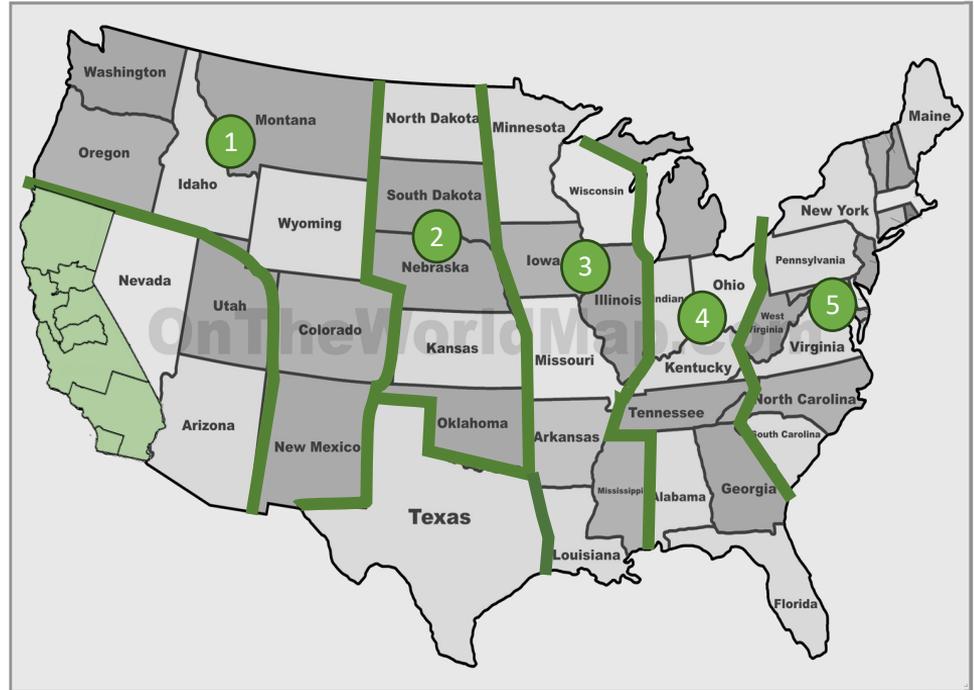
- Used for planning and model estimation and/or validation
- Complimentary sources for a comprehensive picture of truck movements



Goods Movement in SCAG regions

- Regional FAF **Commodity** Flows – “Freight truck”

Destination	2019 Ktons of Goods	Daily "Freight" Trucks	Percent
SCAG Region	298,744	60,600	71.8%
Beyond SCAG	117,381	23,810	28.2%
Total	416,125	84,410	100%
Bay Area	18,185	3,690	4.4%
San Diego County	17,529	3,560	4.2%
Sacramento MSA	4,445	900	1.1%
Fresno/Madera County	2,615	530	0.6%
Rest of California	16,345	3,320	3.9%
Nevada	5,615	1,140	1.3%
Utah	2,535	510	0.6%
Arizona	7,683	1,560	1.8%
Texas	6,166	1,250	1.5%
R1- 500- 900 miles	7,714	1,570	1.9%
R2- 900- 1200 miles	787	160	0.2%
R3- 1200- 1500 miles	10,094	2,050	2.4%
R4- 1500- 2000 miles	13,256	2,690	3.2%
R5- East Coast	4,411	900	1.1%



Key Findings (preliminary)

- Overall, FAF covers less than 10% of all truck trips in the SCAG region
- National Commodity Flow data, estimate economic activity between regions (usually in \$ or tons).
- To translate these to number of trucks on the roads, important considerations are required
- Truck GPS data and classification counts coupled with FAF data, can provide a better picture of all truck activity in a region



County (as Origin)	FAF Daily* Truck Trips	All Daily** Truck Trips	FAF Truck Trips as % of Total
Imperial	2,022	11,981	17%
Los Angeles	66,273	851,809	8%
Orange	21,583	267,953	8%
Riverside	15,150	183,081	8%
San Bernardino	13,515	231,191	6%
Ventura	6,846	56,578	12%
Total SCAG	125,388	1,602,593	8%

Note: Numbers are calculated based on assumptions on average payloads by commodity, truck types, annualization factor, etc.

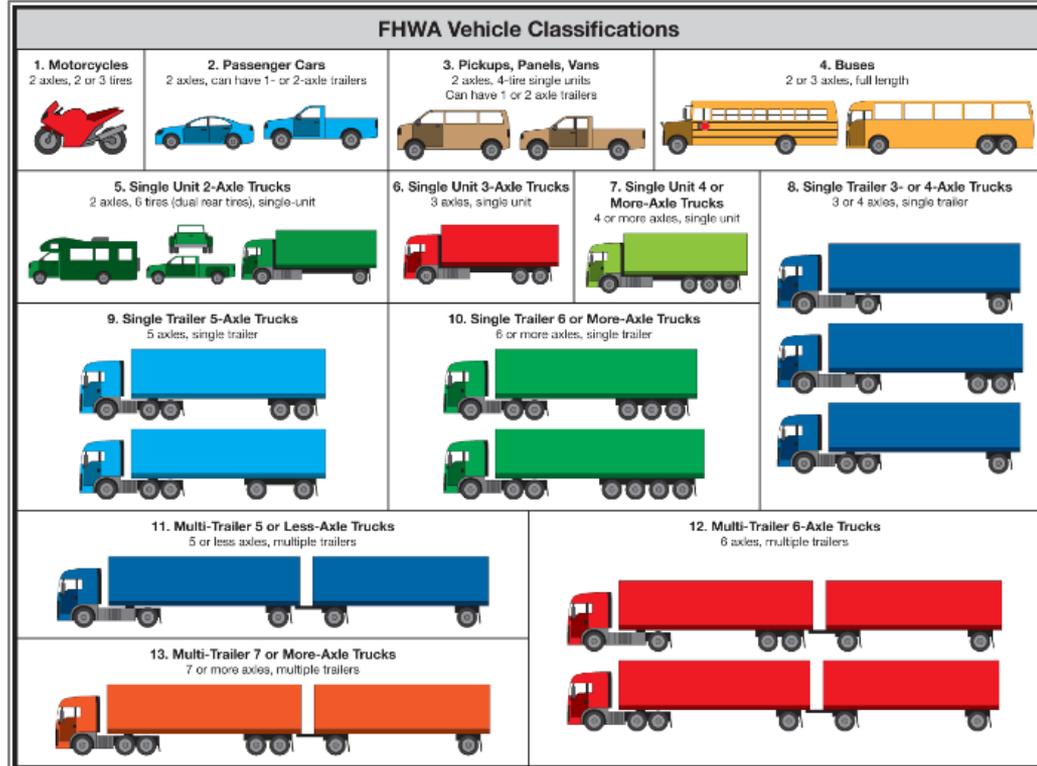
* Assumption: FAF includes Medium and Heavy Trucks (i.e. GVWR>14k lbs.)

** Assumption: All trucks include Light, Medium, and Heavy Trucks (i.e. GVWR>10k lbs.)

Truck Classification

2020 RTP

FHWA-13 Class	SCAG HDT Class
3	Auto
5	LHDT
6-7	MHDT
8 and above	HHDT



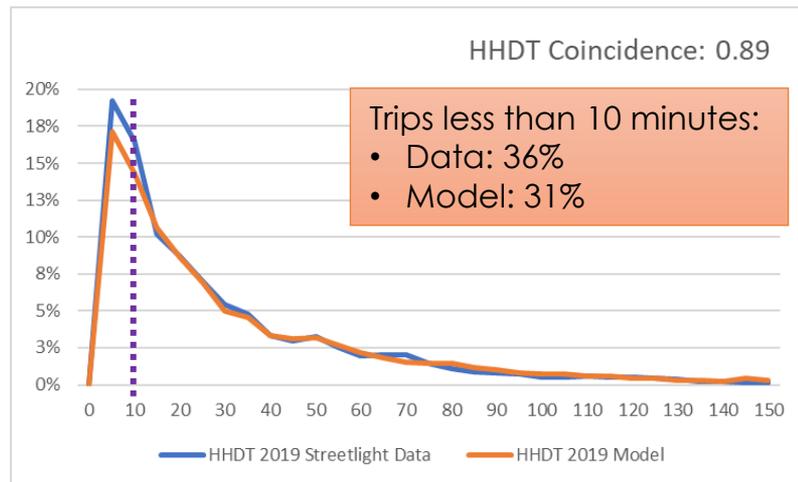
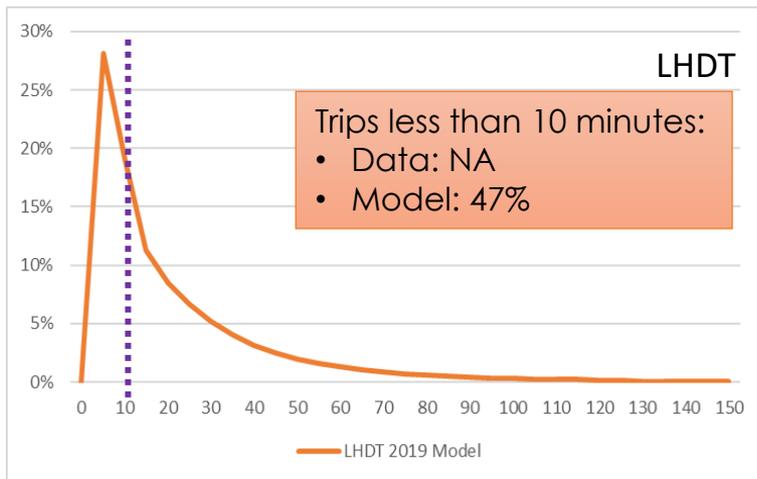
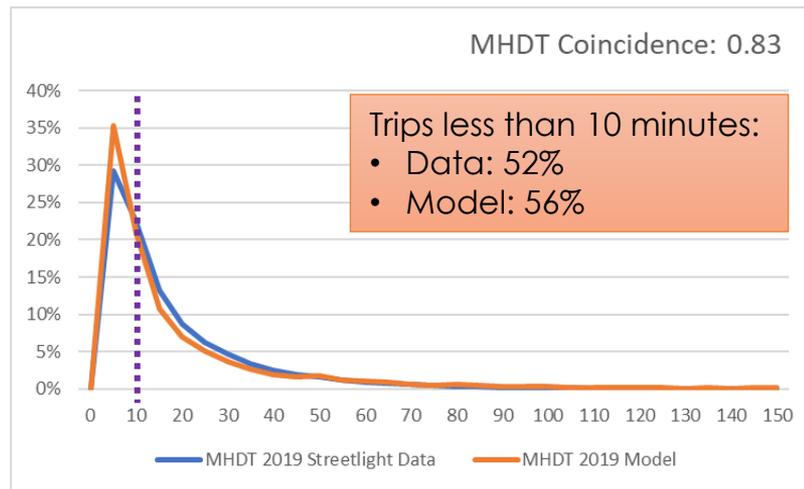
Truck Classification Conversions

FHWA-13 Class → SCAG HDT Truck Class

FHWA-13 Class	Definition	SCAG Class Definition (%)				
		Auto	LHDT	MHDT	HHDT	Sum
1	Motorcycles	100.0	-	-	-	100
2	Passenger Cars	100.0	-	-	-	100
3	Two-Axle Four-Tire Single-Unit Trucks	89.14	8.84	1.99	0.03	100*
4	Buses	-	-	-	-	-
5	Two-Axle, Six-Tire, Single-Unit Trucks	-	34.2	64.0	1.8	100
6	Three-Axle Single-Unit Trucks	-	3.2	25.3	71.5	100
7	Four or More Axle Single-Unit Trucks	-	-	3.0	97.0	100
8	Four or Fewer Axle Single-Trailer Trucks	-	27.6	4.7	67.7	100
9	Five-Axle Single-Trailer Trucks	-	0.1	2.5	97.4	100
10	Six or More Axle Single-Trailer Trucks	-	9.1	2.2	88.7	100
11	Five or Fewer Axle Multi-Trailer Trucks	-	-	5.1	94.9	100
12	Six-Axle Multi-Trailer Trucks	-	-	-	100.0	100
13	Seven or More Axle Multi-Trailer Trucks	-	-	-	100.0	100

*~10% of all FHWA Class 3 are included in the HDT model

Trip Length Distribution (Travel Time)

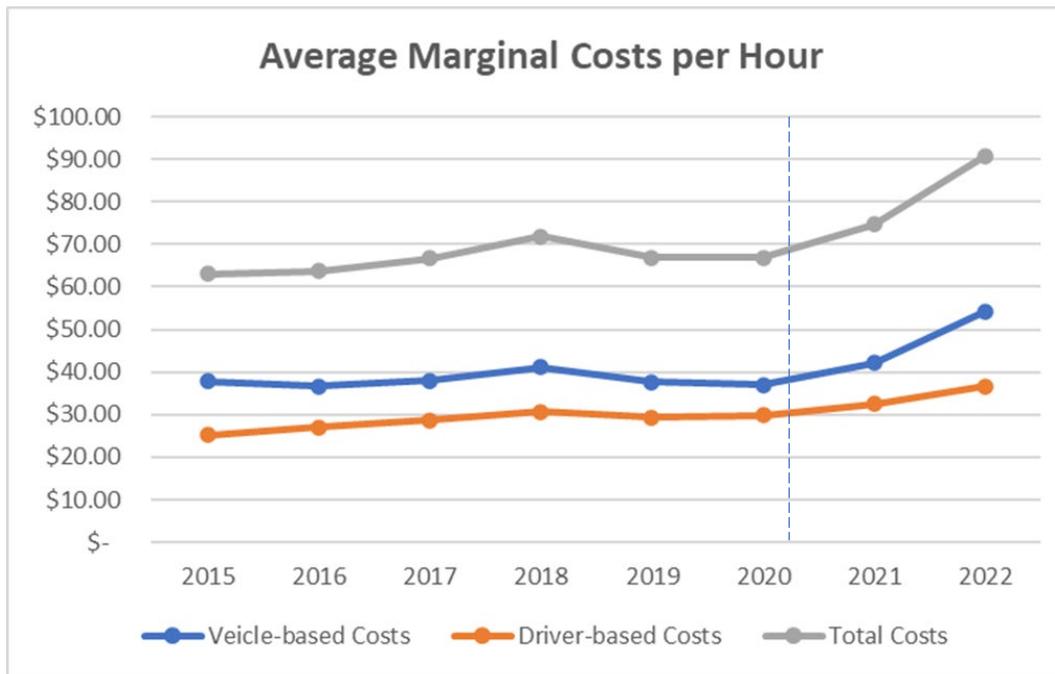


Trucking Cost – Average Marginal Costs per Hour

Motor Carrier Costs	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
<i>Vehicle-based</i>										
Fuel Costs	\$25.78	\$23.29	\$16.13	\$13.45	\$14.50	\$17.07	\$15.14	\$12.52	\$16.78	\$25.84
Truck/Trailer Lease or Purchase Payments	\$6.52	\$8.59	\$9.20	\$10.20	\$10.39	\$10.45	\$10.09	\$11.00	\$11.21	\$13.37
Repair & Maintenance	\$5.92	\$6.31	\$6.23	\$6.65	\$6.58	\$6.72	\$5.87	\$6.00	\$7.04	\$7.89
Truck Insurance Premiums	\$2.57	\$2.86	\$2.98	\$3.00	\$2.95	\$3.32	\$2.80	\$3.55	\$3.46	\$3.57
Permits & Licenses	\$1.04	\$0.76	\$0.78	\$0.88	\$0.92	\$0.95	\$0.79	\$0.67	\$0.64	\$0.60
Tires	\$1.65	\$1.76	\$1.72	\$1.41	\$1.50	\$1.50	\$1.54	\$1.73	\$1.67	\$1.81
Tolls	\$0.77	\$0.90	\$0.79	\$0.97	\$1.05	\$1.17	\$1.38	\$1.49	\$1.30	\$1.14
<i>Driver-based</i>										
Driver Wages	\$17.60	\$18.46	\$19.95	\$20.91	\$21.97	\$23.50	\$21.84	\$22.97	\$25.24	\$29.20
Driver Benefits	\$5.16	\$5.15	\$5.22	\$6.18	\$6.78	\$7.10	\$7.49	\$6.94	\$7.31	\$7.37
TOTAL	\$67.00	\$68.09	\$62.98	\$63.66	\$66.65	\$71.78	\$66.94	\$66.87	\$74.65	\$90.78

Source:
 ATRI June 2023, An
 Analysis of the
 Operational Costs of
 Trucking

Trucking Cost – Post Pandemic Trends



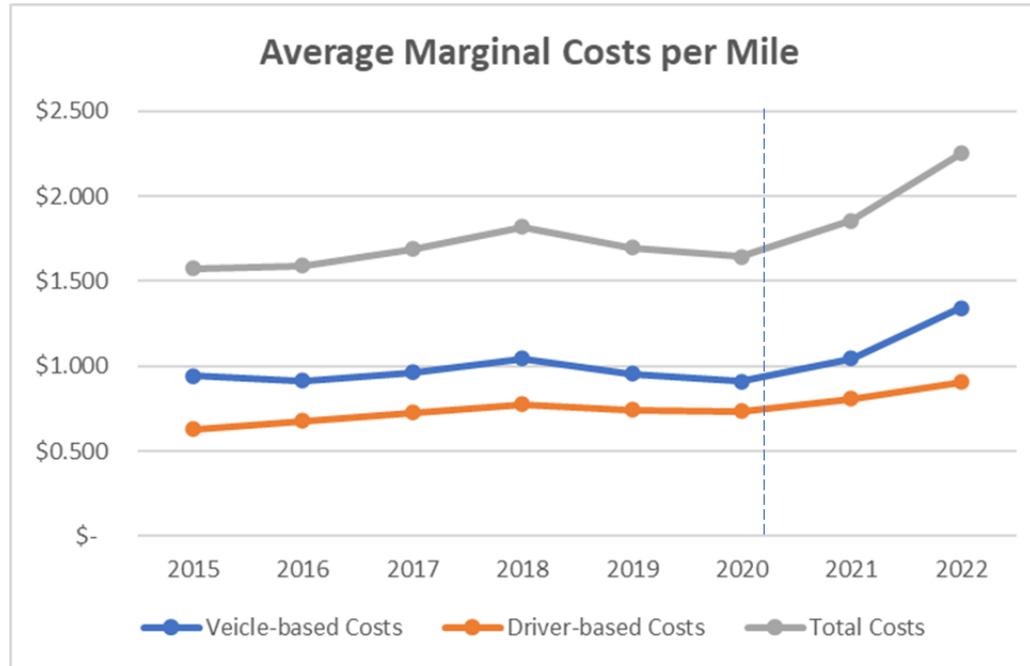
Average Marginal Costs per Hour	2019	2022	Growth %
Vehicle-based Costs	\$ 37.61	\$ 54.21	44%
Driver-based Costs	\$ 29.33	\$ 36.57	25%
Total Costs	\$ 66.94	\$ 90.78	36%

Trucking Cost – Average Marginal Costs per Miles

Motor Carrier Costs	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
<i>Vehicle-based</i>										
Fuel Costs	\$0.645	\$0.583	\$0.403	\$0.336	\$0.368	\$0.433	\$0.384	\$0.308	\$0.417	\$0.641
Truck/Trailer Lease or Purchase Payments	\$0.163	\$0.215	\$0.230	\$0.255	\$0.264	\$0.265	\$0.256	\$0.271	\$0.279	\$0.331
Repair & Maintenance	\$0.148	\$0.158	\$0.156	\$0.166	\$0.167	\$0.171	\$0.149	\$0.148	\$0.175	\$0.196
Truck Insurance Premiums	\$0.064	\$0.071	\$0.074	\$0.075	\$0.075	\$0.084	\$0.071	\$0.087	\$0.086	\$0.088
Permits & Licenses	\$0.026	\$0.019	\$0.019	\$0.022	\$0.023	\$0.024	\$0.020	\$0.016	\$0.016	\$0.015
Tires	\$0.041	\$0.044	\$0.043	\$0.035	\$0.038	\$0.038	\$0.039	\$0.043	\$0.041	\$0.045
Tolls	\$0.019	\$0.023	\$0.020	\$0.024	\$0.027	\$0.030	\$0.035	\$0.037	\$0.032	\$0.028
<i>Driver-based</i>										
Driver Wages	\$0.440	\$0.462	\$0.499	\$0.523	\$0.557	\$0.596	\$0.554	\$0.566	\$0.627	\$0.724
Driver Benefits	\$0.129	\$0.129	\$0.131	\$0.155	\$0.172	\$0.180	\$0.190	\$0.171	\$0.182	\$0.183
TOTAL	\$1.676	\$1.703	\$1.575	\$1.592	\$1.691	\$1.821	\$1.699	\$1.646	\$1.855	\$2.251

Source:
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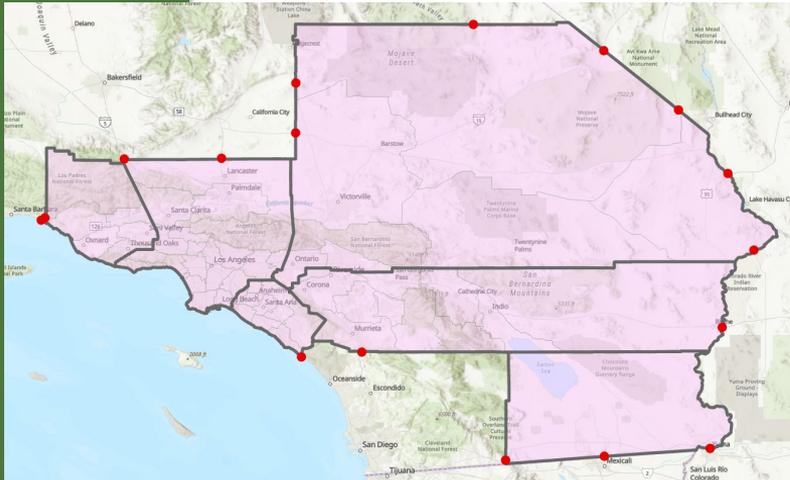
Trucking Cost – Post Pandemic Trends



Average Marginal Costs per Mile	2019	2022	Growth %
Vehicle-based Costs	\$ 0.96	\$ 1.34	41%
Driver-based Costs	\$ 0.74	\$ 0.91	22%
Total Costs	\$ 1.70	\$ 2.25	32%

External Trips

Daily Truck Volume Year 2019



Corridor	LHDT	MHDT	HHDT	Total
CA-101 Ventura	1,328	3,241	2,037	6,606
CA-95	277	146	372	796
I-15 Nevada	555	2,080	7,852	10,487
CA-62 Arizona	2,372	333	533	3,239
I-40	1,179	1,279	6,888	9,346
I-8 Arizona	2,955	602	2,717	6,273
Mexico- east of Calexico	1,178	420	893	2,491
I-8 San Diego	1,413	629	1,406	3,447
I-5 Kern	431	4,204	10,810	15,446
Near 101- Ventura	190	4	-	194
Ca-127 North of San Bernardino	46	99	4	149
CA-58 Kern	1,524	1,494	4,573	7,592
I-10	134	872	9,525	10,532
I-15 San Diego	790	6,666	5,907	13,364
I-5 San Diego	328	5,742	3,242	9,311
CA-14 Kern	1,900	1,627	1,567	5,094
CA-395Kern	12	362	873	1,247
Total	16,613	29,801	59,198	105,613

Calibration and Validation

- Model Calibration at Every Step
- Reasonableness of Trip Generation for Various Land Uses
- VMT Validation by Truck Class
- Assignment Validation (Screenlines) by Truck Class
- Reasonableness of Distribution on Freeways and Arterials

- **Challenge:**

Variance	LHDT	MHDT	HHDT	All Trucks
VMT Targets	40%	16%	44%	100%
Screenline Counts	35%	27%	38%	100%

VMT Summary For Year 2019

2020 RTP

With EMFAC HDT Post Processing

County	LHDT	MHDT	HHDT	Sum
IM	169,804	123,660	763,830	1,057,294
LA	4,313,977	3,505,141	5,305,762	13,124,880
OR	1,349,593	1,416,529	908,505	3,674,627
RV	1,473,394	1,039,418	3,929,035	6,441,847
SB	1,861,625	1,151,847	4,572,523	7,585,995
VN	443,567	280,305	255,167	979,039
SCAG	9,611,960	7,516,900	15,734,823	32,863,682

Without EMFAC HDT Post Processing

County	LHDT	MHDT	HHDT	Sum
IM	190,686	117,053	749,555	1,057,294
LA	2,653,409	2,071,398	8,400,073	13,124,880
OR	796,116	665,951	2,212,560	3,674,627
RV	986,290	757,735	4,697,822	6,441,847
SB	1,148,576	864,563	5,572,856	7,585,995
VN	188,171	156,734	634,134	979,039
SCAG	5,963,248	4,633,434	22,267,000	32,863,682

2024 RTP

TARGET				
County	LHDT	MHDT	HHDT	sum
IM	352,164	78,087	628,942	1,059,194
LA	5,432,178	2,442,377	4,773,989	12,648,543
OR	1,846,539	1,026,851	809,268	3,682,658
RV	1,959,963	681,685	3,433,763	6,075,411
SB	2,457,242	871,256	3,989,465	7,317,963
VN	644,446	211,674	253,942	1,110,062
SCAG	12,692,532	5,311,929	13,889,369	31,893,830

Model #2286				
County	LHD VMT	MHD VMT	HHH VMT	sum
1	296,394	91,236	293,342	680,972
2	5,937,604	2,550,801	5,439,572	13,927,977
3	1,543,253	813,723	1,195,319	3,552,294
4	1,400,450	801,731	2,624,116	4,826,297
5	1,978,081	1,280,624	4,128,629	7,387,333
6	418,706	232,424	271,266	922,395
SCAG	11,574,487	5,770,538	13,952,243	31,297,268

VMT Calibration

2020 RTP- Year 2019 – **without EMFAC HDT Post Processing, TOTAL Trucks**

VMT	LHDT	MHDT	L+M	HHDT	All Trucks
SCAG Region	-49.8%	-5.3%	-36.8%	66.9%	-8.7%

2024 RTP- Year 2019 – Each Truck Class

VMT	LHDT	MHDT	L+M	HHDT	All Trucks
SCAG Region	-8.8%	8.6%	-1.9%	0.5%	-1.9%

Further Investigation and review data for next step:

- The sample size of observed data for the MHDT and LHDT are relatively small
- For MHDT the targets for VMT and screenline counts are in different directions. (The estimated VMT is higher than the Target, but the estimated volume is too low)

Screenlines Validation

- 11 Regional Screenlines
- 24 Sub Regional Screenlines

2020 RTP- Year 2019

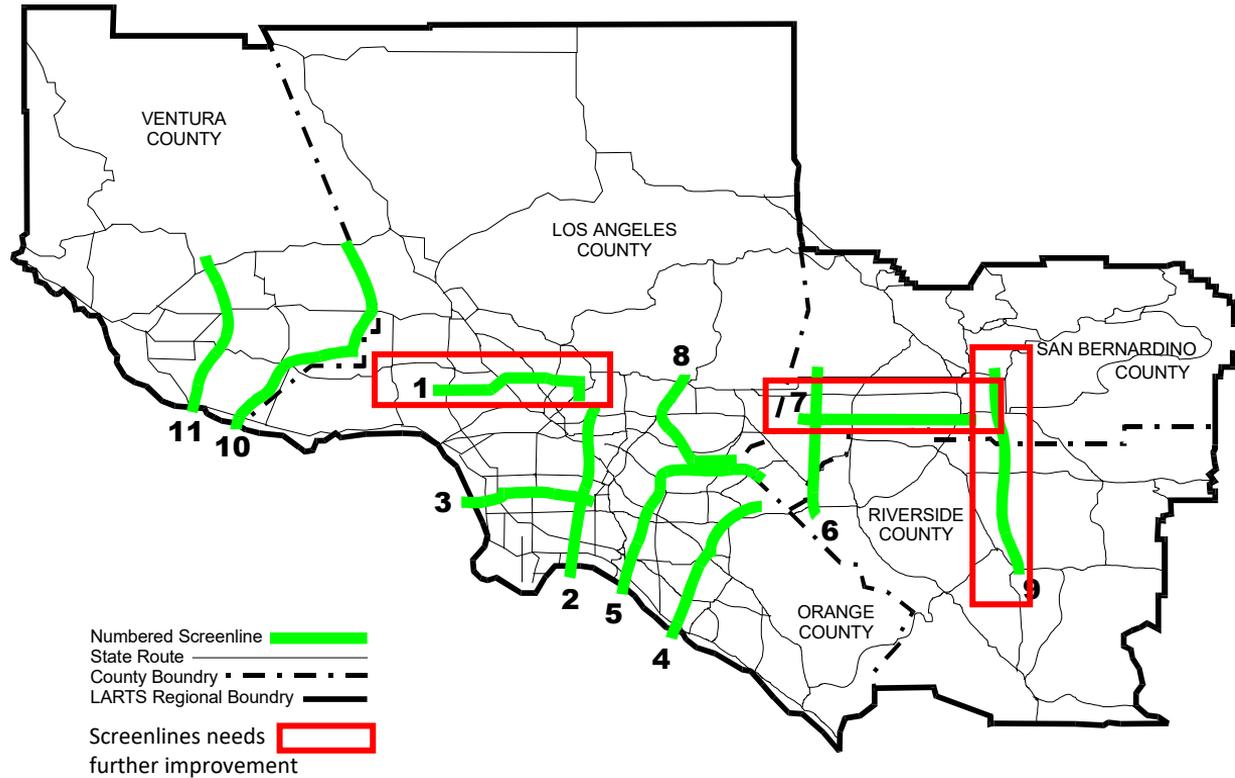
Variance	LHDT	MHDT	L+M	HHDT	All Trucks
Regional Screenlines	-44%	-41%	-43%	91%	4%
Sub-Regional Screenlines	-49%	-48%	-49%	53%	-7%
All	-47%	-44%	-46%	71%	-1%

2024 RTP- Year 2019

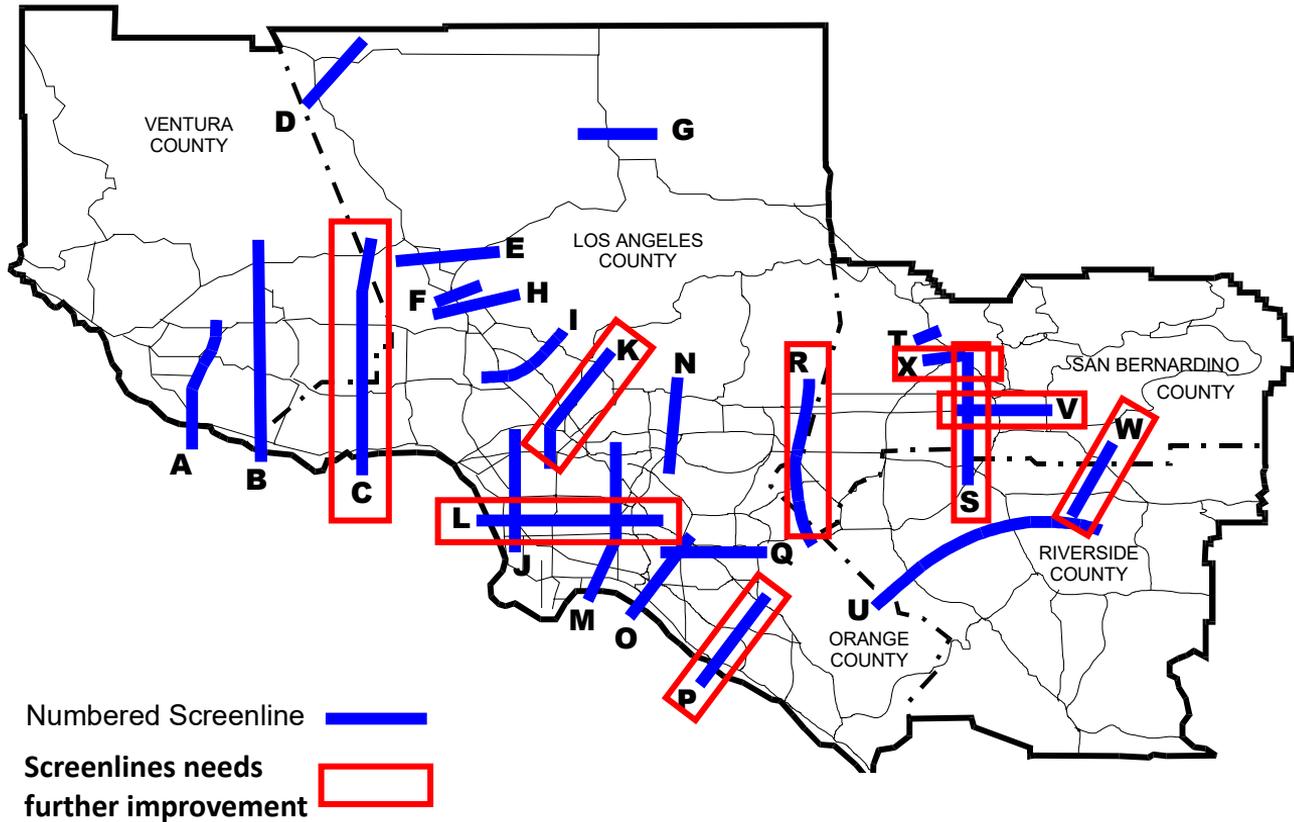
Variance	LHDT	MHDT	L+M	HHDT	All Trucks
Regional Screenlines	10%	-43%	-13%	1%	-8%
Sub-Regional Screenlines	-8%	-38%	-21%	-14%	-18%
All	2%	-41%	-17%	-7%	-13%

*Major Improvements

Regional Model Screenlines

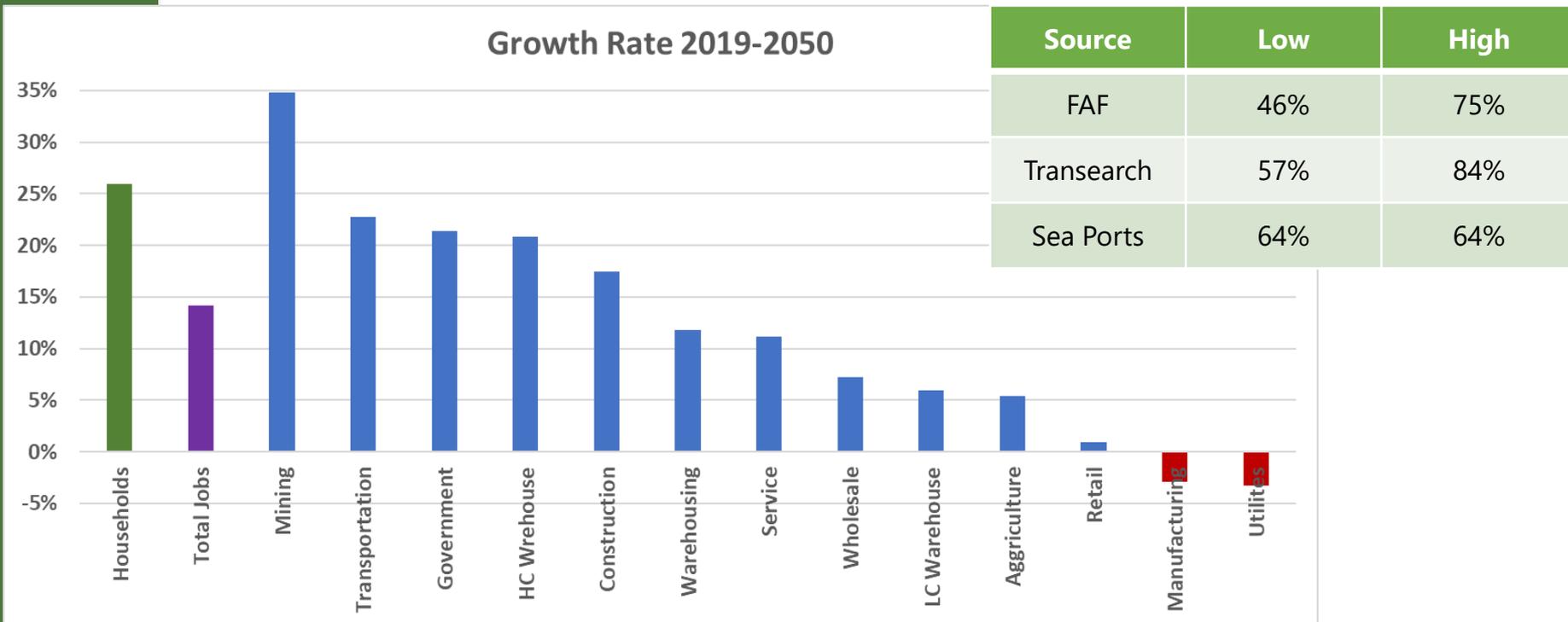


Sub-Regional Model Screenlines



Future Forecast – External Trips Growth rate

Projection Period: 2019 – 2050 in SCAG Region



Source	Low	High
FAF	46%	75%
Transearch	57%	84%
Sea Ports	64%	64%

Next Steps

- Develop trip rates by county / area type
- Investigate Trip length distribution with larger sample
- Establishment survey to collect more information about trip rates
- Improve freeway/ arterial capacity calculation for assignment

Q/A

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