Summary of peer review and revisions to the KernCOG VMIP-2 travel demand model

DKS Associates

For Kern Council of Governments

December 2017

This document was prepared by or under the supervision of the following certified engineers.

Summary of peer review and revisions to the KernCOG VMIP-2 travel demand model

DKS Associates

December 2017

Introduction

This report documents a peer review and revisions by DKS Associates to the Kern County application of the Valley Model Improvement Program version 2 (VMIP-2) to improve its calibration and to address findings from critical peer review.

KernCOG received VMIP-2 from Fehr and Peers in May and June 2017, along with draft versions in the months before. This was a significant revision and improvement of the previous MIP model they delivered in 2012 (and DKS also peer reviewed, revised and recalibrated). Both the new and previous models are advanced four-step travel demand model systems of trip generation, trip distribution, mode choice, and traffic assignment, with nearly all stages recognizing household demographics, auto availability, multiple modes including walk, bike, and transit by walk and by auto access, and explicit models of truck travel demand. Advanced practice features included cross-classified household trip generation, an auto availability model, multi-modal logsum composite travel impedance used in trip distribution and auto availability models, auto-availability user-classes in trip distribution and mode choice, and iteration of the model system with feedback of peak and off-peak travel times due to congestion. VMIP-2 added income-stratification to the Home-Work trip generation and distribution, control of internal-external trip generation by zone, purpose, and scenario, a new highway network derived from a "big data" source, updated census and travel survey data, plus enhancements and simplifications of scenario data spreadsheets and summary analysis processes.

KernCOG's experience and examination of the various drafts of the VMIP-2 prompted them to engage DKS Associates to calibrate the base year, plus review and modify model components and input data as appropriate. The changes to the model from this effort include:

- Household demographic distributions for each of the three unit types (single-family, multi-family, and others) specified by census tract instead of PUMA, and better agreement between household and population data,
- Estimation of the employment type-income relationship from US Census data,
- External data inputs based on the California Statewide Travel Demand Model (CSTDM) Version 2, June 2014,
- Trip generation distinguished by geographic area, with higher rates in the urban areas than small towns and rural areas,
- Redefinition of the user-classes used in mode choice and trip distribution,
- A joint, simultaneous solution for double-constraint in multi-class trip distribution, replacing the previous sequential procedure,
- Reduction of rounding and truncation errors in trip distribution,

- Recalibration of mode choice alternative-specific constants,
- Minor adjustment of time-of-day factors,
- Replacement of the BPR volume-delay functions with the "conical" type, to improve traffic assignments.

Data

Highway network

A new highway master network was provided with VMIP-2, built from a geodatabase with a true shape centerline file. Being new, its coded free-flow speeds (used as a model input) were not entirely self-consistent (e.g. a collector faster than a nearby arterial), or in consistent relationship with speed limits or observed speeds also coded in the network, nor the result of a calibration. The first update was to choose the speed limit (SPD_LIMIT) if one was available, otherwise the highest observed (MAXSPEED) if available, otherwise BASE_SPEED. Speed limits on numerous streets were reviewed in Google StreetView. Arterials and collectors in urban areas were reduced to 5 mph below speed limits, to account implicitly for intersection delays in light traffic. Further adjustments for calibration were made sparingly, deviating no more than 5 mph above or below, and with a review of the alternative speed data fields.

Centroid connector speed was reduced from 30 to 20 mph.

Corrected various errors as found. Activated some roads in the master network that had been excluded from modeling, where appropriate to provide a significant access not already present.

Improvement codings in the master network were specifically chosen for late 2014, seeking consistency with the traffic counts conducted almost entirely within 2014. The Westside Parkway west of Allen, and the widening of the Rosedale Highway, were omitted until after the 2015 base year.

Numerous centroid connectors were relocated, such as removing from major intersections, placing on the correct side of divided roads, and otherwise improving their representation of access patterns.

External links were added to the Los Angeles County gateways. Specifically, I-5 and SR 14 were extended south to their junction, and SR 138 added to connect them just outside Kern County. These extensions better represent the route options for trips such as between Bakersfield and Lancaster, and between Mojave Desert communities and Los Angeles. Without these external links, these travel movements had no choice but to use SR 58 across the mountains. (Note that the assigned traffic volumes on these links do not necessarily correspond to their complete real-world volumes.)

Transit network

KernCOG supplied transit line files based on recent revisions by DKS and KernCOG, with a preliminary attempt to conform to the links and nodes of the new highway network. These had to be further revised where the wrong node of two or more coincident nodes had been chosen, or where routed onto streets that don't exist in the highway network for the respective year.

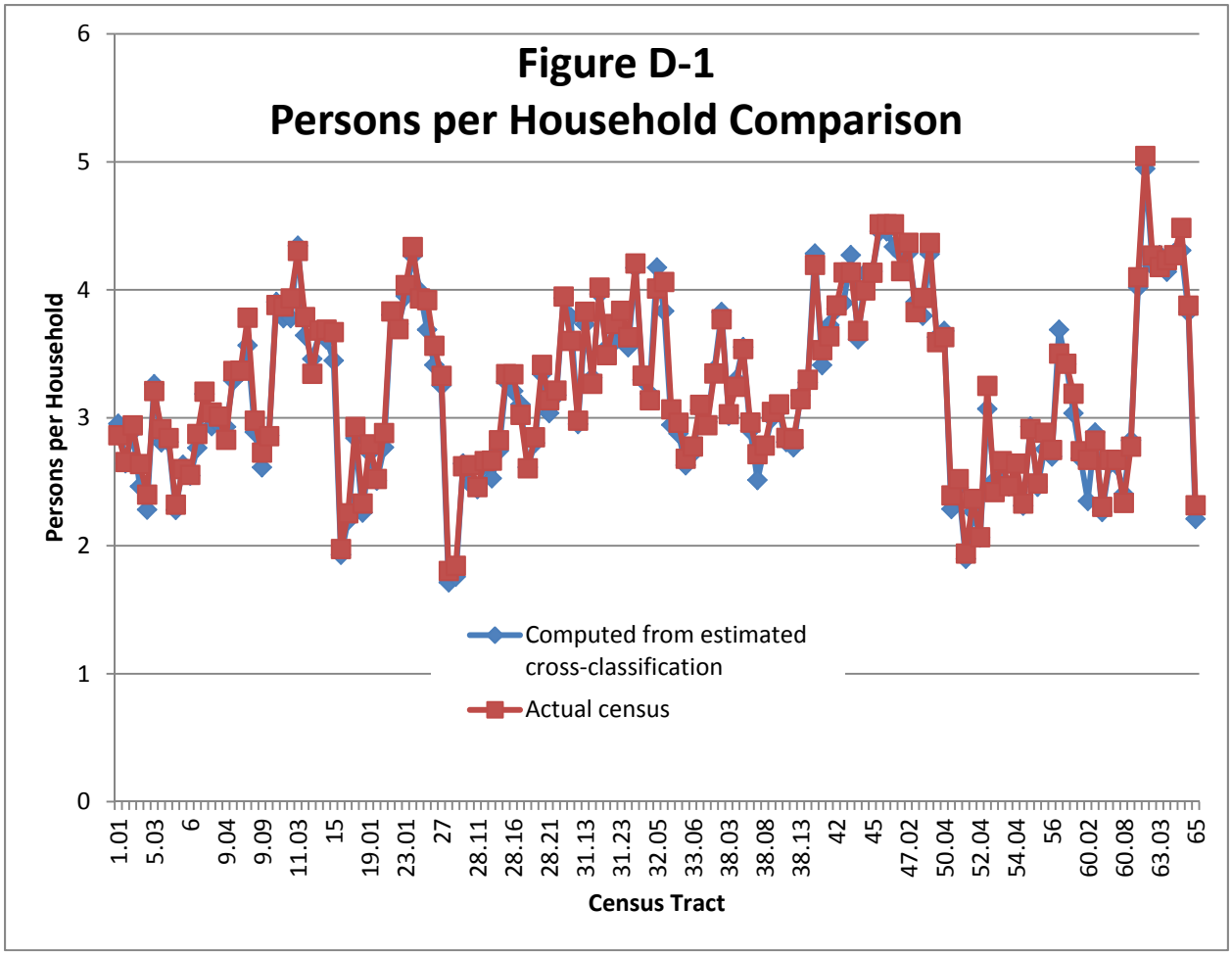
Non-highway "block" coding revised by DKS in 2016 were incorporated into this model.

Demographics

The model inputs households by TAZ cross-classified by unit type, household size, and income category. VMIP-2 as given specified the split factors for each PUMA, of which Kern County has five, but this is the smallest geographic unit for which this multi-dimensioned classification is available directly from the Census.

New split factors were estimated for each of the 151 census tracts in Kern County, using an iterative proportional fitting (IPF) method of reweighting PUMS records (for the PUMA containing the respective tract) to conform to one-dimensional (marginal) census estimates by household size (5 categories), age of householder (4 categories), and income (5 categories) available at census tract geography. Tracts with small numbers of housing units of a given type were merged with neighboring tracts, to avoid spurious effects of small samples. The result was expressed as shares of each housing type (SF, MF, MH) in each tract, and entered into a lookup for the ScenarioPrep workbook's CrossClassRates tables for the household size by income cross-classification, and the age category of head-of-household. (The age ranges of head-of-household was revised, due the census data available, to 15-24, 25-44, 56-64, 65+.)

From an estimated cross-classification on household size by income, the population can be approximately inferred. For the 5-or-more persons categories, an assumed size of 6.5 yields a fair approximation of the actual number of people. Figure D-1 compares the inferred persons per household to the actual reported by the Census, showing a reasonable but not perfect agreement between them, and a confirmatory indication for the IPF estimation.



Another IPF was performed upon population in categories of housing unit type and age, yielding CrossClassRates split factors for the population into age groups.

The *2015–2050 Growth Forecast Update* (KernCOG and PlaceWorks, August 2015) estimates trends into future years of persons per household, and age. The base year, and future years' demographic splits were conformed to these, by way of an additional IPF-like calculation. Specifically, the split factors were weighted by a factor 1 + *nf* and renormalized, where *n* is people per household in the classification, and *f* is a factor solved to match the expected countywide persons per household of the housing unit type, in Table D-1.

Table D-1
Persons per household by unit type

Year	SF	MF	MH
2015	3.36	2.77	2.59
2020	3.42	2.83	2.62
2035	3.41	2.88	2.61
2042	3.342	2.838	2.55

Source: PlaceWorks & KernCOG, *2015-2050 Growth Forecast Update*, August 2015, Table 18
Note: 2042 is interpolated between forecasts for 2040 and 2045.

Employment

A few spot adjustments were made to employment data.

- The boundary among zones 248, 249, 254 was adjusted. Zone 254 consisted of a CSU campus, a hospital, and a large office complex (State Farm), the college having distinctly different street access than the hospital and office complex. As revised, the new zone 248 combines the former 248 and 249, the new 249 takes the hospital and office complex, and the new 254 remains mainly the college campus.
- 4614 government employmees in zone 1994 appeared overestimated. The main govermnent employer there is the county sheriff. Their own website indicates they employ "over 1400 people." Zone 2243's 1204 government employees also appears overestimated, compared to another source indicating 336 detention deputies. Government employment in both of these zones was reduced closer to these lower alternatives.
- Reduced employment of large packing plants in zones 2067 (Wonderful Pistachios in Lost Hills) and 2112 (Grimmway near Arvin).
- KernCOG reviewed and adjusted employment data throughout the region in response to these tentative changes by DKS.

Gateway volumes, trip generation, external fractions, thru trips

The California Statewide Travel Demand Model 2 for years 2010 and 2040 were the basis of auto and truck through trip matrices, IX and XI trip generation, and external fractions for trips in 13 districts in Kern County. The year-specific trends of this model were deemed unreliable, so the average of their travel demand between the two years was adjusted for the KernCOG model base year (2015) and future years.

Being a tour-based model, trips are given in a set of trip-list files. These were aggregated into trip matrices by trip purpose (and home-work stratified by income), then assigned to the network with a subarea extraction procedure, Kern County as the subarea.

The raw subarea extractions for 2010 and 2040 were averaged, then the average was factored with an IPF (or Fratar) procedure to match gateway traffic volume estimates for 2015 and 2035. Table X-1 shows these traffic volume estimates.

Table X-1
Gateway traffic volume estimates
(Used as targets in data preparation, not exactly matched by model output)

Kern MIP Gateway	Location	2015 Daily Total	2015 Truck	2035 Daily Total	2035 Truck
61	SR 33 (N)	1,825	488	3,105	830
62	Barker (Baker)	12	2	14	2
63	King Rd	390	131	488	164
64	I-5 (N)	29,242	9,439	37,026	11,952
65	Corcoran/Dairy	619	98	1,335	211
66	Road 40 (Rowlee), Road 80 (Scofield)	66	3	9,048	411
67	SR 43	2,843	460	3,557	575
68	Roads 128 + 136	1,741	99	2,178	124
69	SR 99	46,874	10,451	59,282	13,218
82	Road 144 (Girard)	2,764	119	4,340	187
70	Roads 152 + 156	859	17	1,236	25
83	Rd 160 (Veneto/Bowman)	786	55	1,056	74
85	Road 192	1,470	116	2,060	163
71	Famoso-Porterville (Richgrove)	4,790	496	5,172	536
72	SR 65	6,294	1,429	7,300	1,657
73	Jack Ranch	281	28	582	58
74	Sierra Way	945	98	1,254	130
29	SR 395 (N)	5,282	696	5,845	770
30	SR 178	2,570	192	4,017	300
75	Searles Sta. Cutoff	253	39	253	39
31	US 395 (S)	3,914	523	4,940	660
76	Randsburg Cutoff + 20 M.T.Pkwy	579	40	899	62
32	SR 58 (E)	13,135	6,291	20,111	9,632
77	20 Mule Team Rd in Boron	1,075	91	1,675	142
81	Lancaster Bl (Redman Rd, 120thE)	4,987	923	6,031	1,116
33	Sierra Hwy	3,030	189	5,045	315
84	(unused, next to SR 14)	0	0	0	0
34	SR 14	35,393	1,765	51,620	2,574
35	60th St West	1,667	119	2,455	175
36	90th St West	1,185	86	1,675	122
78	170th St West	641	44	1,068	74
37	I-5 (S)	65,000	17,315	90,053	23,989
38	Lockwood Valley Rd (Mt Pinos)	1,772	409	2,829	653
39	SR 33 (S)	3,135	1,000	3,563	1,137
79	Soda Lake	26	3	33	3
40	SR 58 (W)	141	25	235	42
80	Bitterwater Valley Rd	41	4	41	4
41	SR 46	6,602	1,857	9,717	2,733

Traffic counts

Fixed typos evidenced by ≠ 2 records for a CountID.

Added counts on SR 178 downtown, mid-2015, from the KernCOG web site's interactive traffic count map.

Models

General

The starting version of the VMIP-2 Cube catalog-app-script system from which based was furnished by Fehr and Peers on 6/15/2017. (Previous DKS edits to other versions were repeated onto that version.)

Incorporated "Beyond Model Travel" module (from F&P, June 2017) into the SB 375 summaries.

Updated accident rate keys to new values specified by KernCOG.

Added a report {scenario dir}_Num_Zones_Connected.csv, reporting the number of zones accessible from each zone, and to each zone. This was useful in diagnosing unusual zone-connection problems not evident in {scenario dir}_UnconnectedZones.txt, such as two or more zones connected among each other, but not to the rest of the network.

Input data spreadsheets were not built from F&P's latest. They do not have export macros (at least, none visible). Tabs to export are now highlighted.

Trip Generation

VMIP-2 added a specification of external fractions for all TAZs in district groups. These are the fraction for each trip purpose's productions in the zone that must distribute to gateway attractions (IX), and similarly for zonal attractions to gateway productions (XI). As given, the districts consisted of each incorporated city, plus a single district for the unincorporated area, as shown in Table TG-1. The revision, in Table TG-2, is applied in 14 contiguous and compact districts of Kern County. (Most consist of one or more cities plus nearby unincorporated areas.) Preliminary external fractions were computed from the California Statewide Travel Demand Model, then adjusted in consideration of P-A balance and gateway traffic volumes.

Table TG-1 (a)
External Fractions as given

Jurisdiction	Home-Work Hi-Inc IX	Home-Work Hi-Inc XI	Home-Work Mid-Inc IX	Home-Work Mid-Inc XI	Home-Work Low-Inc IX	Home-Work Low-Inc XI	Home-Shop IX	Home-Shop XI
Arvin	4.8%	12.3%	5.5%	4.5%	4.9%	3.0%	0.0%	1.0%
Bakersfield	6.1%	1.6%	1.4%	0.9%	0.3%	1.1%	0.4%	1.3%
California City	4.8%	12.3%	5.5%	4.5%	4.9%	3.0%	4.6%	1.0%
County	4.8%	12.3%	5.5%	4.5%	4.9%	3.0%	4.6%	1.0%
Delano	4.8%	12.3%	5.5%	4.5%	4.9%	3.0%	0.6%	0.0%
Maricopa	4.8%	12.3%	5.5%	4.5%	4.9%	3.0%	4.6%	1.0%
McFarland	4.8%	12.3%	5.5%	4.5%	4.9%	3.0%	4.6%	1.0%
Ridgecrest	0.0%	0.0%	5.5%	3.8%	4.9%	3.0%	7.7%	2.6%
Shafter	4.8%	12.3%	5.5%	4.5%	4.9%	3.0%	4.6%	1.0%
Taft	4.8%	12.3%	5.5%	4.5%	4.9%	3.0%	4.6%	1.0%
Tehachapi	4.8%	12.3%	5.5%	4.5%	4.9%	3.0%	4.6%	1.0%
Wasco	4.8%	12.3%	5.5%	4.5%	4.9%	3.0%	4.6%	1.0%
Unincorporated	6.3%	32.9%	7.2%	15.9%	15.4%	3.1%	10.8%	0.1%

Table TG-1 (b)
External Fractions as given (continued)

Jurisdiction	Home-School IX	Home-School XI	Home-College IX	Home-College XI	Home-Other IX	Home-Other XI	Work-Other IX	Work-Other XI	Other-Other IX	Other-Other XI
Arvin	0.0%	0.0%	0.9%	1.0%	0.0%	0.3%	3.6%	2.4%	3.5%	4.3%
Bakersfield	0.0%	0.0%	0.0%	1.2%	2.5%	1.5%	1.1%	1.3%	1.1%	0.7%
California City	0.0%	3.1%	0.9%	1.0%	59.5%	4.0%	3.6%	2.4%	3.5%	4.3%
County	0.0%	3.1%	0.9%	1.0%	2.8%	4.0%	3.6%	2.4%	3.5%	4.3%
Delano	0.0%	1.3%	0.9%	1.0%	1.5%	1.8%	3.6%	2.4%	12.1%	4.3%
Maricopa	0.0%	3.1%	0.9%	1.0%	2.8%	4.0%	3.6%	2.4%	3.5%	4.3%
McFarland	0.0%	3.1%	0.9%	1.0%	3.0%	4.0%	3.6%	2.4%	3.5%	4.3%
Ridgecrest	0.0%	3.1%	0.9%	1.0%	3.2%	18.4%	0.0%	0.0%	0.0%	1.4%
Shafter	0.0%	3.1%	0.9%	1.0%	0.0%	0.0%	3.6%	2.4%	3.5%	4.3%
Taft	0.0%	3.1%	0.9%	1.0%	2.8%	0.0%	3.6%	2.4%	3.5%	4.3%
Tehachapi	0.0%	3.1%	0.9%	1.0%	0.0%	0.0%	3.6%	2.4%	3.5%	4.3%
Wasco	0.0%	3.1%	0.9%	1.0%	0.0%	7.1%	3.6%	2.4%	3.5%	4.3%
Unincorporated	0.0%	13.7%	0.9%	1.0%	3.5%	4.9%	8.8%	4.6%	9.2%	11.2%

Table TG-2 (a)
2015 External Fractions as revised

District	Home-Work Hi-Inc IX	Home-Work Hi-Inc XI	Home-Work Mid-Inc IX	Home-Work Mid-Inc XI	Home-Work Low-Inc IX	Home-Work Low-Inc XI	Home-Shop IX	Home-Shop XI
1_Lost Hills	42.7%	18.2%	45.5%	15.5%	40.7%	12.6%	5.8%	2.8%
2_Delano	56.7%	39.2%	49.5%	26.5%	43.7%	27.2%	5.5%	13.8%
3_Taft	10.6%	13.3%	16.0%	4.2%	3.9%	1.1%	0.6%	0.1%
4_HwyComm	51.8%	34.1%	58.9%	14.6%	55.4%	10.8%	14.0%	50.0%
4_South County	51.8%	34.1%	58.9%	14.6%	55.4%	10.8%	14.0%	3.0%
5_Tehachapi	16.7%	17.7%	16.4%	7.4%	6.8%	2.8%	1.3%	0.3%
6_California City	53.8%	25.6%	50.2%	11.6%	29.5%	5.2%	4.9%	0.4%
7_Rosamond	83.7%	76.4%	77.3%	52.2%	70.1%	29.7%	43.9%	9.7%
8_Sierras	18.8%	8.3%	19.4%	2.2%	9.4%	0.7%	0.7%	0.2%
9_Ridgecrest	12.2%	10.6%	8.2%	10.5%	4.0%	8.9%	0.1%	7.8%
10_Bakersfield	5.5%	4.9%	4.0%	2.5%	1.7%	1.7%	0.0%	0.2%
11_Shafter_Wasco	20.2%	11.5%	17.1%	6.3%	11.0%	6.1%	0.5%	1.1%
12_Arvin_Lamont	5.7%	6.5%	6.7%	2.7%	2.3%	1.8%	0.2%	0.2%
13_Mojave	51.6%	63.6%	48.1%	36.9%	38.6%	22.3%	9.3%	4.1%

Table TG-2 (b)
2015 External Fractions as revised (continued)

District	Home-School IX	Home-School XI	Home-College IX	Home-College XI	Home-Other IX	Home-Other XI	Work-Other IX	Work-Other XI	Other-Other IX	Other-Other XI
1_Lost Hills	7.2%	1.1%	20.3%	6.0%	10.7%	4.7%	12.0%	22.9%	2.2%	2.2%
2_Delano	0.9%	5.3%	4.5%	11.9%	7.6%	17.6%	17.1%	25.6%	8.0%	8.0%
3_Taft	2.7%	0.1%	6.2%	3.4%	2.6%	1.3%	4.2%	4.8%	0.2%	0.2%
4_HwyComm	3.0%	0.3%	19.9%	40.1%	15.3%	50.0%	25.4%	17.4%	50.0%	50.0%
4_South County	3.0%	0.3%	19.9%	40.1%	15.3%	6.0%	25.4%	17.4%	10.0%	10.0%
5_Tehachapi	0.9%	0.2%	27.9%	0.5%	3.2%	1.3%	5.8%	4.0%	0.2%	0.2%
6_California City	4.8%	0.4%	23.2%	0.5%	7.2%	1.2%	10.8%	4.5%	0.4%	0.4%
7_Rosamond	7.8%	1.8%	41.1%	10.9%	41.2%	15.1%	50.1%	20.2%	19.9%	19.9%
8_Sierras	2.9%	0.2%	5.3%	1.6%	4.4%	1.9%	4.3%	3.4%	0.2%	0.2%
9_Ridgecrest	0.0%	3.9%	0.2%	7.7%	3.4%	11.2%	2.5%	5.8%	1.2%	1.2%
10_Bakersfield	0.0%	0.1%	0.4%	2.2%	1.5%	1.0%	1.9%	2.7%	0.1%	0.1%
11_Shafter_Wasco	0.9%	5.3%	2.8%	0.8%	1.7%	2.2%	3.4%	6.6%	0.3%	0.3%
12_Arvin_Lamont	3.0%	0.3%	4.0%	0.3%	1.4%	0.8%	4.7%	4.7%	0.2%	0.2%
13_Mojave	7.8%	1.8%	46.4%	3.0%	13.6%	7.1%	30.8%	9.0%	4.0%	4.0%

One district was created for the highway commercial and factory outlet area around I-5 at Wheeler Ridge; some of its external factors are shared with the South County district, while H-Shop, H-Other, and Other-Other attractions are set to 50% to represent a large share coming from the Los Angeles area.

External fractions are decreased across-the-board in future years, as shown in Table TG-3, so that gateway traffic does not grow faster than trends, independent projections, or much faster than population in adjacent counties.

Table TG-3
External Fraction multipliers for future years

Forecast Year	H-Shop and H-Other XI (Except 4_HwyComm)	All others
2020	0.958	0.975
2035	0.832	0.90
2042	0.778	0.865

The VMIP-2 model applies Home-based Work trip generation and distribution in three household income strata. This technique promotes trip distribution to match attractions by workers of low, medium, and high wage with productions from households of respectively low, medium, and high incomes.

US Census LEHD data reported wage distributions of each employment category, in similar categories to those used in the model. Figure TG-1 graphs these distributions for Kern County in the form of a cumulative distribution for each employment class. To better balance with productions, the wage boundaries were shifted to match the 35th and 72nd percentile of total workers in all jobs (i.e. $2000 and $4400/month). Reading the percentiles of individual employment classes at those wages, and taking successive differences, yields the wage distributions in Table TG-4.

Figure TG-1

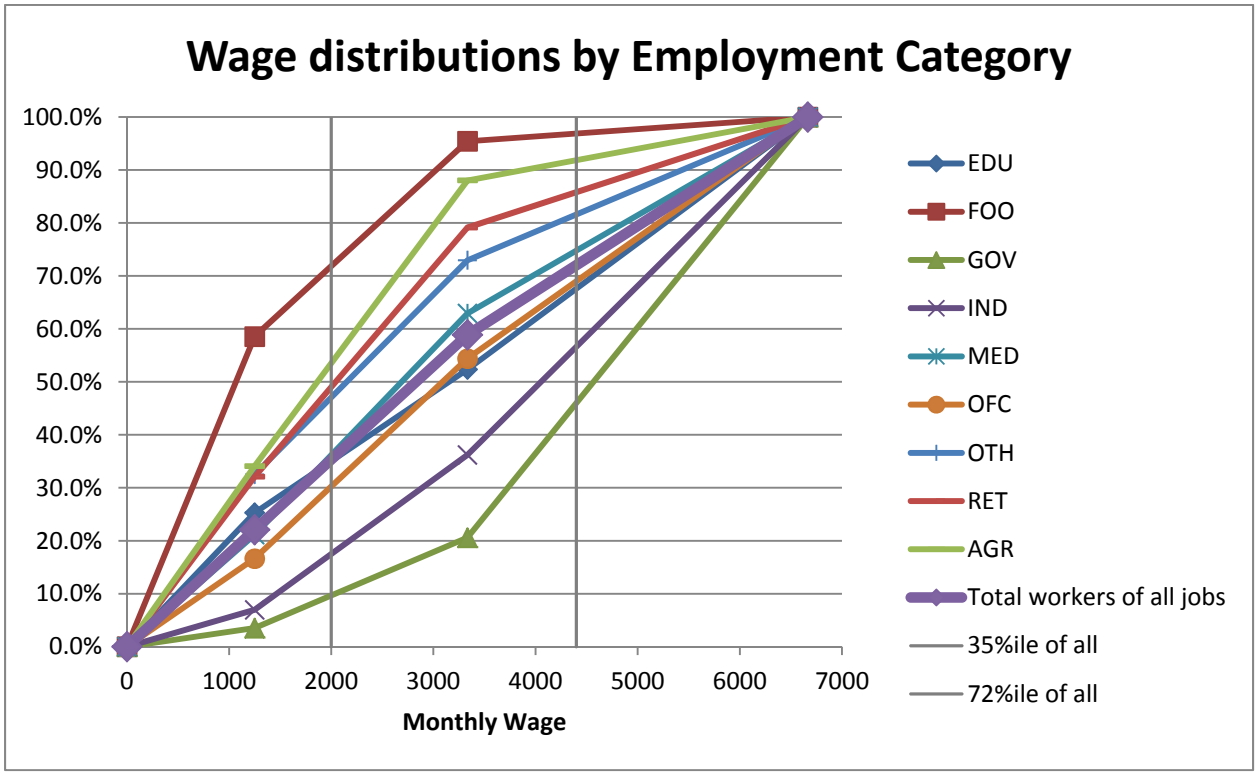


Table TG-4
Wage distributions derived from US Census LEHD, interpolated for compatibility with VMIP-2 household income strata

Employment Category	High	Med	Low
EDU	33%	32%	35%
FOO	3%	24%	73%
GOV	55%	36%	9%
IND	44%	40%	16%
MED	25%	39%	36%
OFC	31%	39%	30%
OTH	18%	35%	47%
RET	14%	47%	39%
AGR	4%	41%	55%

Of course, worker wages don't directly equate to household income, so the assumed compatibility between worker wage and household income is only approximate.

Trip production rates as applied were significantly changed from those reported from the 2012 California Household Travel Survey (2012 CHTS). Reviewing the 2012 CHTS data files, DKS developed a least-squares-error estimation of household trip production rates in the 2012 CHTS with:

- Households in Kern County,
- Constraints imposed upon the trends of successive cells, so that, for example, one more person in a household doesn't result in fewer trips generated,
- Simultaneous estimation of side-factors (which multiply all the rates, controlling for the persons-by-income class) for (a) home-work productions if householder is age 65 or over, and (b) the PlaceType zonal variable for the plurality of people living in the household's census tract.

Table TG-5
Person-trip production rates estimated from 2012 California Household Travel Survey

Home-Work

HH Size	Income Class 1 (low)	Income Class 2	Income Class 3	Income Class 4	Income Class 5 (high)
1	0.478	1.230	1.538	1.660	1.781
2	0.956	1.382	1.683	1.871	2.058
3	1.434	1.534	1.828	2.082	2.335
4	1.825	1.658	1.947	2.255	2.562
5+	1.825	1.658	1.947	2.255	2.562
Multiplier if householder age 65 or up:			0.447		
Multiplier if in PlaceType 1:			0.759		

Home-Shop

HH Size	Income Class 1 (low)	Income Class 2	Income Class 3	Income Class 4	Income Class 5 (high)
1	0.413	0.413	0.414	0.307	0.199
2	0.825	0.766	0.706	0.552	0.399
3	1.238	1.118	0.998	0.798	0.598
4	1.651	1.470	1.290	1.044	0.798
5+	2.063	1.822	1.581	1.289	0.997
Multiplier if in PlaceType 1:			0.969		

Home-Other

HH Size	Income Class 1 (low)	Income Class 2	Income Class 3	Income Class 4	Income Class 5 (high)
1	1.130	1.463	1.796	1.753	1.710
2	2.260	2.925	3.591	3.506	3.421
3	3.389	4.388	5.387	5.259	5.131
4	4.519	5.851	7.183	7.012	6.841
5+	5.649	7.314	8.978	8.765	8.552
Multiplier if in PlaceType 1:			0.699		
Multiplier if in PlaceType 2 or 3:			0.745		

For calibration, the urban-rural multipliers were replaced with factors in Table TG-6. The factors for PlaceTypes 2, 3, and 4 gradually transition from the most rural toward the urban factor.

Table TG-6
Trip production factors by PlaceType zonal attribute

PlaceType	Home-Work	Home-Shop	Home-Other
1 (most rural)	0.83	0.77	0.70
2	0.96	0.78	0.71
3	1.01	0.80	0.73
4	1.05	0.81	0.74
5 (urban)	1.09	1.13	1.04

The trip generation geographic variable was changed from the computed area type "Atype", to a fixed place type (field PlaceType in the SED) which doesn't change in future years. The computed Atype was a step-function of the number of employees plus working-age residents within 30 minutes by auto. The step-function nature of this variable had an unintended result – that some whole cities and large areas rose a level from base to future years, causing a large jump in trip generation. Being a discrete categorical variable meant this caused an abrupt "cliff effect". The new PlaceType is based on Atype computed from a 2015 model, then adjusted the Rosamond area (the computation not accounting for LA County), and adjusted consistency of the zones in each city to be one type (usually the type of the majority of zones therein).

Attraction rates were also adjusted for reasonableness, calibration, and P-A balance. Table TG-7 lists the attractions, and the remaining trip production rates not determined from Tables TG-5 and TG-6.

Table TG-7
Attractions and other trip production rates

Area Type	LU_Type	HK_P	HC_P	WO_P	OO_P	HW_A	HS_A	HK_A	HC_A	HO_A	WO_A	OO_A
1	all households									0.37*HO_P		
1	POP0004	0	0	0	0	0	0	0	0	0	0	0
1	POP0514	1.1	0	0	0	0	0	0	0	0	0	0
1	POP1517	1.1	0	0	0	0	0	0	0	0	0	0
1	POP1824	0.19	0.24	0	0	0	0	0	0	0	0	0
1	POP2554	0	0.04	0	0	0	0	0	0	0	0	0
1	POP5564	0	0.009	0	0	0	0	0	0	0	0	0
1	POP6574	0	0.009	0	0	0	0	0	0	0	0	0
1	POP75	0	0.009	0	0	0	0	0	0	0	0	0
1	EMPEDU	0	0	0.89	0.39	1.42	0	0	0	0	0	0.57
1	EMPFOO	0	0	0.8	7.7	1.42	2.8	0	0	5.08	2.62	7.47
1	EMPGOV	0	0	0.89	0.39	1.42	0	0	0	0	0.36	0.57
1	EMPIND	0	0	0.89	0.39	1.42	0	0	0	0	0.36	0.57
1	EMPMED	0	0	0.89	1.1	1.42	0	0	0	3.58	1.07	1.14
1	EMPOFC	0	0	0.89	0.39	1.42	0	0	0	1.79	0.36	0.57
1	EMPOTH	0	0	0.89	0.39	1.42	0	0	0	0.61	0.24	0.57
1	EMPRET	0	0	0.8	7.7	1.42	6	0	0	4.54	2.38	7.47
1	EMPAGR	0	0	0	0	0.95	0	0	0	0	0	0
1	ELEM	0	0	0	0.22	0	0	1.1	0	0.74	0.47	0.092
1	HS	0	0	0	0.22	0	0	1.1	0	0.74	0.47	0.092
1	COLLEGE	0	0	0	0	0	0	0	0.8	0	0	0
Area Type	LU_Type	HK_P	HC_P	WO_P	OO_P	HW_A	HS_A	HK_A	HC_A	HO_A	WO_A	OO_A
2	all households									0.37*HO_P		
2	POP0004	0	0	0	0	0	0	0	0	0	0	0
2	POP0514	1.1	0	0	0	0	0	0	0	0	0	0
2	POP1517	1.1	0	0	0	0	0	0	0	0	0	0
2	POP1824	0.06	0.24	0	0	0	0	0	0	0	0	0
2	POP2554	0	0.04	0	0	0	0	0	0	0	0	0
2	POP5564	0	0.009	0	0	0	0	0	0	0	0	0
2	POP6574	0	0.009	0	0	0	0	0	0	0	0	0
2	POP75	0	0.009	0	0	0	0	0	0	0	0	0
2	EMPEDU	0	0	0.90	0.39	1.42	0	0	0	0	0	0.57
2	EMPFOO	0	0	0.81	7.7	1.42	2.8	0	0	5.25	2.62	7.47
2	EMPGOV	0	0	0.90	0.39	1.42	0	0	0	0	0.36	0.57
2	EMPIND	0	0	0.90	0.39	1.42	0	0	0	0	0.36	0.57
2	EMPMED	0	0	0.90	1.1	1.42	0	0	0	3.72	1.07	1.14
2	EMPOFC	0	0	0.90	0.39	1.42	0	0	0	1.86	0.36	0.57
2	EMPOTH	0	0	0.90	0.39	1.42	0	0	0	0.63	0.24	0.57
2	EMPRET	0	0	0.81	7.7	1.42	7	0	0	4.73	2.38	7.47
2	EMPAGR	0	0	0	0	0.95	0	0	0	0	0	0
2	ELEM	0	0	0	0.22	0	0	1.1	0	0.743	0.47	0.092
2	HS	0	0	0	0.22	0	0	1.1	0	0.743	0.47	0.092
2	COLLEGE	0	0	0	0	0	0	0	0.8	0	0	0

Table TG-7, continued

Attractions and other trip production rates

Area Type	LU_Type	HK_P	HC_P	WO_P	OO_P	HW_A	HS_A	HK_A	HC_A	HO_A	WO_A	OO_A
3	all households									0.37*HO_P		
3	POP0004	0	0	0	0	0	0	0	0	0	0	0
3	POP0514	1.1	0	0	0	0	0	0	0	0	0	0
3	POP1517	1.1	0	0	0	0	0	0	0	0	0	0
3	POP1824	0.06	0.24	0	0	0	0	0	0	0	0	0
3	POP2554	0	0.04	0	0	0	0	0	0	0	0	0
3	POP5564	0	0.009	0	0	0	0	0	0	0	0	0
3	POP6574	0	0.009	0	0	0	0	0	0	0	0	0
3	POP75	0	0.009	0	0	0	0	0	0	0	0	0
3	EMPEDU	0	0	0.90	0.39	1.42	0	0	0	0	0	0.57
3	EMPFOO	0	0	0.81	7.7	1.42	2.8	0	0	5.25	2.62	7.47
3	EMPGOV	0	0	0.90	0.39	1.42	0	0	0	0	0.36	0.57
3	EMPIND	0	0	0.90	0.39	1.42	0	0	0	0	0.36	0.57
3	EMPMED	0	0	0.90	1.1	1.42	0	0	0	3.72	1.07	1.14
3	EMPOFC	0	0	0.90	0.39	1.42	0	0	0	1.86	0.36	0.57
3	EMPOTH	0	0	0.90	0.39	1.42	0	0	0	0.63	0.24	0.57
3	EMPRET	0	0	0.81	7.7	1.42	7	0	0	4.73	2.38	7.47
3	EMPAGR	0	0	0	0	0.95	0	0	0	0	0	0
3	ELEM	0	0	0	0.22	0	0	1.1	0	0.743	0.47	0.092
3	HS	0	0	0	0.22	0	0	1.1	0	0.743	0.47	0.092
3	COLLEGE	0	0	0	0	0	0	0	0.8	0	0	0
Area Type	LU_Type	HK_P	HC_P	WO_P	OO_P	HW_A	HS_A	HK_A	HC_A	HO_A	WO_A	OO_A
4	all households									0.37*HO_P		
4	POP0004	0	0	0	0	0	0	0	0	0	0	0
4	POP0514	1.1	0	0	0	0	0	0	0	0	0	0
4	POP1517	1.1	0	0	0	0	0	0	0	0	0	0
4	POP1824	0.06	0.24	0	0	0	0	0	0	0	0	0
4	POP2554	0	0.04	0	0	0	0	0	0	0	0	0
4	POP5564	0	0.009	0	0	0	0	0	0	0	0	0
4	POP6574	0	0.009	0	0	0	0	0	0	0	0	0
4	POP75	0	0.009	0	0	0	0	0	0	0	0	0
4	EMPEDU	0	0	0.91	0.39	1.42	0	0	0	0	0	0.57
4	EMPFOO	0	0	0.82	7.7	1.42	2.8	0	0	5.25	2.62	7.47
4	EMPGOV	0	0	0.91	0.39	1.42	0	0	0	0	0.36	0.57
4	EMPIND	0	0	0.91	0.39	1.42	0	0	0	0	0.36	0.57
4	EMPMED	0	0	0.91	1.1	1.42	0	0	0	3.72	1.07	1.14
4	EMPOFC	0	0	0.91	0.39	1.42	0	0	0	1.86	0.36	0.57
4	EMPOTH	0	0	0.91	0.39	1.42	0	0	0	0.63	0.24	0.57
4	EMPRET	0	0	0.82	7.7	1.42	7	0	0	4.73	2.38	7.47
4	EMPAGR	0	0	0	0	0.95	0	0	0	0	0	0
4	ELEM	0	0	0	0.22	0	0	1.1	0	0.743	0.47	0.092
4	HS	0	0	0	0.22	0	0	1.1	0	0.743	0.47	0.092
4	COLLEGE	0	0	0	0	0	0	0	0.8	0	0	0

Table TG-7, continued
Attractions and other trip production rates

Area Type	LU_Type	HK_P	HC_P	WO_P	OO_P	HW_A	HS_A	HK_A	HC_A	HO_A	WO_A	OO_A
5	all households									0.37*HO_P		
5	POP0004	0	0	0	0	0	0	0	0	0	0	0
5	POP0514	1.1	0	0	0	0	0	0	0	0	0	0
5	POP1517	1.1	0	0	0	0	0	0	0	0	0	0
5	POP1824	0.06	0.32	0	0	0	0	0	0	0	0	0
5	POP2554	0	0.05	0	0	0	0	0	0	0	0	0
5	POP5564	0	0.02	0	0	0	0	0	0	0	0	0
5	POP6574	0	0.01	0	0	0	0	0	0	0	0	0
5	POP75	0	0.01	0	0	0	0	0	0	0	0	0
5	EMPEDU	0	0	1.02	0.39	1.42	0	0	0	0	0	0.57
5	EMPFOO	0	0	0.925	8.125	1.42	2.5	0	0	4.94	2.38	7.895
5	EMPGOV	0	0	1.02	0.4	1.42	0	0	0	1.75	0.32	0.59
5	EMPIND	0	0	1.02	0.41	1.42	0	0	0	0	0.32	0.59
5	EMPMED	0	0	1.02	1.26	1.42	0	0	0	3.52	0.95	1.3
5	EMPOFC	0	0	1.02	0.465	1.42	0	0	0	1.75	0.32	0.645
5	EMPOTH	0	0	1.02	0.4	1.42	0	0	0	0.61	0.24	0.58
5	EMPRET	0	0	0.925	8.455	1.42	6.05	0	0	4.41	2.14	8.225
5	EMPAGR	0	0	0	0	0.95	0	0	0	0	0	0
5	ELEM	0	0	0	0.21	0	0	1.1	0	0.743	0.47	0.092
5	HS	0	0	0	0.21	0	0	1.1	0	0.743	0.47	0.092
5	COLLEGE	0	0	0	0	0	0	0	0.8	0	0	0

The adjustment to the attraction rates for outlying-area Government employees eliminated a need for special generators at prisons or military bases.

Special generator for Meadows Field airport enters 900 person-trips per day estimated from recent years' passenger enplanement counts around 121,000. (Placeholders with a few trips remain in the data file for some prisons and military bases.)

Fixed the socio-economic data misreading of zones in California City, as if the name is two data items delimited by a space. (Changed to California_City).

The VMIP-2 model had a trip generation and distribution model for I-I trucks, but used an exogenous truck trip matrix for XX, IX and XI, originally developed for the first VMIP. Closer inspection found its trip ends to and from particular zones showed no apparent relationship with employment in the zones. For example, zone 2088 has 11 HH and 185 employees almost all in agricultural. It generated about 305 truck trips exiting plus a nearly equal number entering per day (TM and TH). Nearby zone 2089 has 69 HH and 573 Ag employees, but generated 215 truck trips exiting and entering - i.e. a much larger zone has significantly fewer truck trips. Another example: the gateway for SR 14 (to Los Angeles County) had no truck trips whatsoever. Revisions to replace this exogenous matrix input:

- X-X input tables and I-X and X-I trip-ends were derived from the CSTDM, IPF-processed to truck volume targets (base-year from counts as available). For the internal side, the document for

MIP-1's truck model, "San Joaquin Valley Model Improvement Program Freight Forecasting Models" (RSG et al, March 2012), provided inbound and outbound commodity flows and intercounty payload factors, by which the truck trip generation rates are increased to include I-X and X-I along with I-I.

- Trip distribution of truck trips was expanded to include I-X and X-I travel along with I-I (not with separate trip purposes for each as with the personal travel models). Friction factors are unchanged.
- Truck X-X is input in the same through-trip file as auto X-X. I-X and X-I trip ends are entered in the same gateway file as personal travel (purposes 9,10,11). Several script files were changed to do this.

Zonal truck trips are now entirely a function of the land use in them, not hard-wired numbers lacking clear relationships or proportionality. However, truck trip models have not been calibrated to truck traffic counts or other independent statistics.

Trip Distribution

Changed the friction factor (FF) lookup table to a comma-separated CSV file in scientific notation, to prevent round-off error. This format supports far wider orders of magnitude than possible in a DBF file. (The DBF file also continues to be created, but not used.)

Adjusted the FF parameters to shorten trip lengths, with values closer to the DKS 2012 estimations. Table TD-1 lists the "B" parameter in the equivalent function FF = exp(B · [logsum impedance, in time units]).

Table TD-1
Friction Factor Parameters for Trip Distribution

Trip Purpose	I-I	I-X & X-I
HWH	-0.12	-0.110
HWM	-0.09	-0.083
HWL	-0.07	-0.064
HS	-0.25	-0.2
HK	-0.34	-0.313
HC	-0.17	-0.156
HO	-0.13	-0.104
WO	-0.12	-0.096
OO	-0.14	-0.112

IX-XI FF parameters are now distinguished from II parameters. IX-XI were set smaller in magnitude, in accord with the flattening out (as seen in logarithmic plots) common in calibrated non-logit gravity models. (Some are shown in DKS Associates, *Cumulative summary of revisions to the KernCOG MIP travel demand model,* July 2013).

Zones with no network connection but having land use had been nonetheless attracting distributed trips, and attracting excessively, as if reached in zero travel time. Script revisions prevent this.

The trip distribution's method of attraction-constraint was changed from a sequential-priority (or "serial dictatorship") scheme, to jointly constrained in a combined iterative proportional fitting. Under the sequential scheme, some zones were oversubscribed by the first HH classes (originally 0 and 1 car HHs), leaving no attractions available to the final class distribution; meanwhile other zones were barely distributed any trips in those classes at all. The new procedure is first to do all distributions singly-constrained, then input these to an iterative joint constraint applied to an emulated rectangular matrix with 3·Z rows (productions and accessibilities in three HH classes) and Z columns (attractions without class distinction). The column adjustment factors (or shadow-prices) are thus equal among HH classes, and class-specific productions are preserved. I-I, I-X, and X-I each have separate trip distributions and constraint solutions.

Trip Distribution and Mode Choice

The household classes for application of mode choice and trip distribution had been 0, 1, and 2+ autos owned; these were changed to [1] 0 cars, [2] 0<cars<persons, and [3] cars≥persons. (The actual classes applied in the model were not as described in the F&P documentation, i.e. [1] 0-cars, [2] 1 car and 2+ persons, and [3] 2+ autos or 1-car 1-person.) A new module was added to Auto Ownership to perform the new classification. Note that the trip distribution matrices ({SCENARIO…}_TRIPTABLE_0VEH.mat, …_1VEH.mat, and …_2VEH.mat) still have file names left from the former definitions. Also some field names and script comments may remain based on the former classifications. In the CHTS version analyzed, the newly defined classifications show significant mode choice distinction between classes, in Table TD-1 (more than either 0, 1, and 2+ auto owned, or the previous documented classification.)

Table TD-1
Mode shares by trip purpose and revised household class

		Percent of CHTS2012 weighted trips by mode						
Trip Purpose	Cars per Person Relation	Drive Alone	Auto 2 Pers	Auto 3+ Pers	Transit	Bike	Walk	Other
HW	No cars	4.9%	27.8%	3.2%	32.6%	2.8%	28.8%	0.0%
	Cars< Persons	77.8%	12.4%	4.4%	1.2%	2.1%	2.0%	0.2%
	Cars≥Person	95.3%	4.0%	0.1%	0.0%	0.2%	0.4%	0.0%
HW Total		81.5%	9.7%	2.5%	2.3%	1.3%	2.6%	0.1%
HS	No cars	0.0%	6.2%	2.2%	38.1%	0.5%	42.5%	10.6%
	Cars< Persons	22.9%	16.0%	42.6%	1.2%	0.7%	16.7%	0.0%
	Cars≥Person	73.3%	24.4%	1.1%	0.1%	0.0%	1.1%	0.0%
HS Total		35.3%	17.7%	29.0%	3.0%	0.5%	13.9%	0.6%
HK	No cars	0.0%	1.5%	2.9%	5.3%	0.0%	54.3%	35.9%
	Cars< Persons	1.9%	15.1%	40.4%	0.1%	3.7%	20.2%	18.5%
	Cars≥Person	4.0%	46.2%	4.1%	2.2%	0.0%	32.7%	10.8%
HK Total		2.0%	16.5%	37.3%	0.4%	3.4%	21.9%	18.5%
HC	No cars	0.0%	6.4%	0.0%	73.9%	19.7%	0.0%	0.0%
	Cars< Persons	60.8%	34.4%	0.0%	4.7%	0.0%	0.0%	0.0%
	Cars≥Person	97.6%	2.4%	0.0%	0.0%	0.0%	0.0%	0.0%
HC Total		73.9%	22.0%	0.0%	3.9%	0.3%	0.0%	0.0%
HO	No cars	0.0%	3.4%	3.2%	20.1%	0.1%	73.1%	0.1%
	Cars< Persons	19.2%	25.2%	41.9%	0.7%	1.4%	11.5%	0.1%
	Cars≥Person	66.1%	21.0%	4.1%	0.0%	0.4%	8.4%	0.0%
HO Total		28.8%	23.4%	31.9%	1.4%	1.1%	13.3%	0.1%
WO	No cars	0.0%	12.9%	21.8%	38.5%	0.0%	14.3%	12.5%
	Cars< Persons	71.7%	7.2%	20.6%	0.0%	0.2%	0.3%	0.0%
	Cars≥Person	76.5%	18.0%	2.8%	0.0%	0.0%	1.1%	1.5%
WO Total		70.9%	11.5%	13.9%	1.4%	0.1%	1.1%	1.0%
OO	No cars	0.0%	16.5%	0.5%	35.1%	0.6%	31.4%	16.0%
	Cars< Persons	16.7%	31.3%	45.8%	0.3%	0.5%	4.2%	1.1%
	Cars≥Person	48.7%	30.1%	10.5%	0.7%	0.0%	9.9%	0.0%
OO Total		25.6%	30.7%	34.8%	1.1%	0.4%	6.4%	1.1%

Mode Choice

Recalibrated constants, using 2012 survey summaries in the new household classifications. The mode shares in Table TD-1 (with minor adjustments as needed) are not model inputs themselves, but were used as targets to adjust alternative-specific constants in the model.

A further adjustment to mode choice was needed when the model mode shares closely approximated the CHTS survey shares but modeled transit ridership greatly exceeded observed passenger counts. This

appears to be a consequence of the survey participant sampling, reported by Kern COG to have included a significant segment of intentionally-recruited transit riders. An overarching adjustment to transit alternative-specific constants achieved a closer fit to overall observed transit ridership (nearly 21,500 passengers per weekday reported in total from Golden Empire Transit, Kern Regional Transit, and Delano Area Regional Transit).

Time of day

Fixed an error in matrix referencing affecting the AM peak hour.

Adjusted to calibrate model-to-count ratios for all periods by across-the-board factoring of peak-hour and peak-period time-of-day factors, and adjusting off-peak factors to compensate.

Adjusted CapFac so that for the multi-hour periods, it is slightly less than the number of hours in the period.

Noting, but did not change: at 956 out of 1179 count locations, the AM peak hour count is less than half the 7-9 AM 2-hour period. At these locations, the actual AM peak hour is 8-9, not the designated hour of 7-8.

Traffic assignment

Changed the traffic delay functions from BPR to Conical (Spiess 1989). Low and moderate congestion in most streets caused all-or-nothing path choice to overload some roads while underloading similar parallel roads; adjusting the speeds had either no result or too much. The BPR function is practically flat at lower congestion levels, leaving link travel time insensitive to volume, so the equilibrium accepts all-or-nothing path choice. The conical function is sloped at zero, so travel time is more sensitive to volume at low volumes, and equilibrium spreads low-volume traffic more smoothly. (The BPR function is also more prone to overestimating delay at high congestion levels, than the conical.)

The BPR functions looked up capacities that were not actually used in level-of-service (LOS) analysis. This may be, in part, due to an unclear relationship between *v/c* ratio and performance. (It is frequently forgotten that in the original BPR formula, $t_c = t_0\left(1 + 0.15\left(\frac{v}{c}\right)^4\right)$, *c* is actually the so-called "practical capacity" from the 1965 Highway Capacity Manual, at or near 80% of the "possible capacity" in common modern use. Ref. e.g. http://onlinepubs.trb.org/onlinepubs/archive/NotesDocs/appxa.pdf)

As now applied for the conical functions, the "LOS capacities" are used. When demand equals capacity, the conical function doubles the link travel time from the free-flow, so these capacities have a clearer relationship to highway performance.

Previous assignment closure criterion settings had allowed unpredictable premature stopping of assignment iterations. Using the "relative gap" assures a specified consistency between travel times on the paths used versus the shortest path (except if it reaches the maximum number of iterations).

Calibration

A collection of links was identified with screenlines. However, the screenlines were not contiguous, many indicated links did not have traffic counts, and they were located only within Bakersfield. New and revised screenline link sets were identified upon links having traffic counts, with as few gaps as possible among groups of parallel roadways, and covering a larger area. Figure C-1 shows the newly defined screenlines. (Most specific count locations are a short distance ahead or back from the screenline crossing points shown.)

A spreadsheet formula reference error in the PM peak hour statistics was corrected.

The set of links included in the "percent within maximum deviation" statistic previously excluded all arterials (FacTyp = 4). This set was revised to include all roadways having 2-way daily traffic count over 3000, this being close to the lower limit where the "maximum deviation" curve is defined.

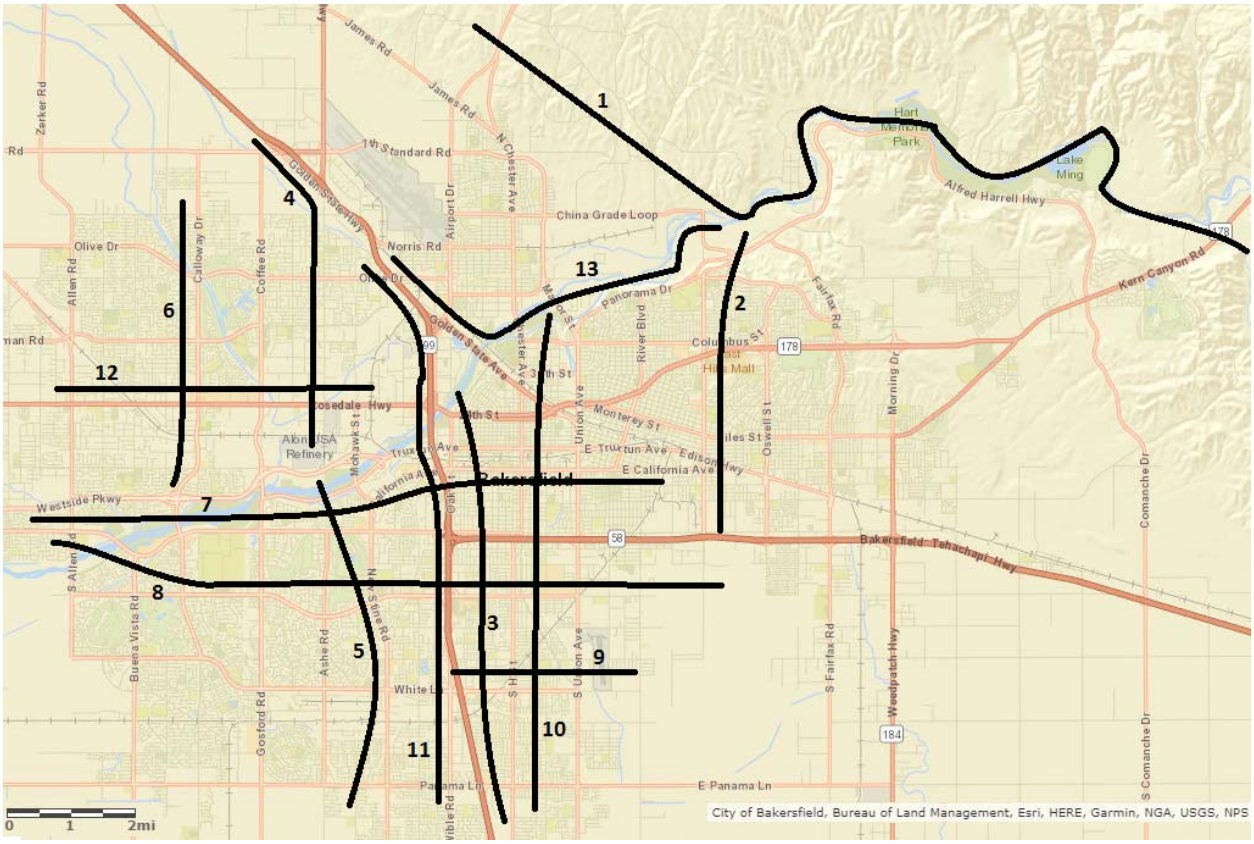
Redefined "percent within maximum deviation" to count only "Yes" and "No" locations, not the excluded "NA" cases.

The tabulation by functional class had computational errors, now corrected.

Corrected the totaling of transit boardings by line. The "rail" submode needed to be included. Rollup is finalized in the Validation Summary spreadsheets with a Pivot-Table (which needs to be refreshed after import). Final rollup combines line names sharing the same first 5 characters. For lines named by the 5-character plus any direction code convention, the rollup combines both directions of line pairs.

Actual calibration statistics are reported in Excel Workbooks furnished to KernCOG concurrently with this report. Selected summaries from these workbooks appear in the pages following Figure C-1.

Figure C-1
Screenline locations



San Joaquin Valley Model Improvement Project (San Joaquin Valley MIP)
ALL Two-Way Volume Model Validation Results
Kern County Model (12/06/2017)

2/7/18 11:43 AM

For information purposes only. Not required for RTP.

DAILY Assignment		
Model/Count Ratio =	0.99	
Percent Within Caltrans Maximum Deviation =	66%	> 75%
Percent Root Mean Square Error =	38%	< 40%
Correlation Coefficient =	97%	> 0.88
%of Screenlines Within Caltrans Standard Dev. =	100%	100%
Total Counted	951	
Link Within Deviation	485	
Link Outside Deviation	247	

AM Peak Hour (7- 8 AM)		
Model/Count Ratio =	1.00	
Percent Within Maximum Deviation =	79%	> 75%
Percent Root Mean Square Error =	67%	< 40%
Correlation Coefficient =	0.92	> 0.88
%of Screenlines Within Standard Dev. =	100%	100%
Total Counted	950	
Link Within Deviation	615	
Link Outside Deviation	163	

PM Peak Hour (5 - 6 PM)		
Model/Count Ratio =	0.98	
Percent Within Maximum Deviation =	82%	> 75%
Percent Root Mean Square Error =	40%	< 40%
Correlation Coefficient =	0.95	> 0.88
%of Screenlines Within Standard Dev. =	100%	100%
Total Counted	951	
Link Within Deviation	636	
Link Outside Deviation	143	

ADT Model/Count by Functional Class		
Functional Class	M/C	# Locations
Freeway	1.10	21
Expressway	1.04	4
Arterial	1.00	747
Collector	0.71	167

AM Peak Period (7 - 9 AM)		
Model/Count Ratio =	1.00	
Percent Within Maximum Deviation =	80%	> 75%
Percent Root Mean Square Error =	46%	< 40%
Correlation Coefficient =	0.95	> 0.88
%of Screenlines Within Standard Dev. =	100%	100%
Total Counted	951	
Link Within Deviation	621	
Link Outside Deviation	158	

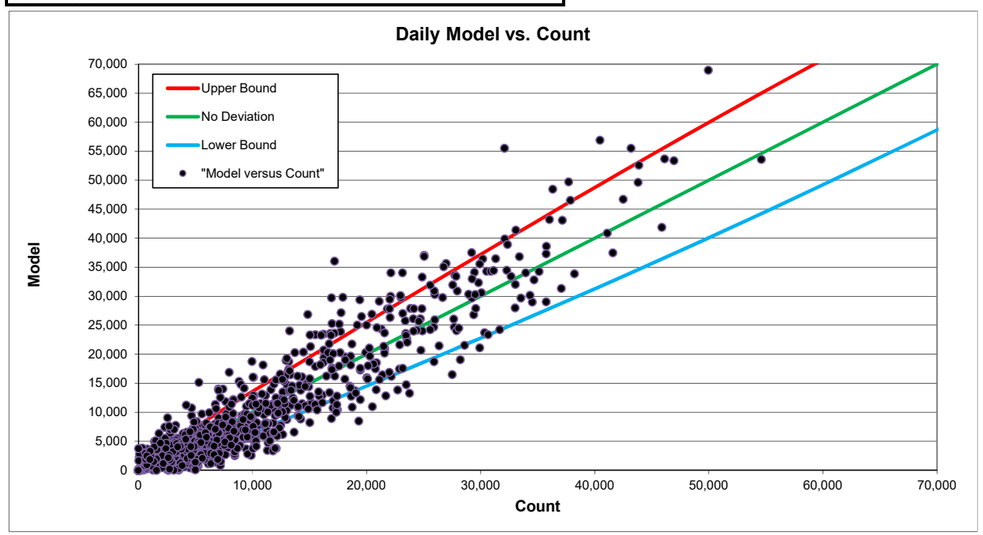
PM Peak Period (3 - 6 PM)		
Model/Count Ratio =	0.99	
Percent Within Maximum Deviation =	81%	> 75%
Percent Root Mean Square Error =	38%	< 40%
Correlation Coefficient =	0.96	> 0.88
%of Screenlines Within Standard Dev. =	100%	100%
Total Counted	951	
Link Within Deviation	631	
Link Outside Deviation	148	

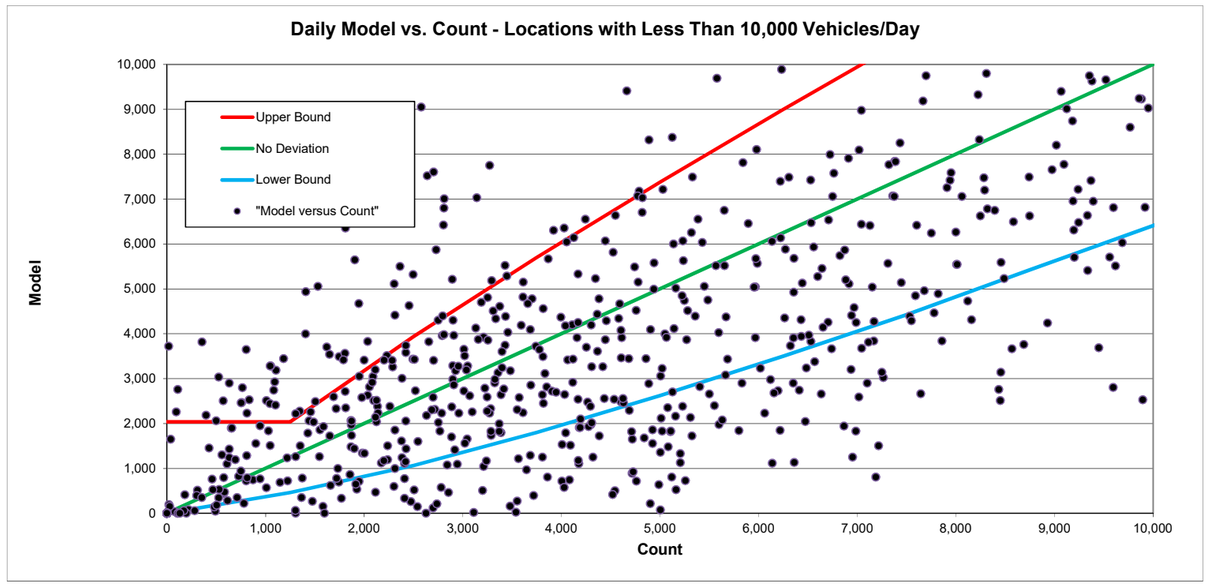
RMSE by ADT Volume Groups		
Count Volume	%RMSE	FHWA
> 50,000	13%	< 21%
25,000 - 49,999	22%	< 22%
10,000 - 24,999	31%	< 25%
5,000 - 9,999	44%	< 29%
2,500 - 4,999	58%	< 36%
1,000 - 2,499	89%	< 47%
< 1,000	307%	< 60%

MD Peak Period (11 AM - 2 PM)		
Model/Count Ratio =	1.04	
Percent Within Maximum Deviation =	80%	> 75%
Percent Root Mean Square Error =	45%	< 40%
Correlation Coefficient =	0.96	> 0.88
%of Screenlines Within Standard Dev. =	100%	100%
Total Counted	951	
Link Within Deviation	621	
Link Outside Deviation	158	

Off Peak Period (10 AM - 11 AM, 2 PM, 7 PM - 7 AM)		
Model/Count Ratio =	0.97	
Percent Within Maximum Deviation =	72%	> 75%
Percent Root Mean Square Error =	41%	< 40%
Correlation Coefficient =	0.96	> 0.88
%of Screenlines Within Standard Dev. =	100%	100%
Total Counted	951	
Link Within Deviation	564	
Link Outside Deviation	215	

Notes:
Total Trip Generation
HPMS Error
Gravity Model Iterations =
Number of Interations per Off-Peak Assignment =
Number of Interations per Peak Assignment =
Time to Run =





Screenline Validation Comparison

Screenline Number	AM peak hour			AM peak period			PM peak period			PM peak hour		
	Counts	Model	Model/Count Ratio	Counts	Model	Model/Count Ratio	Counts	Model	Model/Count Ratio	Counts	Model	Model/Count Ratio
1	507	299	0.59	1,149	712	0.62	2,594	1,763	0.68	851	646	0.76
2	3,941	4,224	1.07	9,561	9,967	1.04	24,202	23,252	0.96	8,671	8,198	0.95
3	13,553	15,636	1.15	31,084	36,034	1.16	73,010	78,972	1.08	25,810	27,444	1.06
4	5,928	5,935	1.00	13,773	13,686	0.99	26,889	29,891	1.11	9,908	10,505	1.06
5	6,710	8,456	1.26	17,450	19,770	1.13	42,763	44,981	1.05	15,523	15,714	1.01
6	3,560	3,579	1.01	9,058	8,272	0.91	20,102	17,570	0.87	7,336	6,262	0.85
7	19,156	19,635	1.03	41,442	45,621	1.10	90,383	98,808	1.09	31,834	34,414	1.08
8	18,297	16,807	0.92	39,328	39,202	1.00	80,640	86,711	1.08	28,291	30,249	1.07
9	10,685	8,482	0.79	21,103	19,646	0.93	41,113	41,264	1.00	14,126	14,356	1.02
10	7,795	8,082	1.04	19,165	18,845	0.98	45,287	43,022	0.95	15,850	15,049	0.95
11	18,245	19,290	1.06	40,422	44,573	1.10	89,537	98,437	1.10	32,535	34,218	1.05
12	4,212	4,412	1.05	9,600	10,331	1.08	23,340	23,227	1.00	8,203	8,166	1.00
13	3,986	4,937	1.24	10,144	11,752	1.16	21,466	27,073	1.26	7,664	9,599	1.25

Screenline Number	Mid-day			Evening-overnight			Daily			Number of Locations
	Counts	Model	Model/Count Ratio	Counts	Model	Model/Count Ratio	Counts	Model	Model/Count Ratio	
1	1,869	1,113	0.60	4,852	3,950	0.81	10,463	7,538	0.72	4
2	17,930	18,382	1.03	49,314	43,773	0.89	101,007	95,374	0.94	13
3	57,504	66,220	1.15	153,147	169,545	1.11	314,744	350,772	1.11	15
4	19,551	24,013	1.23	56,624	67,332	1.19	116,837	134,922	1.15	7
5	32,012	35,953	1.12	91,898	91,581	1.00	184,123	192,285	1.04	9
6	14,183	13,515	0.95	43,672	40,382	0.92	87,015	79,740	0.92	6
7	70,962	82,104	1.16	193,404	212,211	1.10	396,191	438,743	1.11	16
8	63,616	70,914	1.11	179,545	179,647	1.00	363,129	376,473	1.04	17
9	30,578	34,251	1.12	93,134	91,679	0.98	185,929	186,839	1.00	7
10	35,670	34,340	0.96	96,309	86,867	0.90	196,431	183,074	0.93	20
11	68,466	81,463	1.19	185,891	210,120	1.13	384,317	434,593	1.13	17
12	17,138	18,398	1.07	45,183	47,815	1.06	95,261	99,770	1.05	5
13	16,377	20,807	1.27	45,083	53,012	1.18	93,070	112,645	1.21	5

Table 12.3-6:

Trip Assignment – VMT

Evaluation Criterion	HPMS	Model	% Deviation	% XX VMT
+-3%	22,523,190	22,563,476	0.2%	19.2%

Notes: Daily Vehicle Miles Traveled. Highway Performance Management System – 2014 California Public Road Data, Table 6.

Table 12-1.3:
Weekday Person Trips per Household

	CHTS	Model
Total Daily Person Trips	10.6	10.7

Notes: 2012 California Household Travel Survey, Weekday Trips, re-weighted by F&P

Table 12-1.2:

Trip Generation – PA Balance

Trip Purpose	Evaluation Criterion	Productions	Attractions	P/A Ratio	Difference	Percent Difference
HBW	+/- 10%	363,504	393,515	0.92	30,011	8.3%
HBS	+/- 10%	243,210	256,305	0.95	13,095	5.4%
HBO	+/- 10%	1,264,163	1,215,284	1.04	-48,879	-3.9%
NHB	+/- 10%	845,083	878,496	0.96	33,413	4.0%

Notes:

Table 12-5.1:

Trip Distribution – By Purpose (All Modes)

	Trip Purpose							
	Total		HBW		HBO		NHB	
Trip Type	CHTS	Model	CHTS	Model	CHTS	Model	CHTS	Model
II	93%	93%	89%	82%	95%	95%	93%	95%
IX	3%	4%	5%	10%	2%	3%	3%	2%
XI	4%	3%	6%	8%	3%	2%	4%	3%

Notes: 2012 California Household Travel Survey, Weekday Trips, re-weighted by F&P. Includes only internal-to-internal, weekday person trips for all modes.

Table 12-2.1:
Vehicle Availability

Vehicle Availability							
0		1		2		3+	
CHTS	Model	CHTS	Model	CHTS	Model	CHTS	Model
7%	8%	31%	33%	39%	40%	22%	18%

Notes: 2012 California Household Travel Survey, Weekday Trips, re-weighted by F&P

TABLE 12-2.2
MODE SPLIT BY PURPOSE

Purpose	Total (All Modes)		Drove Alone		Shared Ride 2		Shared Ride 3+		Transit		Walk		Bike		Other	
	CHTS	Model	CHTS	Model	CHTS	Model	CHTS	Model	CHTS	Model	CHTS	Model	CHTS	Model	CHTS	Model
HBW	14%	13%	82%	79%	9%	11%	3%	3%	2.4%	1.06%	3%	4%	1.4%	1.8%	0.2%	0.0%
HBO	56%	55%	28%	29%	21%	21%	32%	29%	1.2%	0.50%	15%	16%	1.3%	1.5%	2.2%	2.3%
NHB	30%	31%	38%	39%	26%	26%	29%	29%	1.0%	0.43%	4%	6%	0.3%	0.3%	0.7%	0.0%
Total (All Purposes)	100%	100%	39%	39%	21%	21%	27%	26%	1.3%	0.55%	10%	11%	1.0%	1.2%	1.4%	1.3%

Notes: 2012 California Household Travel Survey, Weekday Trips, re-weighted by FSP. Includes only internal-to-internal, weekday person trips for all modes. School bus trips are categorized as Other.

TABLE 12-2.3

TRIP PURPOSES BY MODE

	Total (All Modes)		Drove Alone		Shared Ride 2		Shared Ride 3+		Transit		Walk		Bike	
Purpose	CHTS	Model	CHTS	Model	CHTS	Model	CHTS	Model	CHTS	Model	CHTS	Model	CHTS	Model
HBW	14.0%	13.4%	29%	27%	6%	7%	1%	1%	26%	26%	4%	5%	19%	21%
HBO	55.7%	55.5%	41%	42%	56%	55%	66%	63%	50%	50%	83%	80%	71%	71%
NHB	30.3%	31.1%	30%	31%	38%	38%	33%	35%	24%	24%	13%	15%	10%	8%
Total (All Purposes)	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Notes: 2012 California Household Travel Survey, Weekday Trips, re-weighted by FSP. Includes only internal-to-internal, weekday person trips for all modes. School bus trips are categorized as Other.

Table 12-4.1:
Daily Transit Assignment

Validation Statistic	Evaluation Criterion	Observed Ridership	Model Ridership	Percentage
Difference between actual ridership to model results for entire system	+/- 20%	21,484	21,746	1%

Notes: Observed Ridership includes Golden Empire Transit (GET), Kern Regional Transit (KRTS), and Delano Area Regional Transit average weekday unlinked trips for 2014

An appendix to *Summary of peer review and revisions to the KernCOG VMIP-2 travel demand model*

Gateway traffic volume estimates

The following tables present comparative traffic volume estimates for the KernCOG model gateway roads at or near the Kern County boundary. The "model application" columns were chosen with consideration to the various sources presented therewith, and serve as the basis for factoring trip matrices extracted from the California Statewide Travel Demand Model to create model inputs.

c.2015 Traffic volume estimates for Kern County gateways
Compiled by DKS Associates

Kern MIP Gateway	Location	Caltrans, detailed tabulation "FY11Ker_Summary" AADT & Midweek (1)		PEMS whole year 2015 (2) 50%Obs		50%Obs		Caltrans published AADT for 2015 (acc'd 4/2017)		2015 Est. Midweek (all veh) (calculated) (3)	c.2015	c.2015	c.2012	c.2010	CSTDM2 2010 as analyzed from trips (4)			CSTDM 2010 (given) Link Vol	Model Application 2015 Daily	
		2009 7-day	2009 3-day	PEMS AADT	PEMS Mid-Week	PEMS AADT	PEMS Mid-Week	2015 AADT (all veh)	2015 Truck (3+ axles)		KernCOG Count	TCAG Count	SCAG Count	SLO Count	Car	Truck	Total		Total	Truck
61	SR 33 (N)	1,795	2,184					1,500	488	1,825					72	91	162	132	1,825	488
62	Barker (Baker)								0		12				4	6	10		12	2
63	Kling Rd								131		586				13	17	30		390	131
64	I-5 (N)	41,594	36,735	39,410	33,895	39,406	34,029	34,000	9,439	29,242					31,932	22,320	54,252	41,090	29,242	9,439
65	Corcoran/Dairy								98		619				654	720	1,374	982	619	98
66	Road 40 (Rowlee), Road 80 (Scofield)								3			66			352	388	740		66	3
67	SR 43	6,805	7,035					2,750	460	2,843					3,140	942	4,081	4,516	2,843	460
68	Roads 128 + 136								99			1,741			1,047	314	1,360		1,741	99
69	SR 99	38,995	37,402	49,151	47,018	49,149	47,016	49,000	10,451	46,874					25,917	12,635	38,552	32,283	46,874	10,451
82	Road 144 (Gilrard)								119			2,764			472	130	602	1,240	2,764	119
70	Roads 152 + 156								0						458	126	585		859	17
83	Rd 160 (Veneto/Bowman)								55			786			111	31	142		786	55
85	Road 192								116			1,470			347	96	443		1,470	116
71	Famoso-Porterville (Richgrove)								496			4,790			6,122	2,345	8,467	8,118	4,790	496
72	SR 65	6,161	5,966					6,500	1,429	6,294					3,166	3,135	6,301	3,898	6,294	1,429
73	Jack Ranch								28		281				67	51	118	308	281	28
74	Sierra Way								98		985				267	206	473		945	98
29	SR 395 (N)	2,782	2,578					5,700	696	5,282					3,992	822	4,814	4,757	5,282	696
30	SR 178	21,424	22,942					2,400	192	2,570					2,733	563	3,296	2,877	2,570	192
75	Searles Sta. Cutoff								0		253				683	141	824		253	39
31	US 395 (S)	4,087	3,677					4,350	523	3,914					2,059	1,211	3,269	2,878	3,914	523
76	Randsburg Cutoff + 20 Mule Team Pkwy								40		579				151	328	479	311	579	40
32	SR 58 (E)	13,542	12,797					13,900	6,291	13,135			10,466		736	3,054	3,791	3,118	13,135	6,291
77	20 Mule Team Rd in Boron								91		984				482	289	772	548	1,075	91
81	Lancaster Bl (Redman Rd, 120th E)								0				4,987		3,174	1,171	4,345	1,347	4,987	923
33	Sierra Hwy								0				3,030		495	22	517	51	3,030	189
84	(unused, next to SR 14)								0						0	0	0		0	0
34	SR 14	29,231	29,372	50,128	52,182	54,484	55,788	34,000	1,765	35,393			35,539		35,460	6,312	41,772	27,810	35,393	1,765
35	60th St West								0				1,667		288	27	315	43	1,667	115
36	90th St West								0				1,185		962	353	1,315	1,111	1,185	86
78	170th St West								0		641				962	353	1,315		641	44
37	I-5 (S)	71,735	62,638	77,872	66,077	77,875	66,072	73,000	17,315	61,943			51,890		52,545	35,483	88,028	61,185	65,000	17,315
38	Lockwood Valley Rd (Mt Pinos)								0		1,772		488		498	988	1,485	926	1,772	409
39	SR 33 (S)	3,896	3,640					3,350	1,000	3,135				3,137	1,174	1,043	2,217	1,660	3,135	1,000
79	Soda Lake								0		26				9	13	23		26	3
40	SR 58 (W)	310	274					160	25	141				129	61	85	147	117	141	25
80	Bitterwater Valley Rd								0		41				8	11	19		41	4
41	SR 46	6,626	5,893	8,503	8,019	12,371	39,195	7,000	1,857	6,602				5,847	1,395	447	1,843	1,091	6,602	1,857

Notes:
(1) Nearest representative location available was chosen, not necessarily at the gateway.
Purpose: to estimate mid-week (T-W-Th) from AADT, not necessarily to establish gateway traffic volume

"(2) 50%Obs" summarized from PEMS records at least half composed of observation, and less than half from imputation
"AnyObs" summarized from PEMS records with at least one actual observation, not just purely imputation
Purpose: also, to estimate mid-week from AADT.

(3) Estimate = AADT * (PEMS T-W-Th) / (PEMS 7-day)

(4) Trip analysis, for extracting IX, XI, and XX flows, does not include trips entering or leaving California, but link volumes do

c.2035 Traffic volume estimates for Kern County gateways
Compiled by DKS Associates

		c.2035 Estimates by source					Model Application (1)	
Kern MIP Gateway	Location	SCAG 2035 (for 16RTP)	TCAG 2040 model (gateways)	SLO County 2035	20170416 Kern MIP2 2035	CSTDM2 2040	2035 Daily Total	2035 Truck
61	SR 33 (N)				4,196	293	3,105	830
62	Barker (Baker)				160		14	2
63	King Rd				279		488	164
64	I-5 (N)				39,713	58,544	37,026	11,952
65	Corcoran/Dairy				310	3,109	1,335	211
66	Road 40 (Rowlee), Road 80 (Scofield)		160		374		66	3
67	SR 43		1,332		2,924	6,319	3,557	575
68	Roads 128 + 136		1,703		13,902		2,178	124
69	SR 99		75,086		34,744	45,916	59,282	13,218
82	Road 144 (Girard)		1,293		3,944	2,440	4,340	187
70	Roads 152 + 156				5,677		1,236	25
83	Rd 160 (Veneto/Bowman)		237		352		1,056	74
85	Road 192		690		2,611		2,060	163
71	Famoso-Porterville (Richgrove)		1,406		4,386	9,108	5,172	536
72	SR 65		7,300		7,281	7,864	7,300	1,657
73	Jack Ranch		729		258	917	582	58
74	Sierra Way				3,153		1,254	130
29	SR 395 (N)				2,579	5,537	5,845	770
30	SR 178				1,913	5,621	4,017	300
75	Searles Sta. Cutoff				155		253	39
31	US 395 (S)				3,745	4,081	4,940	660
76	Randsburg Cutoff + 20 M.T.Pkwy				285	602	899	62
32	SR 58 (E)				15,589	5,907	20,111	9,632
77	20 Mule Team Rd in Boron				1,076	1,066	1,675	142
81	Lancaster Bl (Redman Rd, 120thE)	6,031			2,414	7,216	6,031	1,116
33	Sierra Hwy	5,045			3,459	928	5,045	315
84	(unused, next to SR 14)				0		0	0
34	SR 14	51,620			15,361	60,983	51,620	2,574
35	60th St West	2,455			604	696	2,455	175
36	90th St West	1,675			571	4,293	1,675	122
78	170th St West				410		1,068	74
37	I-5 (S)	86,140			63,420	99,775	90,053	23,989
38	Lockwood Valley Rd (Mt Pinos)	547			1,037	1,868	2,829	653
39	SR 33 (S)	388		3,563	2,102	3,144	3,563	1,137
79	Soda Lake				252		33	3
40	SR 58 (W)			135	63	252	235	42
80	Bitterwater Valley Rd				29		41	4
41	SR 46			9,717	5,576	2,095	9,717	2,733

Notes:
(1) Used to derive, but not control, model gateway inputs.
Actual model gateway volumes are partially controled by internal trip generation.