FEHR PEERS

MEMORANDUM

Date: September 20, 2011

To: Keith Norberg & Karen Fink – TRPA
Curtis Alling & Sydney Coatsworth – Ascent Environmental

From: John Gard – Fehr & Peers

Subject: Validation of TRPA Base Year (2010) Travel Demand Model

RS11-2895

The *2010 RTP Guidelines* published by the California Transportation Commission specify that travel demand models used as part of the development of a Regional Transportation Plan should undergo static and dynamic validation tests to assess their ability to accurately predict travel behavior. The following describes the purpose of these tests:

- Static Validation – compares the model's prediction of traffic volumes against existing traffic counts.
- Dynamic Validation – evaluates the model's response to changes in land use and transportation system assumptions.

Static Validation

The *2010 RTP Guidelines* reference the following list of possible validation measures (as originally specified in the *Travel Forecasting Guidelines*, Caltrans, 1992):

- Volume-to-Count Ratio – Divides the model volume by the actual traffic count for individual roadways through the model.
- Percent of Links Within Caltrans Deviation Allowance – Calculated as the difference between the model and actual traffic count divided by the actual traffic count. Result is then evaluated against prescribed deviation thresholds.
- Correlation Coefficient – estimates the correlation (strength and direction of the linear relationship) between the actual traffic counts and the estimated volumes from the model.
- Percent Root Mean Square Error (%RMSE) – is the square root of the model volume minus the actual count squared divided by the number of counts. It is a measure similar to standard deviation in that it assesses the accuracy of the entire model.

TRPA staff established 24 roadway segments for use in the validation tests. Attachment A displays the peak summer month weekday Annual Daily Traffic (ADT) for each segment along with the estimated traffic volume from the base year TRPA traffic model.

The 24 roadway segments cover both the California and Nevada sides of the Tahoe Basin. Among these segments are the seven gateways that provide access to the Tahoe Basin. Unlike "trip-based models" that use fixed volume factors at gateways, "activity-based" models (like TRPAs) estimate traffic entering/exiting at gateways. Accordingly, these links were included in the validation tests.

Table 1 displays the results of the static validation tests including the applicable criteria for acceptance. As shown, the TRPA base year travel demand model passes all three validation tests that have measurable acceptance criteria.

Table 1 – Static Validation Test Results

Validation Test	Criteria for Acceptance	TRPA Model Result
Volume-to-Count Ratio	Not Defined	Gateways: 0.98 Model-Wide: 1.07
Percent of Links Within Allowable Deviation	≥ 75%	75.0%
Correlation Coefficient	≥ 0.88	0.93
Percent Root Mean Squared Error (%RMSE)	≤ 40%	23%
Sources of validation tests and acceptance criteria are *2010 RTP Guidelines* and Travel Forecasting Guidelines, Caltrans, 1992.		

The model's estimate of daily traffic entering/exiting the Tahoe Basin gateways is within two percent of the actual traffic count. On a model-wide basis, estimated traffic volumes exceed actual counts by about seven percent. These levels of variation are considered acceptable given that they are within typical model error tolerances and daily traffic levels can fluctuate by two to five percent.

In summary, this evaluation has found that the TRPA base year travel demand model satisfies the static validation tests described in the *2010 RTP Guidelines*.

Dynamic Validation

We worked with TRPA staff to develop a series of model runs that assess how the model responds to land use changes, both within and outside of pedestrian-transit oriented development (PTOD) areas. The following eight tests were performed:

Residential Evaluations

- Test #1 – Double number of dwelling units in TAZs 205 & 206 (PTOD area)
- Test #2 – Add 500 dwelling units in TAZ 251 (non-PTOD area)
- Test #3 – Reduce number of dwelling units in TAZs 189 & 190 by 50% (PTOD area)
- Test #4 – Subtract 500 dwelling units from TAZ 12 (non-PTOD area)

Non-Residential Evaluations

- Test #5 – Add 1,000 employees each to TAZs 295 & 297 (PTOD area)
- Test #6 – Double employment in TAZ 62 (non-PTOD area)
- Test #7 – Subtract 1,000 employees from TAZs 200 & 202 (PTOD area)
- Test #8 – Subtract 400 employees from TAZ 181 (non-PTOD area)

For each test, the TRPA base year travel demand model was modified, rerun, and then compared to the base case scenario. Tables 2a and 2b display the comparison results for the residential and non-residential evaluations, respectively.

Table 2a – Dynamic Validation Test Results for Residential Land Use Changes

Test	**Dwelling Unit Change**	**Model-Wide Performance Measures**		
		Change in Vehicle Trips	**Added Trips ÷ New DUs**	**Change in VMT**
#1: Additional Units in PTOD area	+ 566	+3,648	6.4	- 4,648
#2: Additional Units in non-PTOD area	+ 500	+ 1,946	3.9	+23,414
#3: Reduced Units in PTOD area	- 668	- 7,238	- 10.8	- 38,460
#4: Reduced Units in non-PTOD area	- 500	- 3,422	- 6.8	- 10,063
Source: Output from TRPA base year travel demand model.				

The results in Table 2a appear reasonable as evidenced by the following:

- ✓ The addition of new dwelling units causes a net increase in model-wide vehicle trips, whereas a reduction in units causes a decrease in vehicle trips.
- ✓ The number of new daily trips per unit ranges from 4 to 11, with lower trip rates in non-PTOD areas (i.e., reasonable given more secondary homes and trip chaining in non-PTOD areas).
- ✓ The geographic location of new units may help explain the difference in VMT between Tests #1 and #2. In Test #1, the additional units are added in Kingsbury, which is adjacent to various complementary land uses. In contrast, the new units in Test #2 are located north of Glenbrook in a sparsely developed area (i.e., much longer travel distances to amenities).

Table 2b – Dynamic Validation Test Results for Non-Residential Land Use Changes

Test	**Employment Change**	**Model-Wide Performance Measures**		
		Change in Vehicle Trips	**Added Trips ÷ New Emps**	**Change in VMT**
#5: Additional Employees in PTOD area	+ 2,000	+7,650	3.8	+ 65,647
#6: Additional Employees in non-PTOD area	+ 674	+ 3,654	5.4	+ 14,076
#7: Reduced Employees in PTOD area	- 2,000	- 9,442	- 4.7	- 10,833
#8: Reduced Employees in non-PTOD area	- 400	- 1,956	- 4.9	- 16,462
Source: Output from TRPA base year travel demand model.				

The results in Table 2b are also reasonable as evidenced by the following:

- ✓ The addition of new employees causes a net increase in model-wide vehicle trips and VMT, whereas a reduction in employees causes a decrease.
- ✓ The number of new daily trips per employee ranges from 3.8 to 5.4, which indicates that the model is stable.

A comparison of Tests #5 and #7 shows substantially different VMT changes (+65,600 VMT for Test #5 vs. -10,800 VMT for Test #7) despite equivalent employment additions/reductions. The added employees were in Crystal Bay and the removed employees were in South Stateline. These locations have very different surrounding community characteristics, which influence travel behavior. South Stateline has many other amenities that could offset a loss of 2,000 employees. In contrast, the lack of population in the vicinity of Crystal Bay would suggest that the introduction of a substantial amount of new trip-attracting land uses would result in longer distance trips.

Given the relative lack of roadway capacity-expansions planned in the Tahoe Basin, it was not necessary to conduct any dynamic validation tests of roadway network changes.

In conclusion, this evaluation has determined that the TRPA model responds in a reasonable manner to changes in land use. Based on these tests, the model is capable of accurately estimating future travel demand associated with future land use assumptions for the basin.

TRPA Base Year (2010) Travel Demand Model - Static Validation Results

ID	Link ID	LOCATION	Daily Traffic Counts	Model	Model/ Count	Deviation	Maximum Deviation	Within Deviation	Model-Count	Difference Squared
1	6321	US 50 mp 70.62	17,000	15,910	0.94	0.06	0.30	YES	-1,090	1,188,100
2	6254	US 50 mp 71.48	17,200	15,990	0.93	0.07	0.30	YES	-1,210	1,464,100
3	14543	US 50 mp 75.45	39,500	32,690	0.83	0.17	0.23	YES	-6,810	46,376,100
4	5337	US 50 mp 76.41	37,500	40,160	1.07	0.07	0.24	YES	2,660	7,075,600
5	4949	US 50 mp 77.33	38,000	36,440	0.96	0.04	0.23	YES	-1,560	2,433,600
6	2730	US 50 mp 80.14	34,000	34,280	1.01	0.01	0.24	YES	280	78,400
7	551	US 50 ATR 0521109	33,300	35,600	1.07	0.07	0.24	YES	2,300	5,290,000
8	2649	US 50 sta 0041	27,000	33,530	1.24	0.24	0.26	YES	6,530	42,640,900
9	146	SR 28 sta 0035	7,200	16,890	2.35	1.35	0.42	NO	9,690	93,896,100
10	13237	SR 28 ATR 3122409	17,000	26,920	1.58	0.58	0.30	NO	9,920	98,406,400
11	13374	SR 28 mp 11.00	17,300	22,820	1.32	0.32	0.30	NO	5,520	30,470,400
12	8305	SR 28 mp 9.34	23,200	20,000	0.86	0.14	0.27	YES	-3,200	10,240,000
13	10239	SR 28 mp 1.85	13,700	17,630	1.29	0.29	0.32	YES	3,930	15,444,900
14	4077	SR 89 mp 19.54	6,000	9,150	1.53	0.53	0.44	NO	3,150	9,922,500
15	4929	SR 89 mp 11.69	6,400	10,090	1.58	0.58	0.44	NO	3,690	13,616,100
16	13490	SR 89 mp 8.67	14,800	14,950	1.01	0.01	0.31	YES	150	22,500
17	7573	SR 267 mp 9.28	13,300	11,210	0.84	0.16	0.32	YES	-2,090	4,368,100
18	14522	SR 89 MP 0.00 Alpine-El Dorado	3,000	3,020	1.01	0.01	0.60	YES	20	400
19	6499	US 50 MP 65.62 Echo Lake Road	15,100	9,200	0.61	0.39	0.31	NO	-5,900	34,810,000
20	4012	SR 207 ATR 0531509- sta 0024	14,000	17,960	1.28	0.28	0.31	YES	3,960	15,681,600
21	145	US 50 ATR 252125	14,900	14,060	0.94	0.06	0.31	YES	-840	705,600
22	14525	SR 431 sta 770	6,700	8,130	1.21	0.21	0.43	YES	1,430	2,044,900
23	14520	SR 267 MP 6.23 Martis Peak Rd	10,600	10,510	0.99	0.01	0.36	YES	-90	8,100
24	14521	SR 89 MP 13.72 Squaw Valley Rd	13,600	13,780	1.01	0.01	0.32	YES	180	32,400
			440,300	470,920						

Model/Count Ratio =	**1.07**	
Percent Within Caltrans Maximum Deviation =	**75%**	> 75%
Percent Root Mean Square Error =	**23%**	< 40%
Correlation Coefficient =	**0.93**	> 0.88