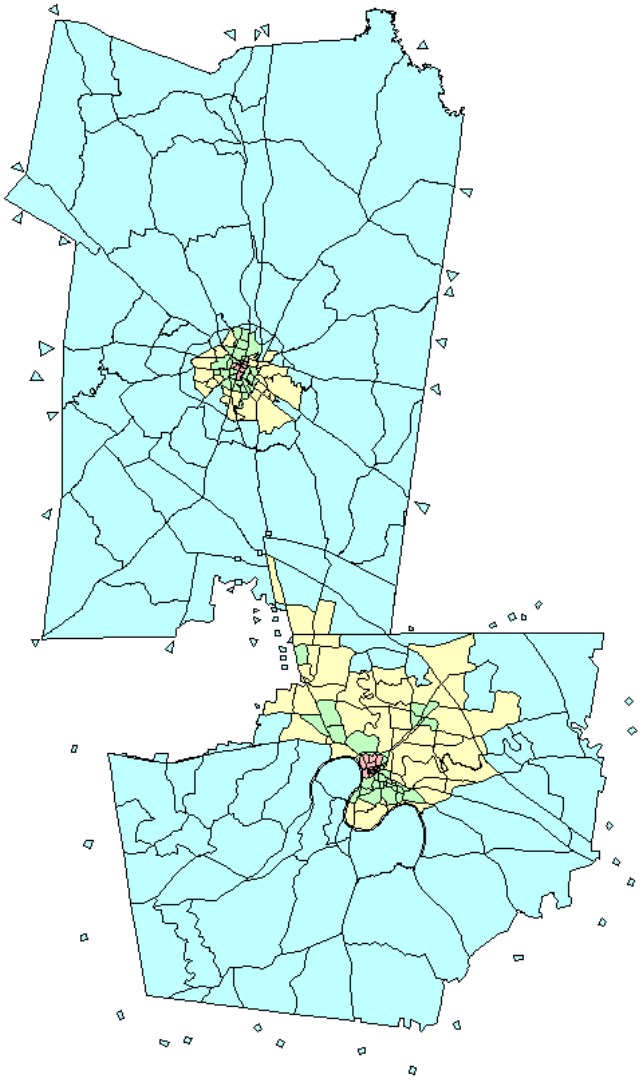
CHRISTIAN COUNTY, KENTUCKY
AND
MONTGOMERY COUNTY, TENNESSEE

MODEL VALIDATION REPORT



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MODEL VALIDATION

Both Christian and Montgomery County had existing previously validated models. The goal of this contract was to expand and update the two models to a base year of 2002. No new surveys were conducted to support this model update with the exception of an OD survey for the Fort Campbell military base that was not completed in time for use. The two models were validated independently and the statistical analyses of the study areas are reported individually. However, the same study design was used, and the same steps carried out in the validation process for each area. In order to allow the reader to compare the results in the two study areas for consistency and compatibility the documentation of the validation process and the reported results were combined into this single technical memorandum.

The ability of travel demand models to forecast future year traffic and other travel behavior are predicated on their ability to estimate "known" traffic volumes and travel patterns under base year conditions for which extensive data is available. There are two components to the process of matching model results to the observed base year travel data. These components are calibration and validation.

Calibration refers to the process of estimating model variables such as trip rates, friction factors, mean trip length, and trip length frequency distributions. All variables are ideally based on surveyed or observed data. Survey data was limited for the Christian and Montgomery County models. The models relied upon the validations of the previous models and their use of local data.

Validation refers to the process of using a calibrated model to estimate travel assignments for the base year and comparing these travel assignments to observed travel data. The typical comparison, when sufficient data is available, is between highway traffic assignments and actual traffic volumes derived from traffic count data. Extensive traffic counts must be available to validate a model.

Validation of the model to counted traffic flows is important to the model effort in two areas. First, it shows if the calibration tools used in the model process and assumptions were reasonable. Second, the validation shows what level of confidence the user can have in the forecast results.

VALIDATION CRITERIA

Although the principle of comparing traffic assignments to traffic count data is intuitively straightforward, subjective review of the travel demand model results and the observed traffic counts is not adequate. The comparative analysis must be carried out in a structured manner using clearly defined benchmarks or measures of success that allow the results of the validation analysis to be tabulated, and quantitatively analyzed in a way that provides the user with a degree of confidence in the statistical foundation and structure of the model.

The model validation procedure for the Christian and Montgomery County models are similar to the procedure used by state DOTs and MPOs throughout the country. The locations of year 2002 traffic counts provided by the Kentucky Transportation Cabinet and the Tennessee Department of Transportation have been coded to the Christian and Montgomery County roadway networks. Traffic assignment results for the validation year (2002) were compared to these traffic counts to calculate a percent error value that was aggregated and tabulated across a variety of categories. These categories are listed below and discussed individually in the following sections:

- Region-wide
- Facility Type
- Area Type
- Volume range.

REGION-WIDE

The first step in the validation process is to analyze overall vehicle miles of travel (VMT) in the study area.

The two VMT estimates, HPMS and count based, are derived using different methodologies and interpret the data at slightly different scales within the study area. The result of these variations is that the two sources of "observed" data are themselves different, making it impossible to match both values.

Both data sources are, however, valuable in both validation and transportation analysis. Therefore, the proposed goal under this criteria is to match the more direct values of VMT provided by the aggregation of the link based count data, but to also check for reasonableness against the overall HPMS numbers by facility type.

As stated earlier, the main validation criterion is the match between counted and modeled VMT. The table below depicts the VMT produced by the model and by the counts and provides a statistical comparison to demonstrate the quality of the match.

Table 1: Counted vs. Modeled VMT, Christian County

Total Counted VMT On Counted Links	1,088,291
Total Modeled VMT On Counted Links	1,101,019
Root Mean Square Error	1,503
% Root Mean Square Error	25.83%
Percent Modeled VMT Of Counted VMT	101.17%

Table 2: Counted vs. Modeled VMT, Montgomery County

Total Counted VMT On Counted Links	1,503,530
Total Modeled VMT On Counted Links	1,447,435
Root Mean Square Error	3,202
% Root Mean Square Error	33.86%
Percent Modeled VMT Of Counted VMT	96.27%

Overall modeled VMT and the portion that appears on counted links are also of interest and are presented in the following table. The Christian and Montgomery County network has count coverage to represent nearly one-third of the total system VMT. This indicates that a significant number of links contain data that can be used to compare observed data to modeled data.

Table 3: Modeled VMT Summary, Christian County

Total Modeled VMT On Counted Links	1,101,019
Percent Of Modeled VMT On Counted Links	54.89%

Table 4: Modeled VMT Summary, Montgomery County

Total Modeled VMT On Counted Links	1,447,435
Percent Of Modeled VMT On Counted Links	42.50%

The following table compares modeled VMT to counted VMT and HPMS estimated VMT at the county level. Each of the counties modeled versus count based VMT fall within an acceptable range. This indicates that the model is performing well across the model areas.

It should be noted that the VMT's given in the following tables do not include trips inside of Fort Campbell military base. The base trips are treated as external trips and are therefore accounted for in the final VMT numbers. Oak Grove, KY is included in the modeled area of Montgomery County. However, VMT's from Oak Grove are only included in the air quality analysis for Christian County and are not included in the VMT's for Montgomery county.

Table 5: County Counted VMT vs. Modeled VMT

County	% of Count	HPMS VMT	Modeled VMT
Christian[1]	98.41%	2,267,714	2,231,719
Montgomery[2]	93.04%	3,437,467	3,198,331

VMT is output from the models in the following aggregations coded on each link of the networks. The table here is for 2002.

Table 6: 2002 Average Speed and Modeled VMT, Christian County

Facility Type	2002 Average Speed (MPH)	2002 Modeled VMT
RURAL INTERSTATE	66.35	430,641
RURAL LOCAL	26.15	136,158
RURAL MAJOR COLLECTOR	39.28	204,682
RURAL MINOR ARTERIAL	48.19	8,036
RURAL MINOR COLLECTOR	39.29	124,007
RURAL PRINCIPAL ARTERIAL	51.54	259,774
URBAN COLLECTOR	18.51	39,465
URBAN FREEWAY	19.49	83,913
URBAN INTERSTATE	59.07	112,237
URBAN LOCAL	25.47	163,540
URBAN MINOR ARTERIAL	39.28	187,533
URBAN PRINCIPAL ARTERIAL	44.31	481,734
Total	45.12	2,231,720

[1] Christian VMT does not include Fort Campbell.
[2] Montgomery Modeled VMT includes neither Fort Campbell nor portions of model in KY.

Table 7: 2002 Average Speed and Modeled VMT, Montgomery County

Facility Type	2002 Average Speed (MPH)	2002 Modeled VMT
KY KY[3]	38.05	425,864.00
RURAL INT RAMP[4]	0.00	0.0
RURAL INTERSTATE	62.91	254,680.00
RURAL LOCAL	24.14	171,842.00
RURAL MAJOR COLLECTOR	41.62	94,567.00
RURAL MINOR ARTERIAL	48.40	244,179.00
RURAL MINOR COLLECTOR	39.79	125,723.00
RURAL PRINCIPAL ARTERI	20.31	83,150.00
URBAN COLLECTOR	29.48	128,145.00
URBAN INT RAMP	31.51	23,583.00
URBAN INTERSTATE	62.60	348,239.00
URBAN LOCAL	24.03	285,207.00
URBAN MINOR ARTERIAL	39.62	616,844.00
URBAN PRINCIPAL ARTERI	36.67	822,172.00
Total[5]	40.45	3,198,331.00

FACILITY TYPE

Another criterion for model validation is to compare assigned traffic volumes to traffic counts aggregated by facility type. The following facility types are used in the Christian and Montgomery County models.

Table 8: Christian And Montgomery County Facility Types

FACILITY TYPE	FACILITY TYPE NUMBER
Freeway	10
Expressway	20
Principal Arterial	22
Minor Arterial	35
Collector	40
Ramp	15
Centroid Connector	99

[3] VMT in KY portion of model.
[4] No VMT in this class for base year.
[5] Does not include KY VMT

The comparison of assigned volumes to counted volumes is considered successful if the value for percent error falls within the ranges suggested by the FHWA depicted below.

Table 9: FHWA Facility Type Validation Targets

FACILITY TYPE	FHWA TARGETS
Freeway	+/- 7%
Major Arterial	10%
Minor Arterial	15%
Collector	25%

The following table shows that the model is matching counts by facility type within the FHWA Facility Type Validation Targets. The freeways and expressways facility types were combined due to the low number of counts available in each class. Also, expressway validation criteria were not available from the FHWA. Both are limited access facilities.

Table 10: Counted VMT vs. Modeled VMT by Facility Type, Christian County

FACILITY TYPE	% OF COUNT	LINKS WITH COUNT	COUNTED VMT	MODELED VMT
Freeway / Expressway	103.81%	29	584,103	606,358
Principal Arterial	92.58%	50	224,829	208,141
Minor Arterial	91.94%	30	75,525	69,436
Collector	106.50%	78	203,835	217,084

Table 11: Counted VMT vs. Modeled VMT by Facility Type, Montgomery County

FACILITY TYPE	% OF COUNT	LINKS WITH COUNT	COUNTED VMT	MODELED VMT
Freeway / Expressway	95.88%	22	773,523	741,645
Principal Arterial	92.52%	37	423,941	392,243
Minor Arterial	98.33%	36	195,231	191,962
Collector	109.70%	64	110,835	121,585

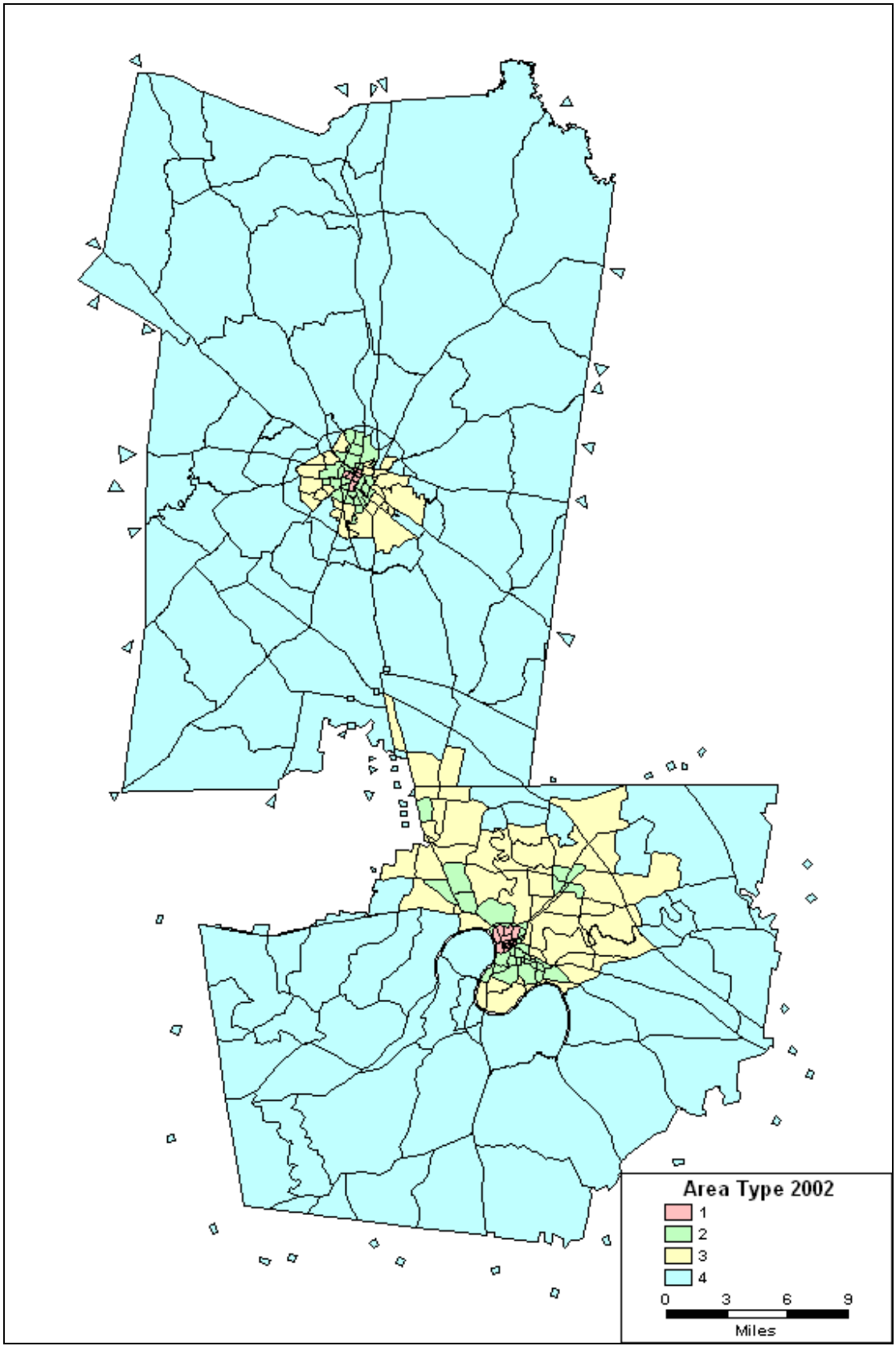
AREA TYPE

The following shows the comparison between assigned and counted volumes by area type. The target for this criterion is for the aggregate modeled volume to be within 15% of the aggregate observed volume for each area type. The following area types were used for the Christian and Montgomery County models.

Table 12: Christian And Montgomery County Area Types

Area Types	Area Type Number
CBD	1
Urban	2
Suburban	3
Rural	4

Figure 1: Christian And Montgomery County Area Type Map[6]



[6] Modeled areas do not include Fort Campbell Military Base

The comparison between counted and modeled VMT by area type is within FHWA validation criterion for all area types for both model areas.

Table 13: Counted VMT vs. Modeled VMT by Area Type, Christian County

AREA TYPE	% OF COUNT	LINKS WITH COUNT	COUNTED VMT	MODELED VMT	ROOT MEAN SQUARED	% ROOT MEAN SQUARED
CBD	86.80%	2	4,116	3,573	539	26.19%
Urban	98.15%	21	62,842	61,680	1,149	38.40%
Suburban	114.02%	30	79,911	91,117	1,053	39.55%
Rural	100.34%	134	941,423	944,650	1,641	23.36%

Table 14: Counted VMT vs. Modeled VMT by Area Type, Montgomery County

AREA TYPE	% OF COUNT	LINKS WITH COUNT	COUNTED VMT	MODELED VMT	ROOT MEAN SQUARED	% ROOT MEAN SQUARED
CBD	89.08%	6	31,217	27,809	1,850	35.56%
Urban	92.54%	14	95,096	88,003	2,931	43.15%
Suburban	95.30%	37	629,671	600,060	5,647	33.18%
Rural	97.86%	102	747,547	731,563	1,742	23.77%

VOLUME RANGE

The final validation criterion is to compare observed verses modeled volumes within acceptable volume ranges. This section documents them as meeting the suggested targets used by the Michigan Department of Transportation (MDOT) depicted below. The MDOT values were selected due to the stringency associated with the more statistically significant facilities carrying volumes above 5,000. While other approaches emphasize the importance of the lower volume facilities, the MDOT approach places a higher value on matching the statistically significant higher volume facilities.

Percent deviation = (Base Year Assignment – Base Year count) / Base Year Count

Table 15: MDOT Volume Range Validation Criteria

AVERAGE ANNUAL DAILY TRAFFIC	DESIRABLE PERCENT DEVIATION
< 1,000	200%
1,000 –2,500	100%
2,500-5,000	50%
5,000-10,000	25%
10,000-25,000	20%
25,000-50,000	15%
>50,000	10%

Based on FHWA 1990 "Calibration and Adjustment of System Planning Models" as documented in Model Validation and Reasonableness Checking Manual, June 2001, Travel Model Improvement Program.

The Christian and Montgomery County models validation meets the criteria for each volume range. The table below provides more detail and comparison statistics.

Table 16: Counted VMT vs. Modeled VMT by Volume Range, Christian County

AVERAGE ANNUAL DAILY TRAFFIC	PERCENT DEVIATION	LINKS WITH COUNT	COUNTED VMT	MODELED VMT	ROOT MEAN SQUARED	% ROOT MEAN SQUARED
0 to 1000	122.81%	33	39,398	48,385	1,384	115.89%
1001 to 2000	90.03%	21	43,363	39,041	888	43.00%
2001 to 3000	102.07%	18	44,936	45,867	1,257	50.34%
3001 to 5000	89.96%	36	118,127	106,265	2,099	63.95%
5001 to 7000	104.81%	19	103,470	108,450	1,202	22.08%
7001 to 10000	102.01%	33	398,765	406,784	1,478	12.23%
10001 to 15000	103.26%	17	149,911	154,797	1,798	20.39%
15001 to 20000	100.58%	10	190,320	191,430	364	1.91%

Table 17: Counted VMT vs. Modeled VMT by Volume Range, Montgomery County

AVERAGE ANNUAL DAILY TRAFFIC	PERCENT DEVIATION	LINKS WITH COUNT	COUNTED VMT	MODELED VMT	ROOT MEAN SQUARED	% ROOT MEAN SQUARED
0 to 1000	136.14%	41	25,944	35,320	1009	159.41%
1001 to 2000	132.45%	5	11,078	14,673	2571	116.06%
2001 to 3000	192.04%	4	8,657	16,625	4,343	200.68%
3001 to 5000	92.36%	24	97,635	90,175	1,956	48.09%
5001 to 7000	109.80%	9	39,215	43,060	1,556	35.70%
7001 to 10000	95.65%	13	89,704	85,806	2,135	30.93%
10001 to 15000	87.60%	18	352,397	308,702	3,261	16.66%
15001 to 20000	94.20%	24	422,047	397,551	6,166	35.06%
20001 to 25000	98.68%	7	246,442	243,192	2,809	7.98%
25001 to 50000	100.91%	14	210413	212329	3,660	15.80%

CONCLUSION

The criteria proposed for the Christian And Montgomery County travel demand model validation process are based on current FHWA and NCHRP guidance and standards and represent reasonable measures for determining the accuracy and reliability of the Christian and Montgomery County models. The validation of the Christian and Montgomery County models described in this section accomplishes two goals. First, it demonstrates that the calibration tools used in the model process and assumptions were reasonable. Second, the validation provides the local area with a high level of confidence in the accuracy and reliability of forecast results obtained from the Christian and Montgomery County travel demand models.

REFERENCE FOR VALIDATION

Model Validation and Reasonableness Checking Manual, June 2001, Travel Model Improvement Program, U.S. Department of Transportation, Federal Highway Administration.

National Cooperative Highway Research Program, Report 365, Travel Estimation Techniques for Urban Planning, 1998, Transportation Research Board (TRB).

National Cooperative Highway Research Program, Report 255, Highway Traffic data for Urbanized Area Project and Design, 1995, Transportation Research Board (TRB).