Appendix 4A: Travel Demand Model Review and Documentation

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Traffic Analysis Zone Development

Socioeconomic Data Collection and Analysis Methodology

The RPC develops several estimated and projected data variables. However, not all variables are reported due to the relevance of the data. Since the ultimate purpose of the data is for use as inputs into the regional traffic assignment model, only seven variables exist for use in the model. These primary variables include the following:

- Total households
- Occupied households
- Total employment
- Retail employment
- Median household income
- School enrollment
- University enrollment

In the course of developing these variables other variables are projected as well though they are not always included in the published projections report, nor are they included in the datasets for modeling. These variables are necessary, however, in the course of the projections methodology in order to accurately calculate the reported variables. These variables are reported at the county level, though not sub-county, and they are as follows:

- Total population
- Group quarters (institutionalized) population
- Housing occupancy rates
- Housing vacancy rates
- Household size

Base Counts

For interim years between decennial census data collection efforts, the RPC uses a residual component methodology in order to estimate population and housing. This basic process uses known population and housing data provided by the Census, and makes adjustments based on changes in housing stock. At the county level, total population and household estimates are based on estimates produced by the Census Bureau, and in some cases by state demographers. At the sub-county level, change is estimated based on sources including local estimates, trends in issued housing permits, and trends in consumer counts from purchased data. A base year dataset for the year 2000 was developed in the geographic information system (GIS) by overlaying the 2000 TAZ geography over the 2000 Census block layer. Using a percentage share density model, the necessary data variables were then extracted from the block data into the zonal layer. Once the block statistics were, in effect, converted into zonal statistics, the resulting zonal attribute table was exported from the GIS into a spreadsheet for continued analysis.

Projected Counts

Future year counts were modeled using a detailed method of trend extrapolation and a comprehensive review process incorporating GIS. Historical growth patterns, known residential and commercial developments, and probable areas of residential and commercial growth expansion are the primary components used to model future year patterns. For each pattern, appropriate mathematical formulas were used for extrapolating the trend into the future. Obvious and inherent problems with this methodology, such as sub-county areas that reflect extreme high growth or extreme negative declines, were singled out and reviewed. Once the county and sub-county projections were patterned, each variable was mapped and reviewed in GIS. Where county and sub-county forecasts were available through primary and secondary data sources, comparisons were made to ensure that the accuracy and relative continuity of the data was consistent**.**

Population and Housing

For 2005, county population and housing estimates were based on Woods & Doole and Claritas Demographics, Inc. estimates at census block level. The block data was aggregated to county totals and compared with census produced county estimates and housing permit data collected from April 2000 through December 2005 at the street address level. Totals between these sources were weighed for accuracy against the housing permit data, and likely county "target totals" were identified. Sub-county level estimates are based on local estimates using the collected housing permit data by geocoding each address in the GIS with the Census TIGER-Line street files, then overlaying the resulting point coverage with the planning district, census tract, and TAZ geographic layers and calculating the totals for each geographic unit. The resulting total gives an estimated total housing unit count.

The 2035 projection focuses on housing. Comparisons between primary and secondary data suppliers of county projections were used to access probable target totals. Secondary variables, such as household size, and vacancy and occupancy rates, were projected using trend extrapolation at sub-county geographies and applied to the projected housing totals to obtain totals for occupied households and non group quarters population. Increased housing unit removal, in areas where the trend extrapolation method reflected slow demolition rates, was calculated by first comparing municipal demolition trends with the age of the housing stock, and a formula applied to units over sixty years old where median household income was particularly low.

School and University Enrollment

Enrollment totals indicate primary areas of continued vehicle trip generation in transportation modeling. School enrollment totals are collected directly from the area school systems, as was the enrollment totals for the local universities. The data was first collected into a spreadsheet, then geocoded in the GIS system using the TIGER-Line files. The resulting point coverage was then overlaid with the TAZ layer, joined with TAZ attribute table in order to ensure accurate zonal coding, then exported and joined with the population and housing data. In addition to both public and private schools and universities, large preschools and adult education centers were included in the dataset for trip generation purposes within the regional traffic assignment model.

The projected number of school and university enrollment totals was computed by applying a traditional cohort-component analysis based on county population trends published by secondary sources and Reviewed by RPC. The resulting data reflects an increase in the senior population and a relatively constant percentage of school age population. The percentages were compared with other data sources for projected school age population for verification. University

enrollment projections were tallied from university sources. School and university data was geocoded in the GIS to assign appropriate TAZ numbers then exported into the dataset. Future school locations were determined based on known developments and probable future locations identified by county officials.

Median Household Income
Income estimates and projections reflect the census money income definition, and are produced for both current dollar values and future year values. The current estimates are collected from purchased data sources that use estimates based on a combination of:

1) Change in consumer financial information from an external Consumer Marketing Database,

2) Change in income summarized from an external consumer household database, and

3) Estimates and projections of trends occurring between decennial census years.

All data is reported by census tract. Therefore, each zone within a tract is assigned the median income total for that tract.

Median household income projections were calculated by applying the rate of increase from other projected income categories reported in primary data sources for counties, and applying that percentage change to median household income by census tract. The data is reported in both constant dollars and projected dollars, which reflect expected changes due to inflation and cost of living. The tract level projections are then applied to each zone within individual census tracts.

Employment Data
Source data for the 2005 base year was supplied by InfoUSA, provided as a database. This database was georeferenced by RPC in the GIS system. Employment statistics are updated continuously by the RPC and maintained in an Employment File Database, which contains information, including employment totals and industry type, on over 32,000 businesses within Jefferson and Shelby counties. The information is collected and maintained in order to track business trends and place-of-work employment statistics for transportation planning. This data is easily manipulated within a spreadsheet and is reported at all geographic levels used by the regional traffic assignment model.

Total and retail employment projections were calculated using the trend extrapolation method and applying data pertaining to known and probable commercial developments. Much of the developments information was reported in square feet or acres, and was converted to employment totals through a standard formula of employment densities as published in the *Trip Generation Studies Report* by the Institute of Transportation Engineers. The county totals were compared to historical ratios of population and housing in order to verify the accuracy and consistency of employment change. The detailed information was published in the report by RPCGB, Population, Housing & Employment Projections, 2005-2035.

Existing + Committed (E+C) Networks

E+C = Existing + Committed, base year for testing that includes projects opened to traffic and committed to funding in 2005. **Improved** = Model year networks coded with all system improvements. **NB**= Model year networks with appropriate socio-economic data but without highway improvements.

Highway Network Development

The existing modeling network is formatted for use with the TranPlan and Voyager under Citilab CUBE modeling software. The TranPlan is used for air quality conformity analysis. The 2005 base network for TranPlan has been converted into Voyager format. The Voyager model is used as analysis screen tools in the 2035 RTP. The TranPlan package is supplied to the Regional Planning Commission of Greater Birmingham by the Alabama Department of Transportation and has been the software in use since 1997.

The most recent modeling work was performed for the 2020 Birmingham Area Long Range Plan, this effort benefited by the work done for the Strategic Regional Multimodal Mobility Plan in 1998. This same modeling stream was updated in November of 2000 to include the addition of a capacity project on I-59, the resulting modeling output was the basis of the amended 2020 Long Range Plan Update adopted by the Birmingham MPO in February 2001 and continued with the plan updates for the 2025 LRTP in June 2002 and 2030 LRTP in January 2006.The adopted plan 2025 LRTP and 2030 LRTP were reviewed by the United States Environmental Protection Agency (Region 4) and satisfied the requirements of 40 CFR Section 93.119.

The 2035 Birmingham Area Long Range Plan update was built upon the foundation of the existing modeling efforts. This modeling effort required additional efforts to bring the network connections up to date with the 2000 census Traffic Analysis Zones. The network data files where reviewed for accuracy and additional projects recommended by project sponsors where added to the future year scenarios.

TranPlan Modeling networks where constructed for the years of 2005, 2009, 2015, 2017, 2025 and 2035. The model years are determined through negotiation with the conformity partners during their quarterly meetings. The model year results are the basis of analysis demonstrating that the implementation of the currently approved Transportation Improvement Program (TIP) and the proposed 2035 Regional Transportation Plan (RTP) developed in compliance with Title 23 and Title 49 of United States Code meet the conformity requirements set forth in the Clean Air Act (CAA). Voyager Modeling networks are developed for years of 2005 and 2035.

VMT based on HPMS Reports and Observed Traffic Counts

The base year 2005 VMT is 25,233,915. Where, the Federal Highway Performance Monitoring System (HPMS) reports vehicle miles traveled for Jefferson and Shelby counties for Interstates through Arterials at 20,135,583. The VMT for lower functional classification roadways, i.e., collectors/ramps are more accurate then estimates in the HPMS. The VMT for collectors/ramps is about 5,098,332 based on MPO's observed traffic counts.

The base year Voyager model assigns 25,960,702 for the same functional classifications of highways. The model assignment is within 2.8% of the base year HPMS and observation data. Level of Service (LOS) by Volume/Capacity (VC) Ratio E and F are defined as those VC equal or greater then 1.10. Table A.1 indicates LOS changes for the base year, 2035 with plan , and 2035 no build(without plan).

Table A.1 Level of Service (LOS) by Volume/Capacity Ratio

Model Network Years Evaluated	LOS A & B	LOS C	LOS D	LOS E	LOS F	Total	*LOS E & F*
	<.75	0.75 - 1.00	1.00 - 1.10	1.10 - 1.25	>= 1.25	All	*>= 1.10*
Base year 2005	67.2%	28.7%	2.6%	1.3%	0.2%	100.0%	***1.5%***
2035 with plan	41.9%	36.9%	11.6%	2.9%	6.8%	100.0%	***9.7%***
2035 No Build	36.5%	35.8%	11.4%	6.2%	10.1%	100.0%	***16.3%***

Based on Voyager modeling, vehicle miles traveled continues to grow, from 27 million plus miles in the base year to over 44 million miles in 2035, an increase of 60% over 30 years or 1.6% per year. Figures A.1 and A.2 illustrate this more clearly.

Figure A.1 VMT growth at LOS E and F

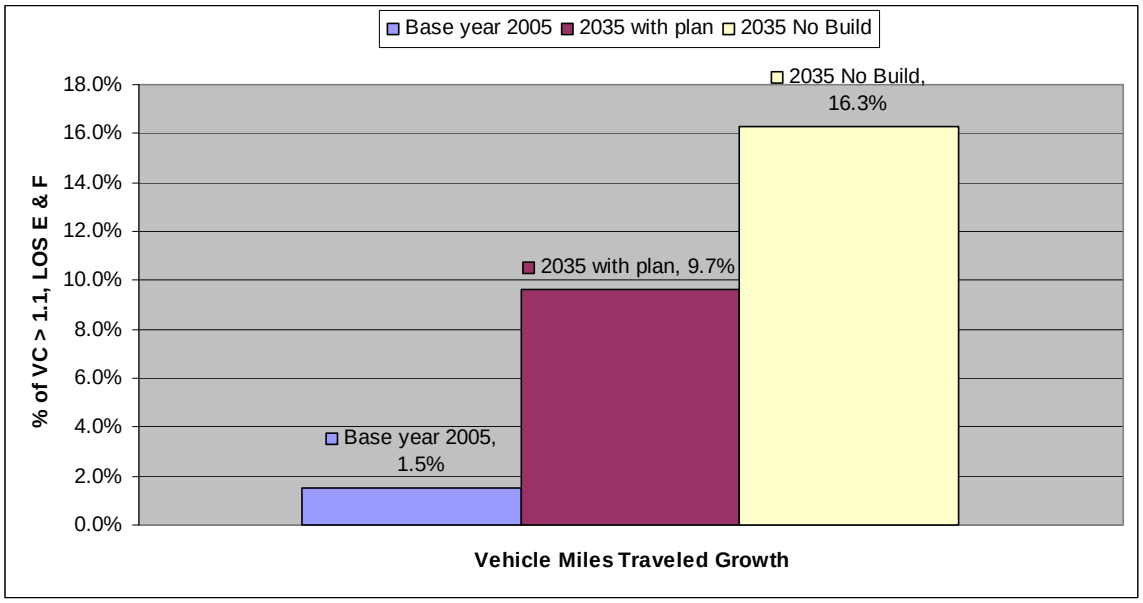
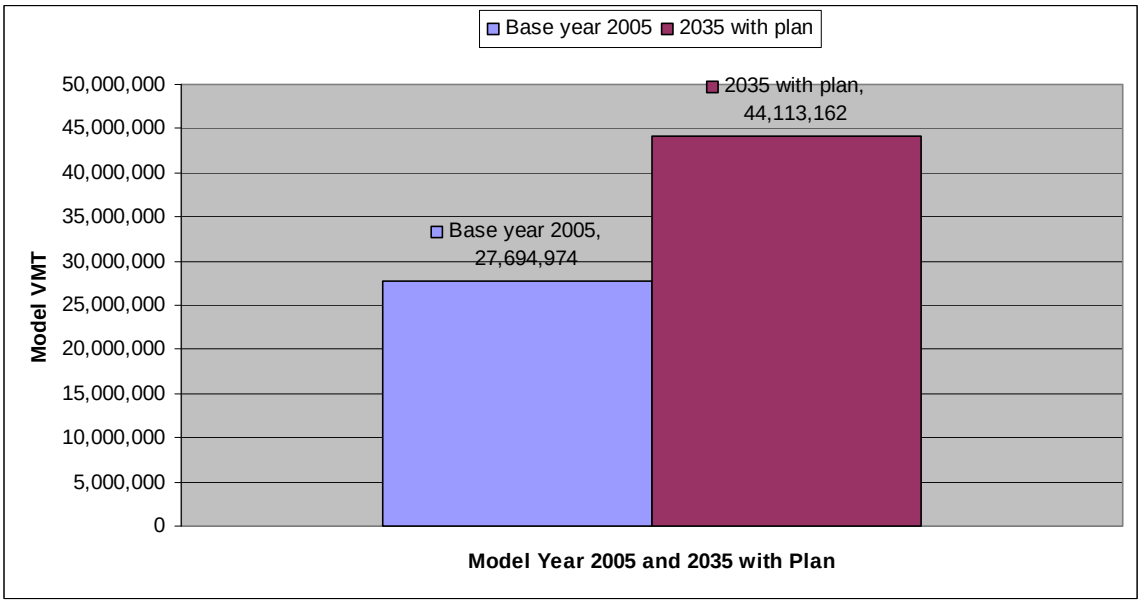


Figure A.2: VMT by model year 2005 and 2035



Validation Parameters

To ensure the accuracy of the travel demand model, the highway assignments were validated using several widely used measures. The primary highway assignment validation measures are Vehicle Miles Traveled comparisons based on modeled volumes and observed traffic counts using Root Mean Squared Error(RMSE) by facility type and volume groups.

Target VMT values were estimated from HPMS reports and MPO observed Traffic counts. Table A.2 summarizes general VMT comparisons for the Existing + Committed Network (Model Year 2005) validation.

Table A.2 Vehicle Miles Traveled Comparisons

VMT	Target	Model
Interstates	10,997,001	10,572,404
Principal arterials	4,647,084	4,678,670
Minor arterials	4,491,498	5,744,700
Collectors	4,467,069	3,762,612
Ramps	631,263	700,101
Total (Non-Local)	25,233,915	25,458,487
VMT / Household	75.1	75.8
VMT / Person	30.4	30.7

The Root Mean Squared Error (RMSE) is commonly used to measure the overall accuracy of modeled volumes relative to counts. RMSE is used because it provides the ability to measure the overall percent difference, when differences may be positive or negative. It is generally not appropriate to use a simple percent difference measure when dealing with positive and negative differences since the overall error is masked due to cancelling effect of the positive and negative values. Table A. 3 shows a comparison of percent RMSE by facility type and volume group for the project model.

The results of the comparisons of VMT and RMSE indicated that the model is operating at an acceptable level for this plan update.

Table A.3 Percent Root Mean Square Error (%RMSE)

FACILITY TYPES	% RMSE	
	TARGET	%RMSE Model
All Facility Types	<36.8%	37.1%
Interstates/Expressways	<18.3%	15.6%
Principal arterials	<36.8%	30.6%
Minor arterials	<43.9%	49.5%
Collectors	<77.5%	70.1%
Volume Group	**% RMSE**	
	TARGET	**%RMSE Model**
ALL VOLUMES	<36.8%	37.1%
0 - 1000	<300%	236.9%
1001 - 2500	<200%	118.9%
2501 - 5000	<100%	62.3%
5001 - 10000	<50%	43.6%
Greater than 10000	<30%	21.1%