A. Travel Demand Model

The purpose of the Appalachian Region Commission (ARC) travel demand model is to evaluate the future conditions upon completion of the Appalachian Development Highway System (ADHS). The proposed ADHS was evaluated using the ARC travel demand model to determine the impact on the travel performance. Highway projects such as adding capacity to a roadway, adding additional mileage of roadways, and relocation or removal of roadways were analyzed using the travel demand model.

Forecast travel demand models traditionally consist of four steps. During the first step, Trip Generation, the number of trips being produced and attracted to or by an area is estimated based on the land use of the area and generation rates which are usually derived from a survey. The second step, Trip Distribution, determines the number of trips from the Trip Generation step that are going between areas. The third step, Mode Split, predicts by which mode of transportation the trips will occur. The final step, Trip Assignment, assigns the trips to a network that represents the modeled area.

The travel demand model developed for the ARC travel demand model is not a four-step model. The ARC travel demand model uses an Origin-Destination Matrix Estimator (ODME) procedure to estimate the trip tables used in the model. The ODME procedure replaces the traditional trip generation and distribution steps of the four-step modeling procedure. ODME is an accepted practice that estimates trip tables based on traffic count data. Traffic count data is generally more readily available than the socioeconomic data that is required for trip generation, and since ODME does not need survey data to derive trip rates and lengths, the procedure is dramatically less costly to implement.

The mode split step in not included in the model. However, three different modes/purposes were used in the model. Trip tables were developed for automobiles and trucks, with the truck being further classified as commodity-carrying trucks and non-commodity-carrying trucks.

The assignment step from the four-step model is used in a similar manner in the ARC travel demand model. Commodity and non-commodity trucks are assigned to the network together with automobile trip table in a multiclass congested equilibrium assignment.

A.1 BACKGROUND

The analysis for the completion of the ADHS requires forecasts of the traffic volumes on the all of the roadways in the ARC region that will vary in response to the ADHS improvement alternatives. While there is no travel demand model for the multistate Arc region, the basic functionality of such a model; i.e., trip tables and networks, were developed as part of this project. A highway network was being developed and trip tables were being estimated from observed traffic counts using an origin-destination matrix estimation (ODME) technique. The TransCAD travel demand modeling software used in this study has an ODME feature available as a standard option.

A.2 MODEL DEVELOPMENT

A.2.1 Highway Network

A TransCAD highway network for the United States was developed as part of FHWA's Freight Analysis Framework – Version 1 (FAF1)[22] project. It provides basic infrastructure and connectivity information for major highways in the United States. The FAF1 highway network of the United Sates uses counties as loading points.

This highway network includes sufficient detail to analyze the ADHS performance. It includes highway throughout the United States, far beyond the boundaries of the ARC region. The FAF1 highway network includes automobile and truck traffic counts on all links in the highway system. Those traffic counts are those reported by the state department of transportation, primarily through the FHWA's Highway Performance Monitoring System. The HPMS submittals also provide lane, speed, and capacity information that were included in the FAF1 network. Only major roads were included in the highway network model.

The boundaries chosen for the ARC travel demand model highway network, was selected to include not only the highways in the ARC region, but the major highway decision points, for example the interstate highways nearby the ARC region, where a traveler could chose to use or not use a route involving an improved ADHS road, based on the quality of service that was being provided. Therefore, rather than just the 417 counties (and incorporated cities in Virginia) as TAZs in the model, and a total of 697 counties are included as TAZs in the model, 280 of which are in a "halo" of TAZs/counties within the model boundary but outside the ARC region. The highway network includes not only 23,042 miles of intestates and other major highways within the ARC region but 76,634

[22] Battelle Memorial Institute, Freight Analysis Framework Highway Capacity Version 1: Methodology Report, Office of Freight Management and Operations, Federal Highway Administration, April 18, 2002.

miles outside of the ARC region for a total of 99, 676 miles of major highways in the entire model area.

At the edge of the model region, 125 external stations were coded to provide for travel between these external stations and the remainder of the United States. The inclusion of these stations allows the inclusion of automobile and truck trips that travel from the rest of the United States to the ARC model TAZs, to the rest of the United States from the ARC model TAZs, or from the western United Stets to the eastern United States passing through the highway in the Arc model region.

A.2.2 Trip Tables

Absent a traditional "four-step" model covering the ARC region, including the "halo" of counties surrounding the Arc region, an alternative method had to be identified to develop base year trip tables. The Origin Destination Matrix Estimation technique implemented in TransCAD was used for this purpose. This technique builds the statistically most likely trip table that is consistent with the highway network and its observed traffic counts. This feature is included as a standard feature in TransCAD. The method is improved with the use of a "seed" trip table. An unvalidated "seed" table was created by applying standard national trip generation rates to the base year socioeconomic data in the model and then distributing those trips based on the average highway travel times between TAZs in the model using a standard gravity model trip distribution.

When assigned to the highway network, the base year trip table will produce average daily trips between counties and the external stations that match the average daily traffic counts. Separate counts were provided for trucks and autos. This information was used to estimate separate automobile and truck trip tables.

The truck trip table is based on observed truck volumes, which include both freight and non-freight trucks. The 2002 FAF2 commodity freight truck table was allocated from FAF2 regions to the ARC model counties using the county percentages by commodity from a 1998 commodity flow freight database developed for ARC by Marshall University. This table includes additional detail about the contents of those freight trucks. These commodity tables were subtracted from the original ODME truck table. This will result in an automobile trip table, a non-freight truck trip table, and additional freight truck trip tables by commodity.

A.2.3 Assignment

The trip tables can be assigned to the highway network in a conventional manner using the congestion on the highway links to determine the shortest paths. Changes in the physical attributes of the highway system can be coded and used to test how traffic volumes will change in response to highway improvements. A terrain code was added to all roads in the Arc highway network which characterizes the highway section as "flat," "rolling," or "mountainous." That terrain

code was based on average terrain in the county. Before calculating congested speeds a Passenger Car Equivalent of 1.5, 2.5, or 4.5, for flat, rolling and mountainous terrain respectively was applied to the assigned volume of trucks prior to comparing the total volume on the highway to the capacity of highways when the congested speed is computed. The congested speeds are used in an equilibrium assignment that ensures that each vehicle traveling between two zones ahs the same congested travel time, regardless of which route is chosen.

A.2.4 Forecast Trip Tables

The estimated trip tables are prepared independently of trip generation and distribution steps so these steps cannot be used to produce forecasts. Forecast trip tables are produced by factoring the estimated trip table based on changes in county-level employment and population. Standard trip generation rates were applied to the Global Insight (medium- growth scenario) 2020 and 2035 population and employment and for the Woods and Poole (high-growth scenario) 2020 and 2035 population and employment forecasts. Those rates were applied to the base automobile and non-commodity freight truck trip tables using the ratio of the base and future control totals by county using an Iterative Proportional Fitting technique (i.e., Fratar). The future freight truck table was developed by allocating the FAF2 2020 and 2035 trip tables in exactly the same manner that the base year commodity trip table was created.

A.2.5 Future Assignments

The development of future year trip tables together with the existing and future highway networks provided the ability to forecast future highway volumes for those future networks. The No-Build highway network was created by updating the base year network with ARC "Cost to Complete" GIS database. That database was used to identify ADHS improvement that have been completed or will be completed by others, in addition to ADHS projects where construction is committed by ARC. Those projects define the No-Build highway network. Those ADHS project for which funding has not yet been secured are part of the Build scenario. The ARC "Cost to Complete" GIS database was used to determine the proposed number of lanes and the proposed design speed for widen section of ADHS highway, and the design and location of new roads.