A COMMUNITY PRIMER

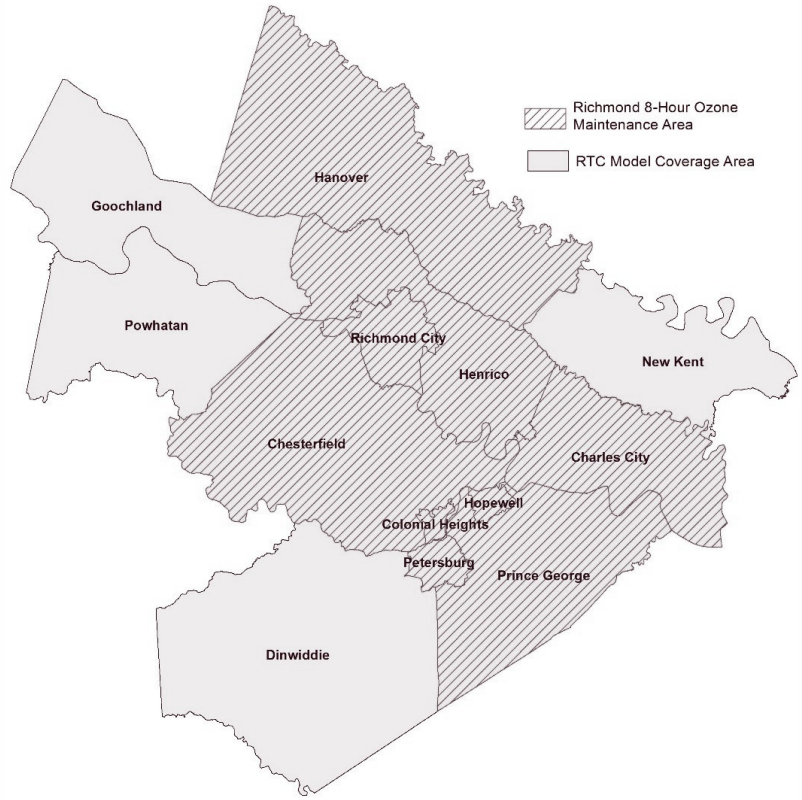
THE RTC MODEL

THE TRAVEL DEMAND MODEL

April 2, 2021

The Richmond Regional Transportation Planning Organization (RRTPO) and Tri-Cities MPO being in one urbanized area have a single Regional Travel Demand Model - the Richmond/Tri-Cities Model (RTC Model or simply 'the model'). The RTC Model was developed by VDOT and is maintained by RRTPO. The RTC model simulates automobile, transit and truck flows on the regional network and forecasts future demand using a four-step process that addresses trip generation, trip distribution, mode choice and route assignment. The RTC Model uses the CUBE modeling platform consisting of a library of scriptable programs that facilitate construction of travel demand forecasting models. The current version of the RTC model was built in CUBE Version 6.4. The RTC Model is an essential analytical tool for both regional and corridor transportation planning.

It is used in future corridor plans, scenario planning efforts, planning studies and to support the development of the Long-Range Transportation Plan (LRTP). In addition, the outputs from the RTC Model are used for further analysis with other tools for air quality conformity, traffic microsimulation, and economic modeling. The coverage area of the RTC model includes the Richmond 8-hour ozone maintenance area as well as New Kent, Goochland, Powhatan, and Dinwiddie counties as shown in the map to the right.

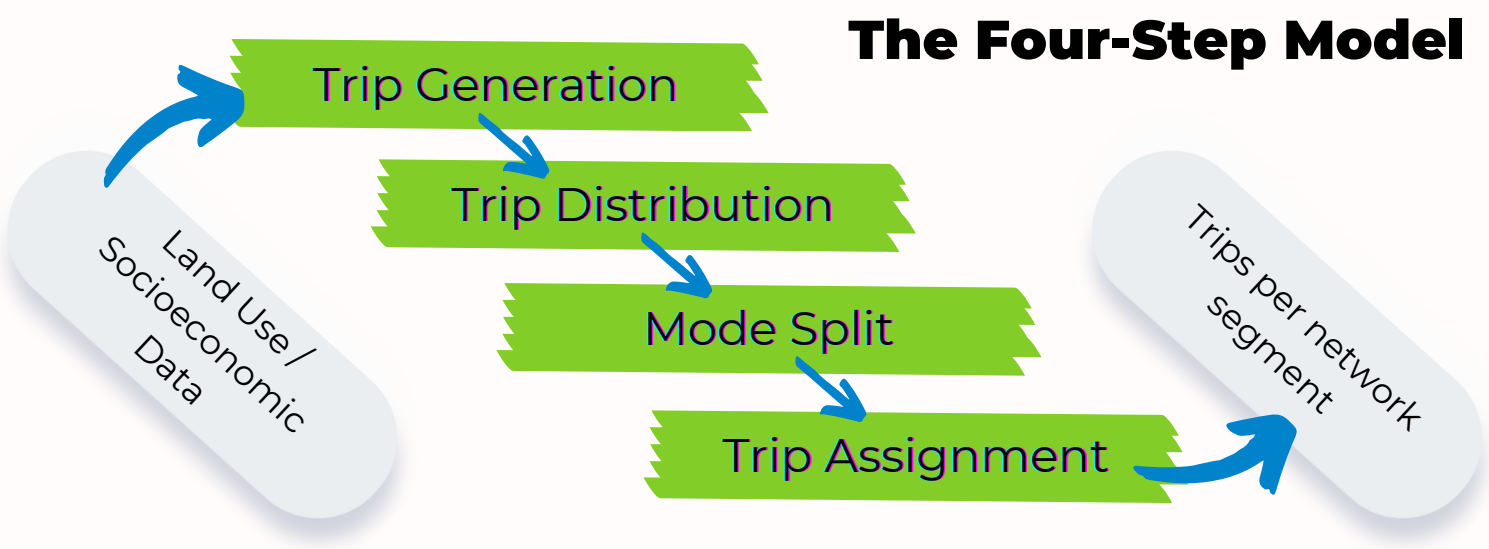


The current version of the RTC Model has a base year of 2017 and a future/horizon year of 2045. The RTC Model was validated against 2017 auto and truck traffic volumes, transit ridership, land use data, demographics, and other socio-economic factors. The 2017 validated model was then used to develop future year model scenario which forecasts future year auto and truck traffic and transit ridership.

In the RTC Model, the highway and transit system data are coded in line files to create a representation of the regional transportation network. Attributes coded into the network include highway features such as road segment length, capacity, number of lanes, federal functional classification, area-type and free-flow speed, and transit operating characteristics such as fares, bus stops, and hours and frequency of service. The networks include all available motorized modes of travel, including single-occupant automobiles, multiple-occupant ("high occupancy") automobiles, park-and-ride, BRT, express bus service, and standard bus service. Based on the coded network, travel time and cost data are tabulated for use in subsequent model steps.

Trip Generation

The trip making activity is estimated during the trip generation and trip distribution steps. Trip generation uses summary information from each traffic analysis zone (TAZ) to compute the number of trips produced in and attracted to each TAZ. The summary information includes number of households, total population, group-quarters population, retail and non-retail employment, and number of automobiles available to households. These socio-economic data are prepared by RRTPO and Tri-Cities MPO and compiled for use in the model. Trips are generated by purpose (home based work, home based other and non-home based). Commercial vehicle activity is separated as different trip purpose. Trips that start or end outside the Richmond region, as well as trips that simply pass through the region, are treated as separate trip purposes as well. These external trips were estimated from traffic counts observed at major exit stations in the year 2017 and then expanded for future years using growth trend estimates provided by VDOT Statewide Planning System (SPS).



Trip Distribution

The trip distribution step joins the production and attraction end of each trip using factors designed to reproduce observed traffic volumes and trip times in the base year. The trip distribution step uses a standard gravity model, with different factors for each trip purpose. It uses feedback from the highway assignment into trip distribution to better approximate observed traffic conditions (and, in the future years, to better estimate the differential effects of additional trips and transportation facilities). The feedback takes into account the effect of congestion on route choice, since the most commonly chosen route to a destination will depend on whether or not a particular route is congested or free-flowing, and the level of congestion in turn depends on what route travelers are most inclined to choose

Mode Split

The trip tables from trip distribution, along with network-based travel time and cost data, are input to the mode split step to estimate trip tables by trip purpose, travel period (peak or off-peak) and mode. The mode split step uses a nested logit model to allocate trips between automobile, regular bus and express bus, based on differences in time and cost among the modes. Auto-occupancy rates that vary by trip purpose is applied to automobile trips, and the trip tables are assembled for assignment to the highway and transit networks.

Trip Assignment

During the highway assignment step, trips between each zone pair are loaded onto the highway network and balanced with congestion effects. Highway assignment uses a capacity restraint formula that limits how many trips can be assigned to each roadway link based on its practical capacity. During assignment, routes are assembled between each zone pair based on the shortest routes under congested conditions. A feedback loop is included to ensure that speeds from the resulting highway assignments are fed back through the forecasting process. The model has full separate feedback loops for peak (AM and PM periods) and off peak (MD and NT) period assignments, which later are combined to create daily outputs

In transit assignment, trips are assigned to the most efficient transit route available, considering waiting time, travel time, transfers required, and fare. Transit assignment is based on the best route and does not have a capacity restraint or congestion balancing component. Transit assignments are made for peak and off-peak periods, not four periods. The model does not deal with non-motorized trips (walk and bike), except for walk access to transit.

The output of the highway assignment process is a network file that includes forecast traffic volumes on each roadway segment, as well as an estimate of congested travel speed. That file is referred to as a “loaded network”.

This overall modeling process is applied for each analysis year.

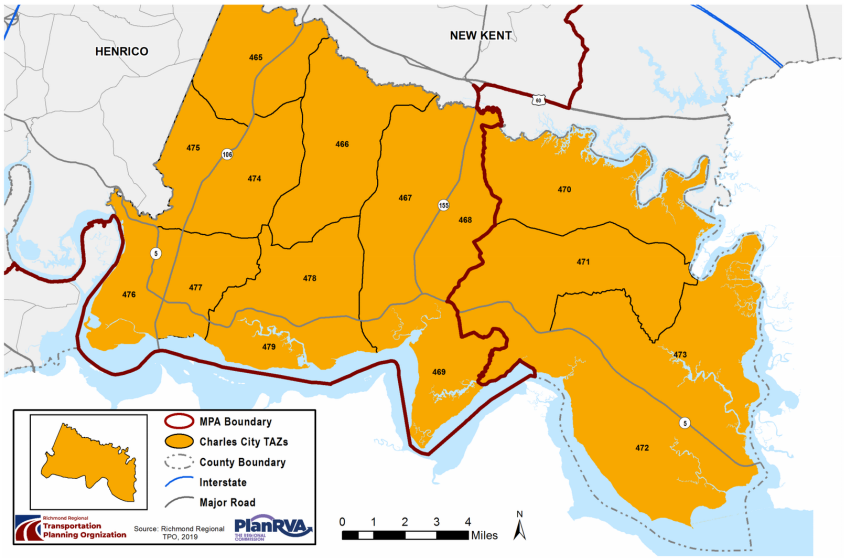
Socioeconomic Forecasts

The RRTPO and Tri-Cities MPO developed the socioeconomic data to be used in the RTC Model with input and active participation from the representatives from the counties of Charles City, Chesterfield, Hanover, Henrico and Prince George as well as the cities of Colonial Heights, Richmond, Hopewell and Petersburg (See below for sample excerpt from Charles City County). The counties of Goochland, Powhatan, New Kent and Dinwiddie are not part of the 8-hour ozone maintenance area but provided input in the development of the socioeconomic data, as they are part of the modeled region.

For 2017 estimates, population and household data was developed using a bottom up approach by tracking local residential development. Automobile data was developed using the 2017 DMV Auto registration data. Employment was developed using 2nd quarter 2017 Virginia Economic Commission (VEC) data.

For 2045 projections, the population control totals were established using the Weldon Cooper population projection. The counties/cities could deviate from the Weldon Copper projection by plus/minus 10 percent. The employment control totals were established by Chmura Economics & Analytics using existing employment projections from other sources as well as secondary research on the economic structural change in the United States. Other control totals were derived from population and employment control totals. The forecasted employment and population were distributed in the TAZs based on pipeline and planned commercial and residential development projects and considering the locality comprehensive plans and future land use maps. The forecasted numbers were prepared under the guidance of the member governments and approved by the respective MPOs.

Charles City County Map



Charles City County

	Population						Housing						School Enrollment				Employment					
	Total		In Occupied Housing Units		In Group Quarters		Housing Units		Households		Automobiles		Grade K-12		Colleges		Total		Retail		Non-Retail	
TAZ	2017	2045	2017	2045	2017	2045	2017	2045	2017	2045	2017	2045	2017	2045	2017	2045	2017	2045	2017	2045	2017	2045
465	766	918	766	918	0	0	358	429	309	370	977	1,170	0	0	0	0	144	156	7	8	137	148
466	1,109	1,329	1,109	1,329	0	0	517	620	447	536	1,525	1,829	0	0	0	0	47	47	5	5	42	42
467	694	832	694	832	0	0	324	388	280	336	802	962	650	617	0	0	144	156	7	8	137	148
468	424	508	424	508	0	0	198	237	171	205	619	742	0	0	0	0	22	34	1	2	21	32
469	169	203	169	203	0	0	79	95	68	82	182	219	0	0	0	0	324	337	32	34	292	303
470	322	386	322	386	0	0	151	181	130	156	354	425	0	0	0	0	33	33	0	0	33	33
471	501	600	501	600	0	0	234	280	202	242	604	724	0	0	0	0	25	25	1	1	24	24
472	481	576	481	576	0	0	225	269	194	232	501	599	0	0	0	0	48	48	5	5	43	43
473	275	330	275	330	0	0	128	154	111	133	290	347	0	0	0	0	0	0	0	0	0	0
474	580	695	580	695	0	0	271	325	234	280	780	933	0	0	0	0	11	21	0	1	11	20
475	419	502	419	502	0	0	196	235	169	202	527	630	0	0	0	0	13	13	2	2	11	11
476	122	146	122	146	0	0	57	68	49	59	111	134	0	0	0	0	59	59	2	2	57	57
477	481	576	481	576	0	0	224	268	194	232	619	740	0	0	0	0	4	4	0	0	4	4
478	689	826	689	826	0	0	322	386	278	333	697	835	0	0	0	0	14	14	0	0	14	14
479	94	113	94	113	0	0	44	53	38	46	84	102	0	0	0	0	21	21	1	1	20	20
Total	7,126	8,540	7,126	8,540	0	0	3,328	3,988	2,874	3,444	8,672	10,391	650	617	0	0	1,668	1,832	96	112	1,572	1,720

Charles City County SE Data Report Excerpt