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Savannah/Coastal Region Metropolitan Planning Organization

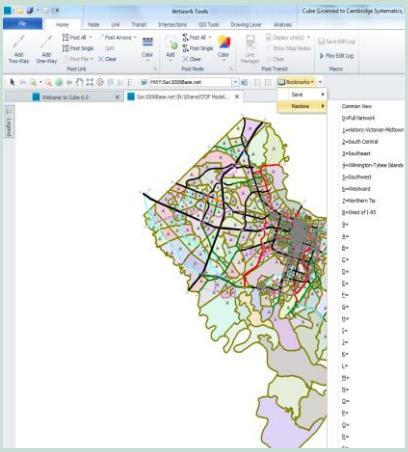
Travel Demand Model Technical Review & Improvements

prepared for

CORE MPO and RS&H

prepared by

Cambridge Systematics, Inc.



September 2013

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Executive Summary

This technical memorandum provides a summary of work completed by Cambridge Systematics for the Savannah/Coastal Region (CORE) Metropolitan Planning Organization (MPO) on reviewing base year 2006 model files and assumptions. The purpose of this two task work effort is to review the current CORE MPO travel demand forecasting (TDF) model structure and recommend model enhancements or structural changes to serve the analytical needs of the MPO.

The first task of this project assessed the suitability of current modeling procedures in light of current and likely future demands for analysis, while the second task focused on recommended model enhancements and associated implementation strategies. The current 2006 model, developed by the Georgia Department of Transportation (GDOT) is in the process of being updated by GDOT. This report can inform the model update and review of final products resulting from the model update.

A detailed review of the current model and its documentation led to the following key findings on suitability of the existing model:

- Refinements should be made to the highway network, especially area types, screenlines, and assumptions used for speeds and capacities;
- Enhancements are recommended for the traffic analysis zone (TAZ) system, particularly with respect to warehousing and distribution centers;
- Model parameter assumptions are often outdated and in need of updating to more current sources; and
- While model validation and sensitivity appear reasonable, there is little documentation on what changes were made to the model during validation… the MPO should insist on these details from the current model update.

Discussions with MPO staff, evaluation of model limitations, and comparisons with peer models led to a series of recommendations on future model enhancements:

- Many options are available for MPO training and data needs;
- The model should be updated to include complete transit modeling capabilities including transit networks, transit skims, mode choice, transit assignment, and post processing;
- Additional refinements to the freight model are recommended that reflect the importance of the Port of Savannah to the regional economy and local traffic conditions;

- A simplified time-of-day model should be considered to better simulate the impacts of peak period congestion;
- While non-motorized travel is beyond the capabilities of most peer models, the unique walkability of Savannah's historic district merits consideration of at least a simplified approach to bicycle/pedestrian modeling;
- The model should be updated to maximize the use of currently available Cube modeling capabilities such as the application manager and consistent visualization through use of vpr files;
- Relocation of South Carolina external zones is recommended for alternate routing patterns;
- Performance measurements required by MAP-21 legislation should result in additional post-processing capabilities for the regional model; and
- Consideration should be given to targeted modeling of tourist travel, especially within the historic district.

There are other recommendations beyond those listed above provided elsewhere in this report; however, the above bulleted items represent the higher, more immediate priorities for model refinement in the Savannah region.

1.0 Introduction

This technical memorandum provides a summary of work completed by Cambridge Systematics for the Savannah/Coastal Region (CORE) Metropolitan Planning Organization (MPO) on reviewing base year 2006 model files and assumptions. The purpose of this work effort is to review the current CORE MPO travel demand forecasting (TDF) model structure for the Savannah-Chatham County region and recommend model enhancements or structural changes needed to serve the current and anticipated analytical needs of the CORE MPO.

The work effort is divided into two primary tasks. The first task focused on a review of the suitability of current modeling procedures in light of current and likely future demands for model driven analysis, while the second task focused on developing recommended model enhancements and associated implementation strategy. The current 2006 model, developed by the Georgia Department of Transportation (GDOT) with consultant support,[1] is in the process of being updated again by GDOT. This report can inform the model update and review of final products resulting from the model update.

1.1 INTERVIEWS WITH MPO STAFF

During a project kickoff meeting held at Cambridge Systematics' Atlanta office on September 19, 2012, consultant staff discussed modeling issues with MPO staff to identify modeling priorities from the MPO's standpoint. Key points made during these discussions included the following:

- Initial thoughts on the work effort were to improve model validation; however, the focus was shifted to assessing model performance and recommending a model improvement plan.
- The current model is used for running project-based scenario analysis; however, model cannot answer the questions the MPO is asking.
- CORE MPO staff runs the model in-house or via consultants, and does not rely on GDOT for model runs.
- Model is essentially a three-step model with no mode choice step.
- Augusta 1996 Household Travel Survey – basis for all model parameters.

[1] *CORE MPO Travel Demand Model Documentation*, prepared for GDOT by PBS&J, June 2009.

- No recent external/roadside origin-destination surveys have been conducted.
- Savannah Area Geographic Information System (GIS) (SAGIS) has GIS data, but for Chatham County only.
- Potential focus areas of model review:
  - Review model validation to flag any major issues;
  - Mode Choice and Public Transit steps;
  - Nonmotorized transit modeling:
    - » The MPO has bicycle/pedestrian counts from the past four years, but no trip/survey data;
  - Look into current tolling capabilities and value-of-time and ways to update;
  - Freight modeling and impacts of the Port;
  - MPO expansion:
    - » Southern part of Bryan County and part of Effingham County to SR 119.
    - » No plans to expand into South Carolina… undeveloped buffer of marshlands; more external trips from Effingham County, Georgia, than South Carolina.
  - Air Quality component and Emissions Calculator – greenhouse gas (GHG) reductions;
  - Tour-/activity-based model – while it is doubtful that the MPO will move to Activity-Based Model, understanding of incremental steps would be helpful;
  - Land-use forecasting:
    - » Only spreadsheet tools are used at this time; and
    - » Comprehensive Planning staff typically compiled socioeconomic data, but RS&H has recently taken over some responsibilities.
- CORE MPO objectives and priorities for model refinement (focus of Task 2):
  - Ability to test smart growth scenarios.
  - Add transit modeling capability.
  - Truck/freight modeling.
  - Toll capabilities.
  - Model expansion into Bryan/Effingham Counties.

- Will MPO move towards greater ownership of model in the future? If benefit is compelling enough, then potentially "yes."
- Off-model techniques, where appropriate.

1.2 ORGANIZATION OF REPORT

Section 2.0 of this technical memorandum covers the first task described above on the existing model, while Section 3.0 describes second task activities on future model enhancements. The report concludes with Section 4.0 describing key recommendations and potential next steps.

2.0 Review/Suitability of Current Modeling Procedures

This first task effort focused on a review of current modeling procedures in the CORE MPO model. The purpose of this review was to assess how well the current model structure meets the analytical needs of the CORE MPO, both current and anticipated. The existing modeling platform; model structure; and resource needs to run, apply, and maintain the model were evaluated and informed the roadmap to implementation (Task 2). Efforts conducted during this task were supplemented with a best practice review of peer MPO models, hands-on testing of the CORE MPO model, and interviews with MPO staff to assess overall resource availability and resource needs as they relate to running and applying the model for a variety of analysis needs. This section of the report is focused on the first primary task.

Table 2.1 is a checklist spreadsheet used to document model checks that were completed, along with commentary, where appropriate. The following describes each model check conducted along with general findings. Section 1.0 of this report described highlights of MPO staff interviews and discussions.

2.1 REVIEW OF HIGHWAY NETWORK

A series of checks were conducted on the existing model network including traffic analysis zones (TAZ), facility types, number of lanes, area types, speeds and capacities, and counts and screenlines. Findings from each of these checks are described below.

TAZs and Centroid Connectors

The traffic analysis zone (TAZ) system used in the model was reviewed for completeness and consistency. It is understood that some of the more peculiar zone boundaries in the current model result from following Census geography. Therefore, some of the recommended zone splits and boundary changes might not be implementable. Independent of the TAZ assessment conducted for this project, MPO staff recently identified new zone configurations in planning for a 2010 Update to the Census Transportation Planning Products (CTPP); however, these updated CTPP zones have not yet been incorporated into the regional TDF model. It is hoped that the ongoing GDOT model update will consider the 2010 CTPP zones along with the 33 TAZ changes to the current model zone system recommended and summarized in Table 2.2.

Table 2.1 Model Suitability Checklist

Item #	Short Name of Suitability Check	Description of Suitability Check and Related Work Efforts	Review Started?	Review Completed?	Comments/Findings on Suitability Check
1	Interviews with MPO staff	Met with CORE MPO staff on September 19th. Subsequent meeting notes describe directions that staff would like for us to consider and what not to investigate.	Y	Y	Issues discussed with MPO staff are all addressed in Section 3 of this report, on Recommendations for Implementation of Model Enhancements.
2	Highway Network – TAZs and Centroid Connectors	Made plots… cursory review underway	Y	Y	*MPO noted that staff played a major role in developing the earlier 2000 network and zone system.* CS provided a list of zones that could/should be reconfigured. *MPO indicated history of Census geography and GDOT maximum number of zones.* See Table 2.2 for specifics.
3	Highway Network – Facility Types	Made plots… cursory review *completed*	Y	Y	Principal and minor arterials are both divided into Classes I and II without explanation on what this means… perhaps this is a functional classification, signal density category, or presence of median. Logical hierarchy in selection of facility types across the network, with a few exceptions.
4	Highway Network – Number of Lanes	Made plots… cursory review underway	Y	Y	Review completed. Summary of comments is provided in Table 2.3.
5	Highway Network – Area Types	Made plots… cursory review *completed*	Y	Y	Some concerns that area type is estimated based on BOTH residential and employment densities… this approach does not properly distinguish suburban commercial from residential. Sometimes suburban, exurban, rural are mixed up. *CS provided pdf of area types/boundaries.*
6	Highway Network – Speeds and Capacities	Reviewed model documentation; reviewed model script for further details	Y	Y	Documentation is somewhat vague on the sources for these assumptions. Contrary to the Florida DOT LOS Handbook, capacities are higher in rural areas and lowest in high-density areas. Speed values reflect a logical hierarchy, although centroid speeds could be lower than local streets. See Table 2.4 for specifics.

Item #	Short Name of Suitability Check	Description of Suitability Check and Related Work Efforts	Review Started?	Review Completed?	Comments/Findings on Suitability Check
7	Highway Network – Counts and Screenlines	Made plots… cursory review *completed*	Y	Y	Screenline numbers in Figure 2.5.1-1 found in model documentation are not consistent with screenlines coded into the network… merits additional evaluation. There are some missing screenline links, S/L 5 is messy, S/L 13 has only one link, and S/L 36 is in place for non-S/L purposes. *MPO indicated counts are inconsistent year over year and not enough special counts.*
8	Socioeconomic Data	Reviewed model documentation and SE data file	Y	Y	Initial reaction is that the SE data format used in the model is rather simplistic and relies heavily on generic distribution curves. Identify alternate considerations. *MPO had concerns over lack of employment surveys.*
9	Model Structure and Parameter Assumptions	Reviewed model documentation and parameter settings appear to be based on 1990s era Augusta household travel survey	Y	Y	It might be more appropriate to update trip rates and other parameters based on 2009 NHTS Georgia Add-On. *Looked into NHTS sample and HH distribution pattern within Georgia and discovered there were only 151 HHs in the survey from Chatham County.*
10	Model Validation and Reasonableness	Prepared model validation worksheet, including comparisons of model statistics against established accuracy and reasonableness standards, peer models, and ACS data	Y	Y	See validation worksheet for specific comments on each step of the model chain. *Penalty locations confirmed to represent rail crossings.*
11	Resource Requirements	Some files were missing from the original CD provided to MPO staff, but were later downloaded from a GDOT ftp site.	Y	Y	Five-minute model execution time… great!
12	Model Sensitivity Testing	Will try a few random modifications to model demand and supply data and check model's responsiveness.	Y	Y	Three model sensitivity tests were run with the model. The resulting elasticity calculation shows a reasonable level of sensitivity to change.

Table 2.2 Traffic Analysis Zones (TAZs) for Potential Splitting

Number	Zone(s)	Issue/Problem	Potential Solution(s)	New Boundary for Splitting
1	14	Bisected by roadway	Split zone	Quarterman Drive
2	15	Bisected by roadway	Split zone	Sea Island Drive
3	18	Bisected by roadway	Split zone	Wilmington Island Road
4	25	Bisected by roadway	Split zone	U.S. 80
5	228	Bisected by roadway	Split zone	Middle Ground Road/Montgomery Cross Rd
6	229	Bisected by roadway	Split zone	Duncan Street/Mitchell Blvd
7	353	Bisected by roadway	Split zone	Gaston Street
8	406	Bisected by roadway	Split zone	Carolan Street
9	415	Bisected by roadway	Split zone	SR 21/Augusta Road
10	423	Bisected by roadway	Shift zone boundary	SR 404/U.S. 17/Talmadge Bridge Approach
11	440	Bisected by roadway	Split zone	SR 204
12	442	Bisected by roadway	Split zone	Ogeechee Road
13	450	Elongated zone	Split zone	Extend boundary of 451/452
14	470	Zone appendage/sliver	Shift zone boundary	Extend 470/471 boundary to the east/south
15	507	Zone appendage/sliver	Shift zone boundary	Shift 506 up to SR 25/N. Coastal Highway
16	529	Elongated zone	Split zone	Extend boundary of 530/534 and 519/520
17	534	Bisected by roadway	Shift zone boundary	SR 307/Bourne Avenue
18	535	Zone appendage/sliver	Shift zone boundary	Extend 535/537 boundary to the south
19	536	Elongated zone	Split zone	Old Dean Forest Road/Sheftall Road
20	543	Bisected by roadway	Split zone	Old Dean Forest Road
21	556	Elongated zone	Split zone	Midpoint roadway or physical feature?
22	557	Elongated zone	Split zone	Midpoint roadway or physical feature?
23	561	Elongated zone	Split zone	Greenview Drive or Cedar Point Drive
24	647	Elongated zone	Split zone	Midpoint roadway or physical feature?
25	648	Large zone/NE boundary is off	Split zone/shift boundary	Little Ogeechee Pond/along Quacco Road
26	146/147	Bisected by roadway	Shift zone boundary	General McIntosh Blvd
27	231/232	Bisected by roadway	Shift zone boundary	Habersham Street
28	311/312	Bisected by roadway	Shift zone boundary	Williamson Street (?)
29	464/456/ 457	Bisected by roadway	Shift zone boundary	Mills Lane (west) and Liberty Pkwy (east)
30	549/560	Zone appendage/sliver	Shift zone boundary	Extend 549/560 boundary to the east
31	613/614	Irregular boundary	Shift zone boundary	Midpoint roadway or physical feature?
32	615/616	Bisected by roadway	Shift zone boundary	Perry Road
33	627/628	Bisected by roadway	Shift zone boundary	Osteen Road

Supplemental work efforts will be necessary to fully assess the location of centroids and centroid connectors for recommended zone configurations, although it is recognized that some adjustments to these locations might be underway during the GDOT model update. A complete assessment of centroid/ connector locations should include an assessment of potential access from each zone in conjunction with a review of volume-over-count ratios on adjacent roadway segments.

Numerous instances were identified on plots where roadway alignments in the current model do not properly follow zone boundaries. It appears that current model zone boundaries are more geographically correct than the corresponding model network. Consideration could be given to using a vendor-supported database (e.g., NAVTEQ) for development of highway networks in the future.

Highway Network Facility Types

Highway network coding of facility type was checked for general consistency. In general, the coding of facility types looks reasonable, although there were instances of higher order facilities terminating in lower order facilities that should be confirmed. Also, the stretch of Abercorn Street in the Georgetown area could potentially be coded as an arterial rather than expressway since it includes a couple of at-grade intersections, although admittedly there is no driveway access along this segment. One item that remains puzzling, even after reviewing the GDOT document, entitled *General Summary of Travel Demand Model Development Procedures*,[2] is the classification of arterials into Class I and Class II. No definition was provided for these categories such that this coding could be verified.

Highway Network Number of Lanes

A cursory review of laneages identified three segments where the lanes coded into the model were inconsistent with satellite imagery from Google Maps. It is possible that some of these segments have been widened since the model base year. Table 2.3 provides a listing of these three roadway segments.

Table 2.3 Number of Lanes Coding

Number	Roadway	From	To	Model Lanes	Google Lanes
1	SR 21/Augusta Road	Minis Avenue	Burnseed Blvd Ramps	4	6
2	Pooler Parkway	Westbrook Lane	Quacco Road	2	4
3	U.S. 80	Chatham County Line	Cherry Street	2	4

[2] *General Summary of Travel Demand Model Development Procedures*, prepared for Georgia Department of Transportation by PBS&J, March 2009.

Highway Network Area Types

Area types are automatically assigned to the highway network based on population and employment densities. While use of an automated area type process has some advantages, such as accounting for density changes among different years and alternatives, it also interferes with the need for local knowledge to be injected into the assignment of area types. One concern of the process used in the Savannah model is that area type is always estimated based on BOTH residential and employment densities. Results from this approach do not properly distinguish suburban commercial from suburban residential. Also, sometimes suburban, exurban, and rural are mixed up in terms of sequencing with sole reliance on density. In general, suburban areas are closer to the urban core than exurban and rural areas should lie beyond exurban areas. The resulting area type designations are inconsistent with designated urbanized area boundaries.

Highway Network Speeds and Capacities

Available documentation is somewhat vague on the sources for assumptions on speeds and capacities, even after reviewing the GDOT document on travel demand model development procedures. Contrary to the *Florida DOT LOS Handbook*[3], capacities in the Savannah model are higher in rural areas and lowest in high-density areas. Speed values reflect a logical hierarchy, although centroid speeds should be lower than local streets. Even the location of the speed/capacity data in the model script could be modified, such that a separate dbf file is used to store this information for ready access and limited updating for new model versions. Table 2.4 provides a comparison between GDOT standard speeds and capacities vs. those values found in the Savannah model.

At this point in time, there are a multitude of sources for data on operating speeds and posted speeds so reliance on older lookup tables is not entirely necessary. For a cost, data vendors such as INRIX, NAVTEQ, and TomTom can provide extensive roadway network databases with both posted and operating speeds. A number of options are available to collect speed data in the field now from Geologgers to Bluetooth readers, and tracking of anonymous cellular movements. Even these data must be used with caution as speeds vary by time of day and data might not fully account for acceleration and deceleration times.

[3] *Quality/Level of Service Handbook*, Florida Department of Transportation, 2013.

Table 2.4 Existing Model Network Speeds and Capacities

	Area Types									Area Types								
	High Density Urban	High Density Urban Commercial	Urban Residential	Suburban Commercial	Suburban Residential	Exurban	Rural			High Density Urban	High Density Urban Commercial	Urban Residential	Suburban Commercial	Suburban Residential	Exurban	Rural	
FTYPEs	1	2	3	4	5	6	7	Facility Types	FTYPEs	1	2	3	4	5	6	7	Facility Types
Capacity									**Savannah- GDOT Difference**								
1	1,900	1,900	2,000	2,000	2,200	2,200	2,000	Interstate	1	0	50	0	50	-100	-140	20	Interstate
2	1,800	1,800	1,900	1,900	2,000	2,000	1,900	Freeway	2	-200	-140	-170	-110	-150	-180	-120	Freeway
3	1,300	1,300	1,400	1,400	1,500	1,500	1,400	Expressway	3	0	80	50	130	100	70	140	Expressway
4	1,200	1,200	1,300	1,300	1,400	1,400	1,300	Parkway	4	-30	40	10	70	40	10	80	Parkway
6	1,600	1,600	1,800	1,800	1,900	1,900	1,800	Freeway-to-Freeway Ramp	6	-200	-70	-150	-20	0	1670	20	Freeway-to-Freeway Ramp
7	1,400	1,400	1,700	1,700	1,800	1,800	1,700	Entrance Ramp	7	-500	-370	-550	-420	-400	-430	-360	Entrance Ramp
8	1,200	1,200	1,400	1,400	1,600	1,600	1,400	Exit Ramp	8	-400	-390	-590	-580	-780	-790	-610	Exit Ramp
11	1,100	1,000	1,200	1,200	1,400	1,400	1,200	Principal Arterial - Class I	11	-150	-40	-220	-210	-400	-420	-240	Principal Arterial - Class I
12	900	900	1,000	1,000	1,100	1,100	1,000	Principal Arterial - Class II	12	0	0	-100	-100	-200	-220	-140	Principal Arterial - Class II
13	800	800	900	900	1,000	1,000	900	Minor Arterial - Class I	13	0	10	-90	-80	-180	-190	-110	Minor Arterial - Class I
14	700	700	800	800	900	900	800	Minor Arterial - Class II	14	-70	-70	-160	-160	-260	-270	-190	Minor Arterial - Class II
15	750	750	850	850	950	950	850	One-Way Arterial	15	10	10	-80	-80	-180	-190	-110	One-Way Arterial
21	600	600	700	700	800	800	700	Major Collector	21	-80	-70	-160	-150	-240	-250	-160	Major Collector
22	500	500	600	600	700	700	600	Minor Collector	22	-120	-110	-210	-200	-300	-310	-220	Minor Collector
23	550	550	650	650	750	750	650	One-way Collector	23	-90	-80	-180	-170	-270	-280	-190	One-way Collector
30	400	400	500	500	600	600	500	Local Roads	30	-60	-50	-140	-130	-220	-230	-140	Local Roads
32	0	0	0	0	0	0	0	Centroids	32	0	0	0	0	0	0	0	Centroids
Speed									**Savannah - GDOT Difference**								
1	55	60	60	60	60	70	70	Interstate	1	0	0	0	0	0	0	0	Interstate
2	50	55	55	55	55	60	60	Freeway	2	0	0	0	0	0	0	0	Freeway
3	50	50	50	50	55	55	55	Expressway	3	0	0	0	0	0	0	0	Expressway
4	45	50	50	50	50	55	55	Parkway	4	0	0	0	0	0	0	0	Parkway
6	55	55	55	55	55	55	55	Freeway-to-Freeway Ramp	6	0	0	0	0	0	0	0	Freeway-to-Freeway Ramp
7	45	50	50	50	50	55	55	Entrance Ramp	7	0	0	0	0	0	0	0	Entrance Ramp
8	22	23	30	31	34	40	47	Exit Ramp	8	0	0	0	0	0	0	0	Exit Ramp
11	25	28	33	34	37	47	52	Principal Arterial - Class I	11	0	0	0	0	0	0	0	Principal Arterial - Class I

	Area Types									Area Types								
	High Density Urban	High Density Urban Commercial	Urban Residential	Suburban Commercial	Suburban Residential	Exurban	Rural			High Density Urban	High Density Urban Commercial	Urban Residential	Suburban Commercial	Suburban Residential	Exurban	Rural	
FTYPEs	1	2	3	4	5	6	7	Facility Types	FTYPEs	1	2	3	4	5	6	7	Facility Types
12	23	26	31	32	35	45	49	Principal Arterial - Class II	12	0	0	1	1	1	0	0	Principal Arterial - Class II
13	22	23	30	31	34	40	47	Minor Arterial - Class I	13	0	0	1	1	1	0	0	Minor Arterial - Class I
14	21	22	27	30	32	38	45	Minor Arterial - Class II	14	0	0	0	0	0	0	0	Minor Arterial - Class II
15	23	26	30	32	35	42	48	One-Way Arterial	15	1	1	2	1	1	3	1	One-Way Arterial
21	17	18	21	27	29	34	42	Major Collector	21	3	3	1	1	1	1	2	Major Collector
22	14	15	18	24	26	30	40	Minor Collector	22	0	0	2	1	1	0	0	Minor Collector
23	17	18	21	27	29	34	42	One-way Collector	23	0	0	0	0	0	0	0	One-way Collector
30	14	14	17	18	22	28	35	Local Roads	30	0	0	1	2	1	0	-3	Local Roads
32	14	14	17	18	22	28	35	Centroids	32	0	0	1	2	1	0	-3	Centroids

Highway Network Counts and Screenlines

Cambridge Systematics staff reviewed screenline locations currently found in the model network and confirmed the completeness of each screenline and the inclusion of traffic counts for each screenline link. Screenline numbers in Figure 2.5.1-1 of the model documentation are not consistent with screenlines coded into the network. There are some missing screenline links here and there; Screenline 5 is somewhat disjointed; Screenline 13 is comprised of only one link; and Screenline 36 is in place for nonscreenline corridor summary purposes. Discussions with MPO staff indicated that counts are inconsistent year over year and not enough special counts are conducted to coincide with base year(s).

2.2 REVIEW OF SOCIOECONOMIC DATA

In the opinion of Cambridge Systematics, the socioeconomic data format used in the model, while consistent with most Georgia models, is rather simplistic and relies heavily on generic distribution curves. Sufficient data are available from the American Community Survey (ACS) and CTPP to replace these stratification curves with ones specific to the Savannah region. Even the location of the household stratification curves in the model script could be modified such that a separate dbf file is used to store this information for ready access and limited updating for new model versions. The MPO also expressed concerns over lack of employment surveys. Employment data are best estimated using a variety of proprietary (e.g., Infogroup) and nonproprietary (Longitudinal Employer Household-Dynamics or Quarterly Census of Employment and Wages) sources.

2.3 MODEL STRUCTURE AND PARAMETER ASSUMPTIONS

Cambridge Systematics staff reviewed model documentation and parameter files to better understand the source of parameters used in the Savannah model. In many cases, either the parameter settings used were based on outdated assumptions or the source was not documented and could not be confirmed. In place of generic parameters or those based on past surveys of different areas, it might be more appropriate to update trip rates and other parameters based on the 2009 National Household Travel Survey (NHTS) Georgia Add-On; however, the NHTS sample and household distribution pattern within Georgia only included 151 households in the survey from Chatham County. New information is available from the following reports authored by Cambridge Systematics that could be used for new parameter assumptions and validation standards:

- National Cooperative Highway Research Program (NCHRP) Report 716;[4]
- Model Validation and Reasonableness Checking Manual Second Edition;[5]
- Florida Standard Urban Transportation Model Structure (FSUTMS)-Cube Model Validation and Calibration Standards;[6] and
- Long-Distance and Rural Travel Transferable Parameters for Statewide Travel Forecasting Models.[7]

Each of the abovementioned reports can be used as a source for new transferable model parameters or updated calibration and validation guidance. As part of the parameter check, Cambridge Systematics reviewed all penalties included in the model and found that penalties were only included at rail crossings and draw bridges; locations where the use of penalties can be justified.

2.4 MODEL VALIDATION AND REASONABLENESS

A comprehensive model validation worksheet was prepared to summarize model output statistics for each step in the model chain. Statistics output by the model were compared against statistics found in model documentation to ensure replication. Comparisons were also made between the model and observed data, other models, and guidelines/standards of acceptability. The validation worksheet can be found in Appendix A.

Below is a summary of model validation findings and suggested improvements:

- **Trip Generation.** Percent home-based other (HBO) trips are somewhat high, but many models divide HBO into additional trip purposes. Commercial vehicle and internal-external trips look reasonable. Aggregate trip rates for trips/household (HH) and trips/person are towards the upper end, yet

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[4] *NCHRP Report 716, Travel Demand Forecasting: Parameters and Techniques*, prepared by Cambridge Systematics for Transportation Research Board, 2012, http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_716.pdf.

[5] *TMIP Travel Model Validation and Reasonableness Checking Manual 2nd Edition*, prepared by Cambridge Systematics for Federal Highway Administration, 2008, http://media.tmiponline.org/clearinghouse/FHWA-HEP-10-042/FHWA-HEP-10-042.pdf.

[6] *FSUTMS-Cube Framework Phase II: Model Validation and Calibration Standards*, prepared by Cambridge Systematics for Florida Department of Transportation, 2008, http://www.fsutmsonline.net/images/uploads/reports/FR2_FDOT_Model_CalVal_Standards_Final_Report_10.2.08.pdf.

[7] *NCHRP Report 735, Long-Distance and Rural Travel Transferable Parameters for Statewide Travel Forecasting Models*, Prepared by Cambridge Systematics for Transportation Research Board, 2013, http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_735.pdf.

acceptable. Home-based work (HBW) trips/employee is at the low end of acceptability, while persons/HH is at the high end. ACS comparisons confirm that the persons/HH might be high, while the employment/population ratio might also be high compared to the ACS.

- **Trip Distribution.** Average trip lengths are somewhat low by most standards. Very small difference between statistics output by model run vs. available model documentation. Percent intrazonal is slightly high for the HBO trip purpose but fine for other trip purposes.
- **Mode Choice.** While the model does include a simplified, trip end-based mode choice model, there are no substantive summary statistics output by this model step. Model outputs indicate a total of 10,363 linked transit trips, but observed transit ridership data are needed to assess the reasonableness of this number. Estimates of unlinked transit trips would require a transit assignment be added to the model (step not in present model version).
- **Highway Assignment.** Assignment screenline results generally look good with the exception of Screenline 13. It is somewhat unclear why there are different sets of screenline summaries… This leads to some confusion. Cambridge Systematics' model run estimates of vehicle hours traveled (VHT) and vehicle miles traveled (VMT) do not match what has been documented in the PBS&J/GDOT report. Perhaps this could be from postprocessing. Not surprisingly, ramps do not validate well; however, it is surprising that freeways do not validate better. In fact, freeways, exit ramps, and entrance ramps all score a volume/count ratio of 0.83 to 0.84, meaning that improving one might help the other. Rural roadways validate poorly at a volume/count ratio of 1.53. Percent root-mean-square error (RMSE) is better than most models, with the exception of roadways with less than 1,000 daily trips.

2.5 RESOURCE REQUIREMENTS

Model execution only took five minutes using Cambridge Systematics' computer resources. This reflects the lack of complex algorithms, market segmentation, time-of-day modeling, logit modeling, transit assignment, and feedback. Model execution does require some level of knowledge about Cube (Voyager/TP+) scripting. It would be good to design a Cube application for the Savannah model to streamline and visualize model execution and access to model input files.

2.6 MODEL SENSITIVITY TESTING

The base year model was tested for sensitivity by running three simplified alternate scenarios:

1. Double employment by type and total for Zone 533;
2. Double population and households for Zone 619; and

3. Expand roadway between these two zones from two lanes/direction to three lanes/direction.

A 2003 study of model sensitivity and elasticity conducted by Cambridge Systematics for the Utah DOT[8] was used as a basis for calculating model elasticities for the above scenarios and determine acceptable ranges of model elasticity based on study research. Scenario 3 above was most consistent with the types of alternatives tested in the Utah DOT study. The resulting elasticity value of 0.688 is consistent with other studies cited in the Utah DOT report that quantified typical elasticities for roadway widening projects between 0.2 and 0.8. It is reasonable to conclude that the Savannah model is reasonably elastic, although additional testing of road widening projects in different areas of Chatham County could be used to further back this up.

[8] *Wasatch Front Regional Council (WFRC) Model Sensitivity Testing and Training Study*, prepared by Cambridge Systematics, Inc. for Utah DOT, 2003.

3.0 Recommended Model Enhancements and Implementation Strategy

This section of the report provides a set of recommended model refinements and enhancements for the Savannah/CORE MPO based on discussions with MPO staff on desired capabilities, knowledge of peer models, and the information presented in Section 2.0 of this report. The purpose of the work effort described in this section is to recommend model enhancements or structural changes needed to serve current and anticipated analytical needs of the CORE MPO. The work effort is focused on addressing unmet analytical needs of the MPO, developing recommended model enhancements, and associated implementation strategies.

The first subsection addresses MPO staffing for model support, including agency and staff roles, staffing resources, training needs, data needs, and magnitude of investment levels. This is followed by a discussion of potential model refinements based on initial discussions with MPO staff, which identified desired model refinements and analyses to be addressed in this task. Subsequent discussions with MPO staff focused on unmet analytical needs and the resulting section addresses both needs and wants, for the following considerations:

- Transit analysis (supporting route analysis, alternatives analysis);
- Toll analysis;
- Subarea analysis (small area/supporting site impact work);
- Freight analysis/mode;
- Evacuation analysis;
- Time-of-day analysis;
- Bicycle and pedestrian demand;
- Animation/visualization tools;
- Documentation, model/planning area expansion, and minor refinements;
- Scenario analysis;
- Model-generated performance measures; and
- Advanced modeling.

The discussion continues with a subsection on general priorities and magnitude of cost, and concludes with a discussion on how the CORE MPO stacks up to some peers in terms of model sophistication and capabilities.

3.1 MPO STAFFING AND EXPERTISE IN MODELING

The CORE MPO has expressed interest in evaluating the role of their agency, its staff, and other partners in maintaining and updating the Savannah regional travel demand model, especially as the metropolitan planning area (MPA) has expanded, along with expansion of the model coverage area. This requires background information on alternative roles and in-house resources. Regardless of the extent that MPO staff will be involved in "hands on" modeling efforts, it is important that staff be familiar with the latest analytical techniques and data used in travel demand modeling. Magnitude of investment levels must also be considered in any decision-making on this topic.

Agency and Staffing Roles and Resources

The three key participants in MPO model development, maintenance, and refinement usually include MPO staff, state DOT staff, and a consultant team. The prominence of each role varies from one MPO to another. In the nation's largest regional MPOs, it is common to have staff persons who are fully devoted to technical analysis and modeling; whereas, small- and mid-sized MPOs do not usually have the resources for staff dedicated to such technical activities. In many cases, the state DOT serves as the lead agency for maintaining and enhancing MPO travel demand models.

With the exception of the Atlanta Regional Commission (ARC), the Chattanooga/North Georgia TPO, and the Hinesville MPO, Georgia DOT takes the lead responsibility for modeling activities in the State. The ARC is one of the nation's largest MPO areas while Chattanooga straddles two states; the predominant one (Tennessee) being more accustomed to MPO "ownership" of their models. With the fragmented MPO structures found in neighboring Florida, Florida DOT district offices usually lead modeling efforts rather than the MPOs. One of the few exceptions being the North Florida TPO, which is a regional organization (comprised both the Jacksonville and St. Augustine urbanized areas) operating in a Florida DOT district dominated by this single metropolitan region.

Consultants typically do the "heavy lifting" when it comes to model development, calibration, and validation, regardless of MPO size. The reasons for this include the inability of MPOs to fully devote staff resources to such labor-intensive and time-sensitive efforts and the need for specialized expertise that requires knowledge on a variety of modeling platforms, techniques, and tools that cannot be achieved within the context of a single MPO. That said, larger MPOs will sometimes take on select aspects of the model development process in-house and focus consultant efforts on the most specialized and

technical aspects of the process where a broad base of experience is most warranted.

Training Needs, Available Model Outreach, and Training Opportunities

While MPO staff do not necessarily need to become experts in model estimation, validation, and calibration, it is beneficial to have some understanding of these concepts and the ability to judge whether sound approaches were used during the model development process. MPO staff should be able to edit model input files and execute the model after modifying input data assumptions. Training opportunities are available through a variety of sources; however, regular use of modeling software to update files and run alternatives is key to a good understanding of travel demand modeling.

Since the 1990s, the Federal Highway Administration (FHWA) has sponsored the Travel Model Improvement Program (TMIP) aimed at fostering knowledge exchange and the sharing of new techniques among the nation's modeling community. TMIP comprises numerous components, including a "listserv" email exchange; research and recommended practice studies and reports; free training webinars; model peer reviews; and "ask the modeling experts" discussions. It is highly recommended that MPO staff subscribe to the listserv as this email list largely represents the portal to TMIP announcements on new reports, webinars, and other training opportunities.

Many state DOTs and large MPOs hold regular model users group meetings with presentations on a variety of model-related topics along with training opportunities. The ARC holds model users group meetings quarterly. While these meetings focus on model advancements in the greater Atlanta region, other topics such as GDOT and national studies are also included on some of their agendas. Unfortunately, these meetings do not presently provide for attendance via telephone or the Internet.

The Florida DOT supports a statewide Model Task Force that meets one to three times a year to set policies on modeling procedures and conduct research. The Florida DOT also provides a series of training workshops, maintains a web site with documentation of standards and on-line training webinars, and supports different model users groups throughout the State. Both Florida and Georgia use the same Citilabs/Cube modeling software platform, and many of the issues and techniques used in Florida are relevant to modeling in Georgia as well.

Data Needs

Model-related data is a technical area where MPO staff are most likely to shine. Data mining tends to be a process more conducive to frequent repetition than model development, validation, and calibration, which are rarely conducted more often than twice a decade in any given MPO region. Repetition is essential to mastering most technical planning tasks.

Someone on the MPO staff should ideally be familiar with the use of data from the 2010 Census, CTPP, one or more sources of estimating workplace employment, and the ACS, as well as the different geographies these data are available in. MPO staff should be fluent in a full range of transportation network databases, both from state and national sources. It would be good for MPO staff to become somewhat familiar with travel behavior survey databases, such as the NHTS, especially with completion of the recent NHTS Add-On survey funded by the GDOT. Familiarity with statistical analysis methods and software would enable staff to conduct occasional analysis of regional travel patterns in response to requests from MPO board members and other planning agencies within the region.

Magnitude of Investment Levels for Internal Staffing

In the absence of information on typical salary and benefit costs for the Metropolitan Planning Commission, this brief discussion is focused on the magnitude of investment for increasing staff responsibilities and capabilities in modeling.

The most expensive option would likely be to hire a full-time staff person responsible for travel demand modeling and related data analyses. Qualified staff with this experience are expensive to hire as this is a unique skill set. While hiring a planner or engineer with mostly academic experience in travel demand modeling could be a more cost-effective option initially, such a hire will likely require periodic training and/or guidance from a consultant in how to handle more challenging assignments. It would be important for such a staff person to be regularly engaged in modeling tasks, such as network editing, scenario testing, and postprocessing, in order to maintain the skill set. Such an individual would potentially be prone to hiring by consultants looking to add a key resource.

While a more general technical staff person/part-time modeler might be a less costly staff addition in terms of salary, the quality of skills in the modeling arena would not likely be as strong as a full-time modeling staff person, and training needs might even be more costly due to the lack of an individual's expertise.

The most ideal investment might be to hire a mid-level staffer with experience and training in travel demand modeling, GIS, and data mining and analysis. There is considerable overlap among these three work areas; whereby, skills in one area (e.g., GIS) could be directly applicable to the other work areas (modeling and data mining). Such a staffer could stay technically engaged, but would still need some level of periodic training by vendors, consultants, and/or state and Federal agencies.

3.2 DESIRED MODELING CAPABILITIES AND UNMET ANALYTICAL NEEDS

The following describes each potential model enhancement and unmet analytical need with a discussion on rationale, alternative implementation strategies, and other considerations.

Transit Analysis

The current Savannah regional model includes a simplified "trip end" mode choice step "based on socioeconomic characteristics within traffic zones (i.e., income, auto ownership) rather than service characteristics between zones." The trip end approach to mode choice allows for transit trips to be estimated without the overhead of transit networks and path building. Once transit trips are estimated, these trips can be excluded from the highway assignment process. The trip end approach, however, has limited explanatory power since it cannot be used to test alternative transit and highway network strategies and estimate the impacts of such projects and service changes.

With the City's historic development patterns, operation of the River Street Streetcar, and the MPO's desire to conduct alternatives analyses of high-capacity transit projects in the future, the regional model should be enhanced to include transit networks and path building procedures, a logit mode choice model, and transit assignment capability. While a new household survey is strongly recommended for updating several components and assumptions in the regional model, funding for a household survey is not a prerequisite for adding mode choice and transit networks to the model; however, the mode choice model itself would have to be transferred from a similar region that conducted a recent household survey. Mode share targets for single-occupant vehicles (SOV) and high-occupancy vehicles (HOV) would benefit greatly from household survey data, but can be estimated using available data from the ACS for work trips and the 2009 NHTS Georgia Add-On for nonwork trips.

Transit onboard surveys were completed for the area in 2006 and 2012. Chatham Area Transit recently provided slides that summarize findings from the 2012 onboard survey, as well as monthly ridership statistics by route and average weekday transit transfers. Access to completed survey data would be necessary in order to analyze current transit travel patterns and estimate transit model parameters. In order to validate transit assignment boardings, route ridership numbers should be reported by average weekday rather than monthly, although the weekday transfer estimates will be helpful in comparing linked vs. unlinked trips. Other desirable data collection for transit modeling would include boarding counts and travel time surveys by passenger car and bus on the same streets, at similar times. The Federal Transit Administration (FTA) has issued updated rules for New Starts projects (http://www.fta.dot.gov/12347_5221.html); and transit onboard surveys and related data collection efforts are strongly recommended by the FTA.

Toll Analysis

Several corridor studies conducted within the Savannah region have looked at tolls as a consideration for project funding. The recent popularity of managed lanes presents additional options to toll select travel markets rather than relying on tolling of all vehicles, although such facilities require a greater level of sophistication in modeling. Since the Savannah region is largely void of toll highways today, calibration of relationships between cost and time is difficult. Therefore, it is recommended as a first step that a stated-preference/Willingness-to-Pay (WTP) Survey be conducted to estimate value-of-time in the Savannah region. Key nonresident travel components in Savannah, such as tourists and trucks, would need to be included in such a survey in order to address their stated response to varying toll strategies.

In addition to conducting WTP surveys and incorporating value-of-time into the model stream, other model enhancements could include time-of-day modeling (to test variable toll pricing options); additional market segmentation of auto and truck trips (tolled vs. nontolled, transponder vs. cash tolls); and alternate network modeling techniques (dynamic traffic assignment, specialized facility type codes).

Subarea Analysis

The Savannah regional model is not very large, and so run execution time is minimal; meaning that the entire model can be run even for subarea analyses. Thus, there likely no need for a subarea window network extraction. In order to conduct subarea analyses, such as select link or select zone, all that is needed is a Cube script file for executing these special analyses. Generic script files can easily be generated for use by MPO staff for these analysis types; whereby, the only information required would be specific node and zone numbers for processing. Ultimately, as discussed later under "Visualization Tools," the model should be updated to take advantage of the Cube Application Manager, with a model execution menu that could include options for select link and select zone analyses.

On the subject of model execution time, and in response to questions from MPO staff, it is not unheard of to have multiple versions of the same model geared towards special model applications. For example, a separate model version could be developed for analyzing transit ridership vs. another version for highway applications. The highway version could use auto occupancy factors to convert person trips to auto trips, while the transit version could include a nested logit mode choice model with transit networks, skims, feedback loops, and transit assignment, thus increasing model run times. Should run times from an expanded MPO model area, with full transit capabilities, become too onerous in the future, then consideration could be given to alternate model versions for different policy analyses. For now, though, it is recommended to use a single model version for all analyses.

Freight Analysis/Mode

The structure of the current travel demand model is significantly improved relative to previous versions in terms of how the Port of Savannah is handled. The Port is incorporated as a special generator, and trips to local distribution centers (DC) are separated out from trips that leave the region. The remainder of this subsection describes issues to be addressed in future refinements to freight/ truck modeling in the Savannah regional model with a special focus on how port-related trucks are handled.

While the TAZ structure could be enhanced at select distribution centers, there are presently no plans on revisiting the recently finalized 2010 Census zone system. As requested by the MPO, Table 3.1 does identify five distribution center zones that could be considered for splitting at some point in the future. Figures 3.1 and 3.2 depict the location of distribution centers in the base year 2006 and horizon year 2035 models, respectively.

Table 3.1 Warehousing/Distribution Center TAZs

Number	Zone(s)	Issue/Problem	Potential Solution(s)	New Boundary for Splitting
1	515	Large number of truck trips	Split zone	Split zone along Black Creek
2	517	Large number of truck trips (2035)	Split zone	Split zone along Expansion Blvd.
3	518	Large number of truck trips	Poss. boundary shift	Align zone boundary to Jimmy DeLoach Pkwy
4	531	Large number of truck trips	Split zone	Split zone along Innovation Drive
5	638	Large number of truck trips (2035)	Split zone	Split zone along S Morgan Pkwy

Figure 3.1 2006 Savannah Distribution Centers in Regional Travel Demand Model

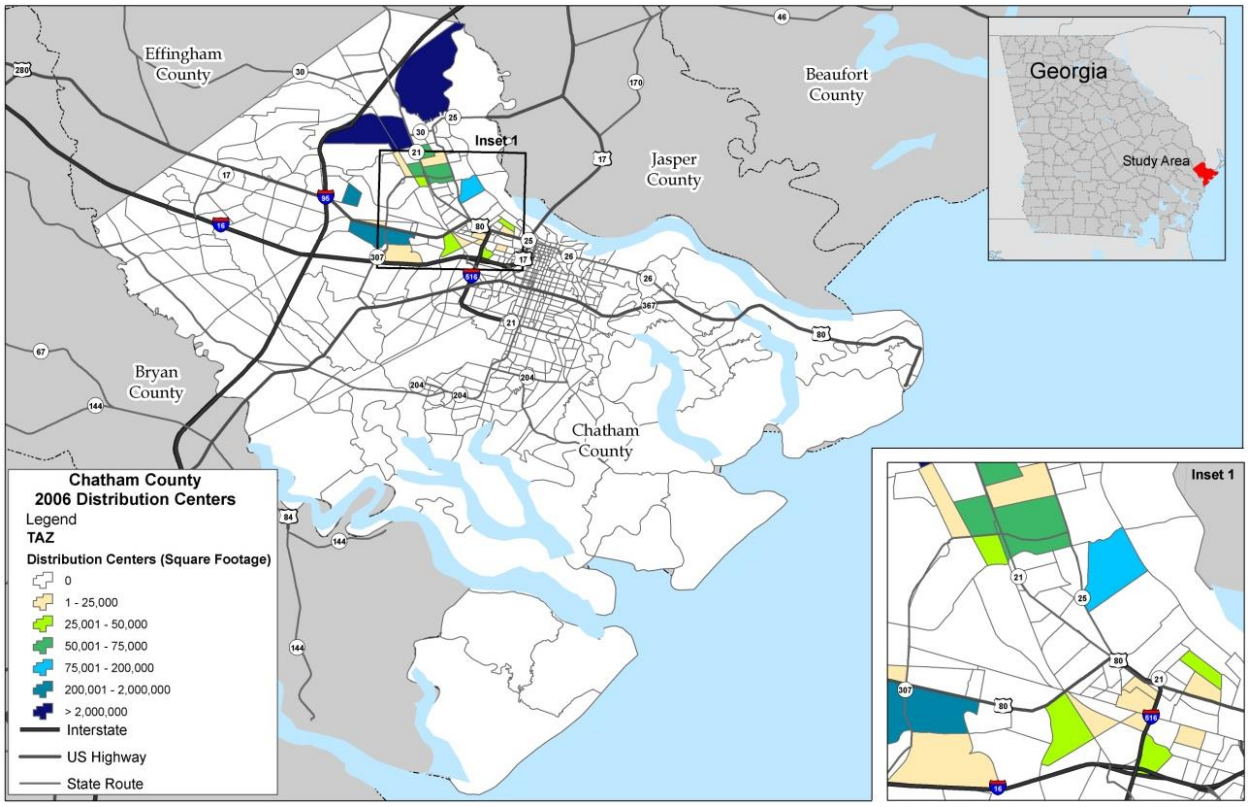
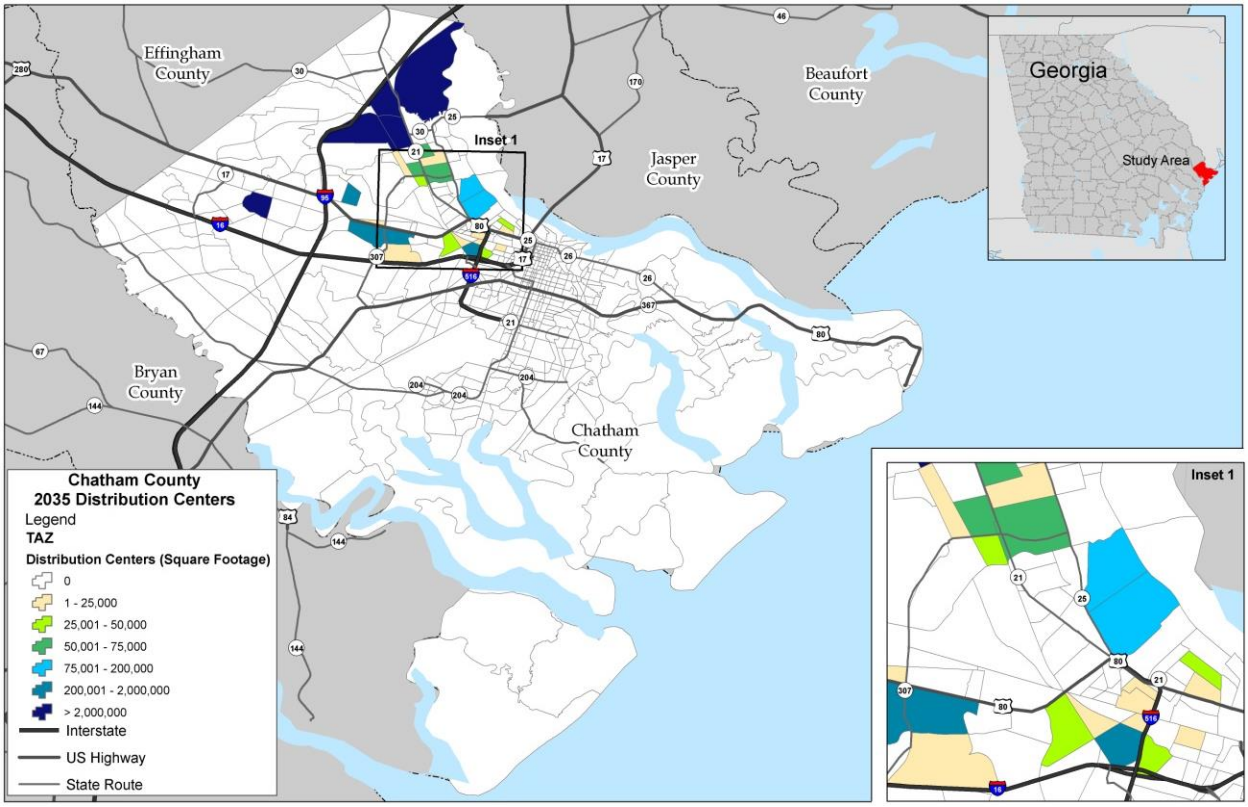


Figure 3.2 2035 Savannah Distribution Centers in Regional Travel Demand Model



Identification of Key Distribution Centers

The model estimates truck trips from distribution centers based on square footage of distribution center space in each TAZ in the port subregion. It is unclear how this relationship was established, but it would be better to conduct a new truck intercept survey at the port gate. The most recently conducted survey was done in 2006 as part of the GDOT Truck Lane Needs Identification Study. Since 2006, there have been significant changes in the location of distribution centers near the port and the port's customer base. A gate survey can be done relatively inexpensively using a minimum of four data collectors over an 8- to 10-hour a day for about 2 days. Any such surveys should be coordinated with port staff to ensure cooperation and proper scheduling. These new data can also be compared to the old survey data to determine how truck trips are trending over time.

The model does not appear to have identified many new locations for distribution centers in the forecast year 2035. Interviews of distribution centers along with economic and site developers in the Savannah region could be used to identify the location and size of future distribution centers. These interviews are likely to provide a 5- to 10-year view of expansion locations. It will need to be combined with information on available industrial land in the port subregion

to determine long-term locations for future distribution center expansion. In case money for such interviews is not available, analysis of available industrial land is still recommended to estimate the potential for expansion of distribution centers in the future.

External Truck Trips

Existing model documentation describes the allocation of port trucks to external stations (in Table 2.2.7-2), but it does not explain the basis of those percentages. It also indicates that this allocation is the same regardless of whether or not the trucks use a distribution center or not. For the trucks not destined for distribution centers, a port gate truck intercept survey should be used to identify the distribution of port trucks to external stations.

For the trucks that do use a distribution center, a new establishment survey should be conducted on the key distribution centers to determine which external stations are used. There may not be a strict relationship between the location of the distribution center and the external stations used due to the fluidity in customers for many distribution centers. Very small establishment surveys were conducted as part of the GDOT Truck Lane Needs Identification Study and the Georgia Interstate Needs Assessment Plan, but a more systematic survey would be needed to fully inform the model of how trucks are traveling through the subarea. As mentioned above, these establishment surveys should also be used to collect information on likely future locations of distribution centers relative to the potential to expand operations on existing sites.

The model assumes that 15 percent of external-external (E-E) trips are heavy trucks at each of the external stations. The basis is of this percentage is unclear. However, the percent should be much higher on I-95 relative to other roadways, particularly noninterstates. An estimate of the number of E-E trucks can be generated using count data and roadside truck origin-destination (O-D) surveys conducted at weigh stations on I-95. Such surveys were conducted in 2006. Surveys could potentially be supplemented with analysis of global positioning system (GPS) data from the American Trucking Research Institute (ATRI).

The model assumes that two percent of internal-external (I-E) trips are heavy trucks. This number appears to be reasonable, but the basis of this percentage is unclear and should be compared against available classification count data from GDOT and South Carolina DOT. Of course, true confirmation, as it applies to I-E trips, would require O-D survey data.

Model Truck Volumes and Forecasts

Model documentation says there are 5,916 port trucks in the base year of 2006. Using 2006 port numbers of 2.16 million twenty-foot equivalent units (TEU), assuming 20 percent by rail, each truck averages carrying 1.8 TEUs and with 250 working days per year, would equal approximately 3,840 trucks in 2012 in both directions combined (1,920 in and 1,920 out). This number likely includes

loaded and unloaded trucks. If each loaded inbound truck were followed by an unloaded outbound, and each loaded outbound were preceded by an unloaded inbound truck, then the 3,840 number would be doubled. The difference between the modeled total of 5,916 and the estimate of 7,680 (3840*2) assuming no reuse of trucks indicates that the reuse (i.e., a loaded inbound truck is not followed by an unloaded outbound, but is instead followed by a loaded outbound) is around 23 percent, which seems reasonable. Ultimately, the port truck volume estimate can be validated based on data collected and stored at the Port of Savannah.

The port forecast used in the model was extracted from the 2007 Annual Port Report. The Port has since generated a new forecast for use in the GDOT Freight and Logistics Plan, which should be used instead. This forecast includes better accounting for the impacts of the recent recession, the Panama Canal expansion, and the harbor deepening. A high-level comparison between the model port forecast and the more recent port forecast indicates that the model forecast is very high.

There is additional complexity in the port forecast in that the current Garden City Terminal layout will "max out" in about 10 to 15 years based on current utilization patterns. Growth beyond that timeframe is much more likely to occur at a new terminal, such as the terminals planned for the future Jasper Port. This Port is actually projected to be built on the South Carolina side of the river, but could have trucks that impact Chatham County depending on how the roads are aligned. It may be necessary to include the Jasper Port as another separate special generator in the model and use trip generation and assignments based on the Jasper Port's current projections.

Other Potential Truck Modeling Issues

There is no mention of passenger car equivalents (PCE) used for trucks in the model. This will be an important factor to consider, particularly for roadways with large percentages of trucks that are operating near capacity.

There is no mention of validation to truck counts in the model documentation. There are several key roads, particularly I-95, I-16 and near the Port, where having accurate truck volumes will be critical to the proper functioning of the model.

Evacuation Analysis

Evacuation modeling differs from typical MPO modeling of weekday travel demand as the focus of evacuation modeling is on simulating a specific event or catastrophe. Data on highways, households, hotels, and motels found in a typical MPO model would be very useful in evacuation modeling as well, except that the way this information is used differs greatly for the purposes of simulating disaster response. For example, rather than simulating trips from households to places of employment, education, and shopping, trips are

estimated from households in vulnerable areas to destinations in nonvulnerable areas, such as hotels, shelters, friends, and family. Rather than simulating typical weekday travel behavior, patterns are defined using post-evacuation surveys that identify the probabilities of evacuating and likely destinations. So while model input data can be used for evacuation modeling, the approach to trip making will be entirely different from how the existing model simulates trips.

Once the object of sketch planning and spreadsheet tools, hurricane evacuation modeling has advanced considerably in response to advancements in GIS, computer technology, and traffic modeling software. Today, it is appropriate to use traffic meso-scale simulation and microsimulation modeling techniques for modeling emergency evacuation in order to incorporate a finer grain of traffic control information, vehicle characteristics, a mix of background and evacuating traffic, and advanced dynamic traffic assignment (DTA) algorithms. Data from the "macro" model (the regional travel demand model) can be used as a starting point for basic network characteristics prior to the development of more detailed meso- and microsimulation models. Hence, future evacuation analyses should benefit from many of the refinements recommended for the MPO regional model.

Another important consideration is the extent of geographic coverage for evacuation modeling. Recent studies have moved beyond the simulation of individual urbanized areas, recognizing that evacuation does not simply abide by regional boundaries, and that cumulative impacts from adjacent areas must be accounted for as well. To some extent, the need to model larger geographic areas runs counter to the use of microsimulation tools; however, the latest tools now have the capability of modeling much larger networks. The topic of evacuation modeling merits additional discussion and research into the sufficiency of prior efforts in coastal Georgia in order to address any limitations or shortcomings.

Time-of-Day Analysis

The current Savannah model only simulates daily travel; whereas, modeling travel by time of day has become common in many MPOs, even in small- and medium-sized areas. Daily roadway capacities are generally derived from hourly capacities and associated peaking factors. Most daily highway assignment models either use hourly capacities factored to daily equivalents or daily volumes, at least temporarily, factored to hourly estimates through use of what is typically called a "CONFAC" parameter.

The most common time-of-day models instead use factors to estimate how many trips take place during three or more time periods of the day. Trips are further split directionally during this process, such that trips are mostly traveling from home to work during the AM period and from work to home in the PM period. Most models separate nonpeak period trips further into Midday and Nighttime periods. Time-of-day modeling allows the analyst to test policies that differ in peak periods than at other times of the day, such as tolls, transit fares, and

parking costs. Contra-flow lanes can be tested to operate in the proper direction during peak periods, while peak-hour express bus services can also be limited to the proper time periods and directional flows.

Most time-of-day models cannot simulate peak spreading; however, advanced models (activity-based, DTA) are capable of shifting trips among different hours of the day in response to levels of congestion. Time-of-day factors can be estimated using data from the Georgia NHTS Add-on data in conjunction with hourly traffic count data from telemetry sites in Chatham County.

For the purposes of accurately simulating peaking characteristics, it is recommended that a simplified time-of-day model be developed for the CORE MPO region that takes person trips by mode and purpose as input, applies a series of factors from the Georgia NHTS Add-on and available telemetry count data from throughout the region, and apportions daily trips into auto vehicle and transit person trips for three to four time periods for the purposes of network assignment. These same loadings can subsequently be used to generate congested highway skims and used as feedback into an updated trip distribution or mode choice step. Daily assignments would still be produced as the addition of loaded networks from the different time periods.

Bicycle and Pedestrian Demand

In recent years, interest has been growing regarding the benefits of nonmotorized transportation for personal health, motorized trip reduction, GHG reduction, and air quality benefits that it generates. As a consequence, there has been an increased need to collect counts and survey data on nonmotorized transportation use and characteristics. Collecting such targeted and enhanced data related to nonmotorized trips from travel surveys, counts, and nonmotorized infrastructure databases, however, remains a continual challenge. These data may be used to calibrate parameters for travel demand model enhancements that include nonmotorized trip analysis. The data may also be used off-model to guide long-term planning decisions. For example, the intensity of use of existing nonmotorized facilities may indicate where and how soon investments need to be made, and may also guide policies related to encouraging increased usage of nonmotorized modes of travel.

Several types of data may be collected on nonmotorized travel, primarily divided into two groups. The first group includes data that may be used to define travel behavior characteristics, which are then used to guide trip decision-making. This group includes various types of survey data. These data are typically used to define parameters (constants and coefficients) for trip generation and mode choice. The second group includes data that represents a record of travel activity at a specific location. These data include various types of traffic counts and would be used for validation in the modeling context or to guide policy in an off-model context.

Recently, the CORE MPO has taken the initiative to start collecting nonmotorized trip counts at 9 to 11 locations in the Savannah urban core. Data are available for September of 2009, 2010, and 2011. Changes in bicycle and pedestrian counts have been monitored between these analysis years and documented in a series of brief annual technical memoranda. Since data collection was limited to counting bikes and pedestrians, there is no information available on trip purpose, origin, or destination.

At this point, there is limited regionwide information on nonmotorized travel in the Savannah region, from a generalized percent of work trips available from the ACS and CTPP. The greatest proportion of walk trips is likely within the Savannah historic district; and much of this is likely tourists who would not be part of a traditional household survey, ACS, or NHTS. While hardly an ideal approach, bicycle and pedestrian counts in the urban core could be compared against vehicle counts at the same corridor locations to at least gauge the relative impact of nonmotorized travel compared to other travel modes. This information could be supplemented with a visitor intercept survey that collects information on the mode, origin, destination, etc. of the intercepted trip.

Travel models with nonmotorized components typically include scoring of Pedestrian Environment Variables (PEV) by zone for use in estimating the share of bicycle/pedestrian trips during mode choice. In the Gainesville, Florida 2007/ 2035 model, for example, four PEVs were used and each TAZ was scored 0 to 3 for each variable. Gainesville PEVs were as follows:

- Sidewalk availability,
- Ease of street crossing,
- Nonmotorized connections, and
- Building setbacks.

A score of zero (0) would be given for zones with no sidewalk availability. A PEV classification scheme would be needed for modeling nonmotorized trips. A combination of field data collection and use of Google Maps should be able to provide the necessary PEV data for classifying each zone. Such data has the potential added benefit of enhancing procedures used in estimating access to transit in mode choice modeling. While this example is rather simple and somewhat subjective, there are more objective ways to evaluate pedestrian environment tying directly into GIS data.

Animation/Visualization Tools

Animation and visualization in modeling is often equated with 2-D and 3-D modeling of landforms and structures, although the topic in this technical memorandum covers all aspects of visualization beyond just dimension. 2-D and 3-D modeling is more common place in microsimulation than in static travel demand models. Meso- and microsimulation models are typically far more intricate than regional MPO models with a focus on simulating very narrow time

periods and detailed intersection operating characteristics. One of the problems with trying to model hourly or 15-minute time slices, along with signal operations at the regional level, is that nobody can precisely estimate changes to these dynamics over the long term, and regional models typically forecast simulate travel patterns 20 to 30 years into the future.

One of the greatest visual enhancements that could be made to the Savannah model would be to maximize use of the Cube Application Manager. The Application Manager is a flowchart system that can be used for model development, file access, network display, model execution, and to visualize model flow, including input and output files. Model execution menus can also be created within the Cube "catalog" to allow the user to easily execute individual and grouped steps of the model chain. Cube catalog keys can also be generated to store model parameters that are referenced in model scripts. Access can be restricted to certain keys, such that model parameters set during calibration/validation cannot be modified when executing new model runs.

The current model setup for Savannah, as well as other models in Georgia, is a single model script that directs model execution options, file access, and generation of output summaries. While this approach "gets the job done," it has a greater potential for errors and misunderstandings than use of Cube Catalogs and the Application Manager. For example, locating model parameters and other key assumptions in the current model requires a time-consuming process of scanning through pages of script. Model execution is also complicated, in that the script must be edited and modified in order to run individual model steps. Unless the person executing the model understands Cube scripting, it is difficult to comprehend the model structure from merely reading a script file.

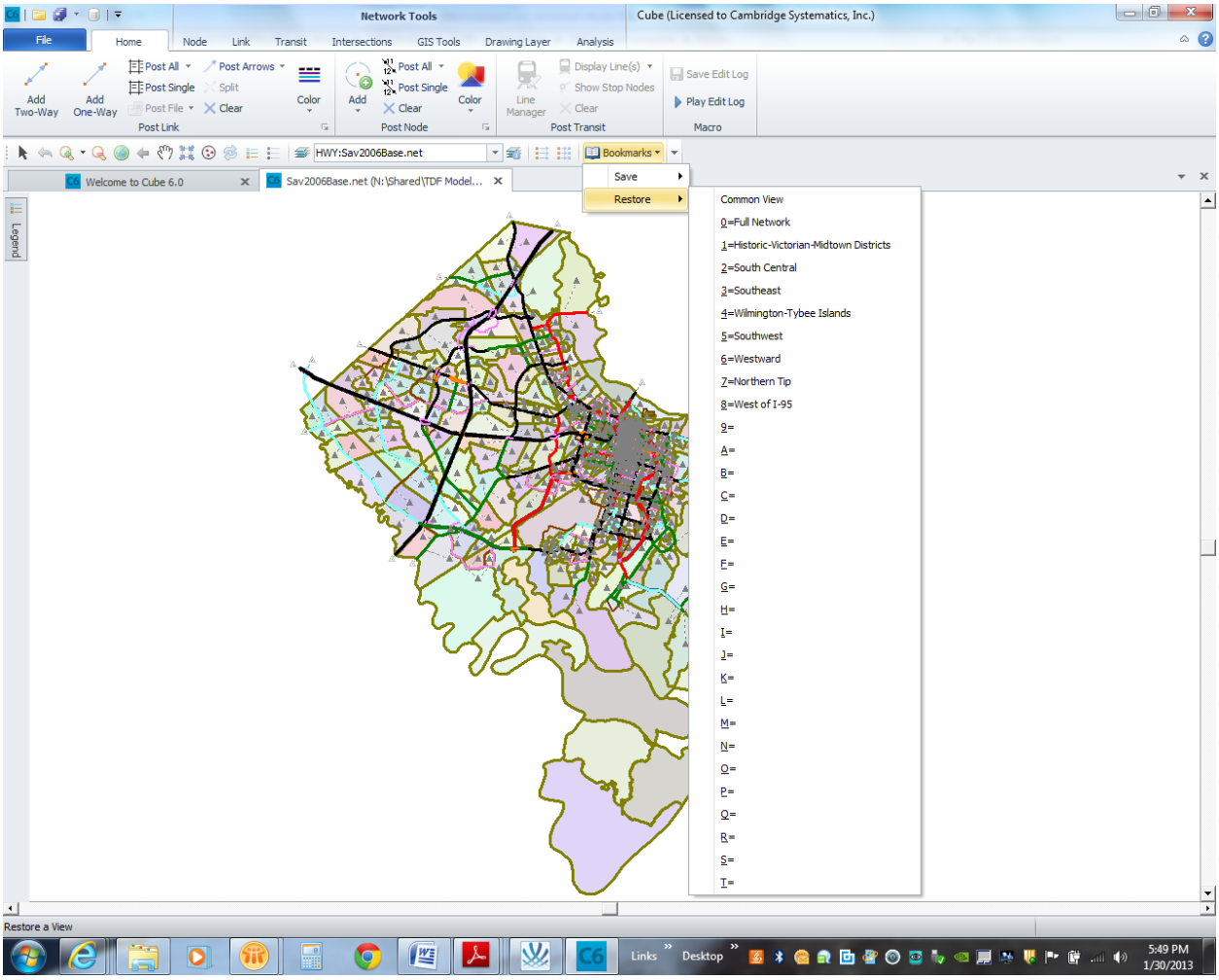
Cube provides additional options for visualization of model inputs and outputs. The Cube network editor allows for the user to save color selections for each attribute in a .vpr file, along with bookmarks of subarea windows. This way, when the network is opened, colors will already be set for each attribute and only one click is required to zoom in to different areas within the region. We have prepared a new .vpr file for the Savannah model that we have provided and demonstrated to you. Cube can also be used to prepare other graphics, such as desire lines, isochrones, and node-point charts. Cube also has the ability to insert "junction" displays into the model network, and the user can select from a variety of junction types to replace simple node intersections in regional models with diagrams that better reflect the nuances of complex intersections.

Cube also includes the ability to edit files using ArcGIS and storing files in a geodatabase. For staff already working in a GIS environment, this will come as second nature to them and maps can easily be created using ArcGIS without having any file conversion issues. The graphics capabilities of ArcGIS are further advanced than those available in the Cube network editor.

Figure 3.3 depicts the Savannah network as it opens with the new .vpr file prepared by Cambridge Systematics. Some of the features shown in this display

include preset colors for displaying number of lanes, multiple layers including TAZ shape files, and bookmarks saved to toggle between subarea windows zoomed into different areas of the network. While these features could be used without a customized .vpr file, use of this file automates the desired view when opening the network and saves considerable time creating displays.

Figure 3.3 Screenshot of Savannah Network with Cambridge Systematics'.vpr Setup



Documentation, Model/Planning Area Expansion, and Minor Refinements

Enhanced documentation was suggested by MPO staff as an area for improvement. We have grouped in a few other topics discussed previously with MPO staff as part of this section, including model and planning area expansion, highway networks, and model validation. An expanded Metropolitan Planning Area (MPA) boundary is already being proposed as suburbanization continues to spread beyond the historic MPO area in Chatham County and the Georgia

DOT has initiated model expansion to include the entirety of neighboring Effingham and Bryan Counties.

Documentation

It is very important that model documentation includes as many details as possible in an easy to read, attractive, yet efficient format. Future documentation should obviously take advantage of the latest in technology to generate visually pleasing pdf reports with full document search capability and minimize file size for easy transmittal to others as an email attachment. It is strongly recommended that the next model validation study include documentation of adjustments made during the validation process. In reviewing current model documentation, it is unclear what assumptions the validation started with and what adjustments were made during the validation process. The current documentation pdf is very large, making it difficult to transmit as an email attachment. It appears to have been scanned from a print copy.

Responsibilities for documentation should lie with the parties responsible for conducting each specific work effort. If different parties are responsible for different model inputs and components, as is often the case, it might be best to start with brief technical memoranda on topics, such as base year demographic data, model structure, model calibration/validation, and forecasting. These technical memoranda could then later be merged into one or more technical reports that comprise all materials originally documented in the technical memoranda.

Important items to be documented during a model update should include, but not be limited to, the following:

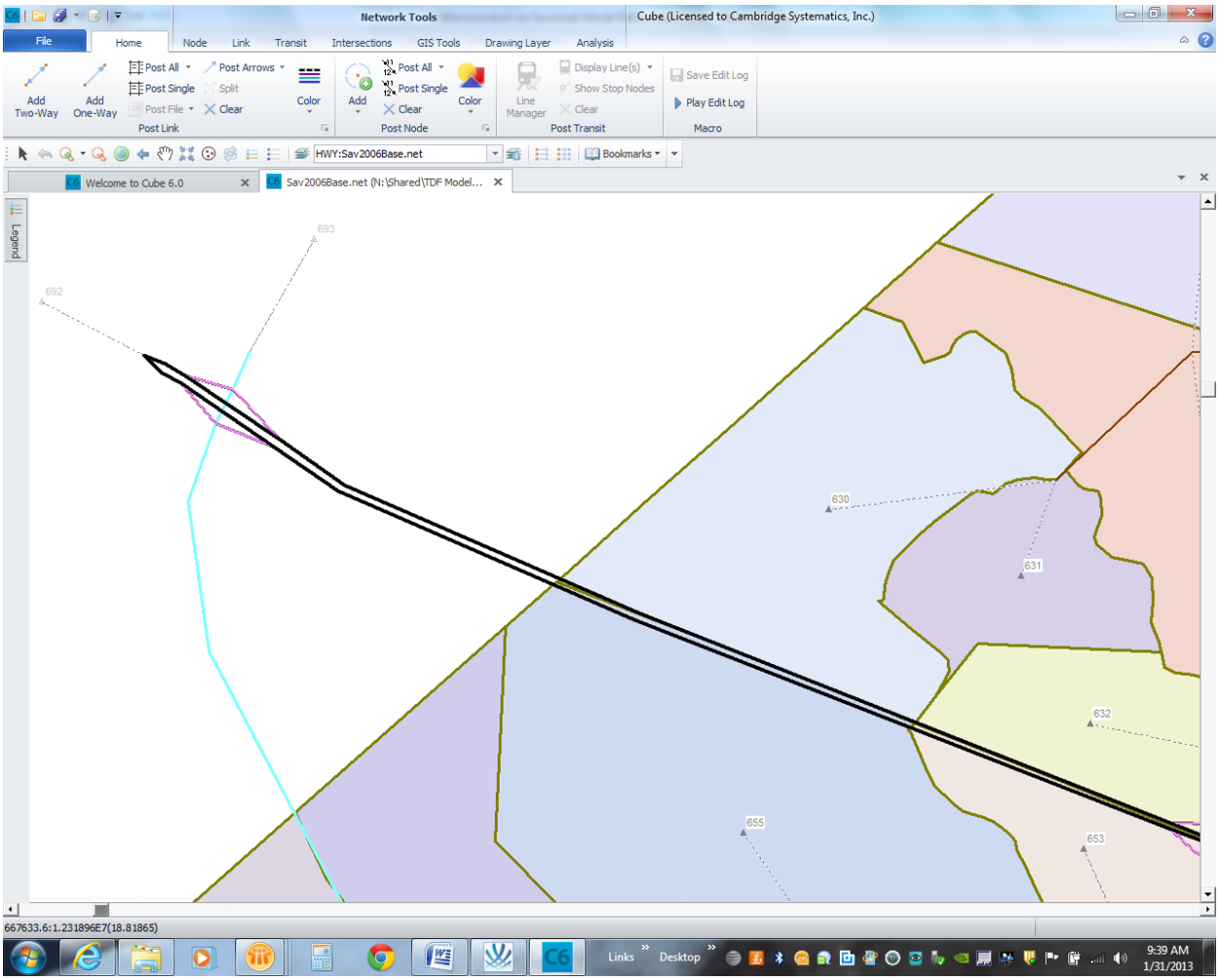
- Sources of model input data;
- Validation of input data and related assumptions;
- Mathematical formulations of model components;
- Sources of initial transferred or estimated model parameter settings;
- Model calibration and validation adjustments and corrections;
- Base year model performance (before and after validation);
- Future year forecasting assumptions and growth rates; and
- User information on how to run the model.

Model and Planning Area Expansion

As discussed with MPO staff, daily commute trips from adjacent counties have increased over the years. The model is already being expanded by GDOT beyond the Chatham County line to incorporate the vast majority of daily commuters and minimize the number of routine daily I-E trips in the model. Clearly, this expansion should include, at a minimum, the entirety of Effingham

and Bryan Counties, regardless of where the final MPA boundary is determined to be. Even the existing CORE MPO model included a small sliver of network within Effingham County, as depicted in Figure 3.4, allowing for external trips to select a path into Chatham County from the west.

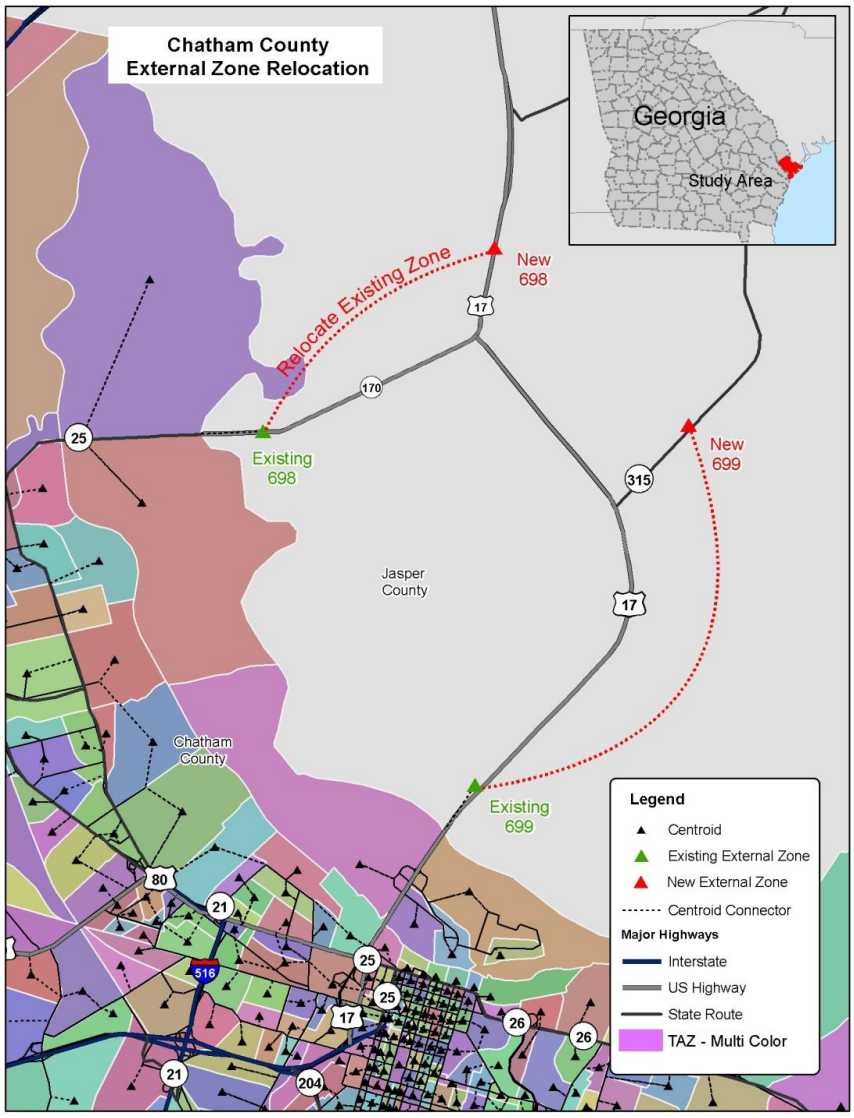
Figure 3.4 Current I-16/Old River Road Network Configuration in Effingham County



The CORE MPO will need to collaborate with adjacent counties to identify roles and responsibilities for designating TAZs, estimating base year demographics, and preparing future year forecasts. Draft TAZs prepared by GDOT for adjacent counties should be reviewed by MPO staff for compatibility with the Chatham County zone system. Shifting current western and southern external zones to the opposite boundaries of Effingham and Bryan Counties will necessitate estimating impacts to external forecasts (total external trips by year) and splits (I-E vs. E–E). Some combination of forecasts from the Georgia statewide model and extrapolated traffic count trends should be used to estimate year 2040 external trips at all model external zones.

While there are currently no plans to add internal zones on the South Carolina side of the Savannah River to the model, we do recommend that the South Carolina external zones be relocated further away from Savannah to allow for routing decisions to be based in part on congestion within Savannah. External Zones 698 (SR 25/SR 170) and 699 (U.S. 17) should be relocated north and east, such that Zone 698 be located on U.S. 17 north of the South Carolina SR 170 intersection, while Zone 699 be moved to South Carolina SR 315 just north of U.S. 17. This minor extension of the model network would allow for external trips to select which bridge to use based on anticipated congestion and trip end location with Chatham County, similar to the example in Figure 3.4. It would also be advisable to add at least one internal zone north of the Savannah River to account for the future Jasper Port, which will likely impact truck traffic in Savannah and at most external zones. Figure 3.5 depicts this location.

Figure 3.5 South Carolina External Zones Recommended for Relocation



Highway Networks

The previous model review memorandum provided considerable commentary on several topics related to highway networks, including TAZs and centroid connectors, facility types, number of lanes, area types, speeds and capacities, and traffic counts and screenlines. That text will not be repeated here; however, commentary in that memorandum should be considered during the next model update effort.

Model Validation, Reasonableness, Model Structure, and Parameter Assumptions

As with highway networks, the earlier model review memorandum provided considerable discussion on the topics of model validation, reasonableness, model structure, and parameter assumptions. Likewise, that text will not be repeated here; however, commentary in that memorandum should be considered during the ongoing model update effort.

Scenario Analysis

Scenario analysis is an important component of the long-range transportation plan (LRTP) process. The typical LRTP includes testing of a number of different network (supply) alternatives, and sometimes even land use alternatives (demand). Some of the more common alternatives would include the following:

- Horizon year travel demand with existing-plus-committed (E+C) network;
- Horizon year travel demand with highway-focused network Needs alternative;
- Horizon year travel demand with transit-focused network Needs alternative;
- Horizon year travel demand with blended network Needs alternative;
- Alternative interim and/or horizon year land use scenarios; and
- Horizon and/or interim year travel demand with Cost Feasible Plan networks.

The latest schedule of modeling activities from GDOT indicates they will be responsible for developing base year, existing, committed, and Needs networks, and only including model runs with each.

Of course, in order to test any transit-focused network alternatives, a more robust mode choice model and related transit networks and skimming processes would need to be added to the CORE MPO model. It is our understanding that the GDOT is not willing to test alternative scenarios as part of their LRTP modeling support efforts. Such an undertaking could be assumed by the MPO with or without MPO consultant support. Estimating the cost of scenario testing would require feedback from the MPO on the number of scenarios, types of scenarios, analysis years, and division of responsibility among consultants, MPO staff, and others.

Alternative land use scenarios could be developed either using a land use forecasting model, allocation model, Delphi (panel) technique, or a manual spreadsheet analysis process. With the MPA boundary moving into adjacent counties, it becomes more complicated to test and implement alternative land use scenarios as other jurisdictions must be consulted with to identify where growth should shift and how much one county might grow versus another. Nonetheless, the testing of alternative land use scenarios can benefit both elected officials and citizens, such that they can better understand the impacts of development patterns on VMT, mode split, average trip length, etc.

Model-Generated Performance Measures

With the recent passage of new Federal transportation legislation (Moving Ahead for Progress in the 21st Century (MAP-21)), there is a strong focus on performance-based planning at the MPO level. In light of this emphasis, all MPOs should be giving thought to how they wish to quantify performance of their transportation systems for both existing and future conditions. Many of these measures will be quantified, at least in part, from travel demand model output.

The current CORE MPO model produces most of the commonly used measures, such as average trip length by purpose, VMT, VHT, volume-over-capacity, etc. Since the model does not include a complete transit model, all output summaries are either for person trips or vehicle trips (auto and truck). Enhancing the model's transit capabilities will enable the summary of mode splits, transit vs. auto travel times, and ridership by route; all of which are important to the process of testing and evaluating alternative scenarios.

Once it is determined what additional measures the MPO would like to monitor, a new postprocessor should be developed for the model stream that calculates necessary attributes and produces tabular and graphical summaries of system performance. While the region currently has no significant air quality conformity issues, it might be beneficial to include an air quality postprocessor to help quantify emissions impacts of different transportation strategies. Some MPOs also include benefit/cost calculators in postprocessing of assignment results.

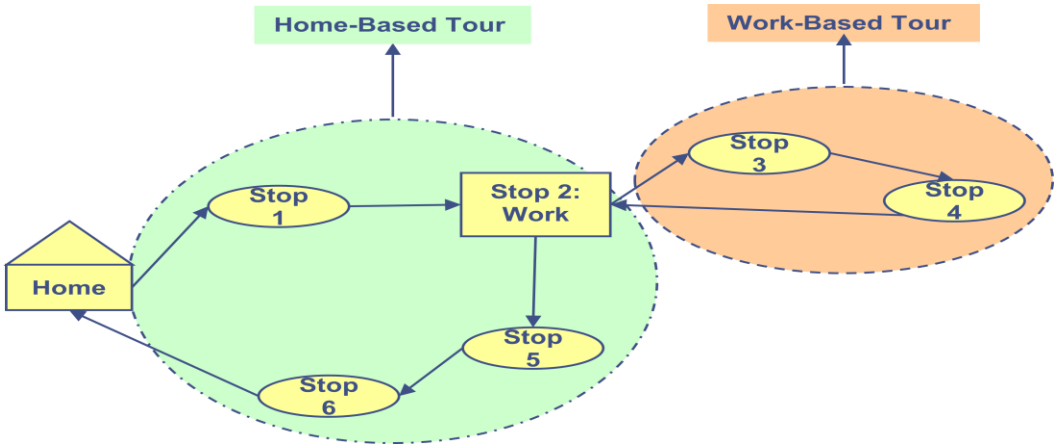
Advanced Modeling

While it is our understanding that the MPO is not ready to make the change to activity-based modeling (ABM) at this time, it is important for the MPO to understand the rationale for choosing such a model, the concepts used, and requirements for developing such a model. ABM has certainly "taken off" over the past few years in the nation's largest MPO regions. The rationale is the complexity of transportation decisions that must be made in these regions that goes beyond the traditional approach of widening roadways to address all capacity deficiencies. The need to explore innovative strategies aimed at very specific travel markets during certain time periods speaks well to consideration

of activity-based models. While it could be argued that the largest metropolitan regions have the most congestion and need most to consider alternative transportation-related strategies, many smaller MPOs also want to take a more balanced approach to transportation planning and pursue some of the same strategies being employed in the nation's largest MPOs.

A separate document is included with this transmittal that discusses the conversion of four-step models to activity-based models. Figure 3.6 depicts "tour" examples modeled in ABM.

Figure 3.6 Example of Tours in Activity-Based Models



3.3 General Level of Priority and Order of Magnitude Costs

The preceding discussion covered a lot of travel demand modeling topics, some minor and others being a major shift in approach. Going back to the same topics outlined in this technical memorandum, the following bullets identify items for short-term, mid-term, and longer-term consideration, along with order of magnitude costs:

- Transit analysis – short term, medium cost ($20k-$30k);
- Toll analysis – short term or midterm, medium cost ($15k-$25k);
- Select link/select zone (Subarea) analysis– short term/optional, low cost ($2k-$5k);
- Freight analysis/mode – short term, medium to higher cost ($40k-$65k);
- Evacuation analysis – midterm, higher cost ($75k-$125k);
- Time-of-day analysis – short term or midterm, medium to higher cost ($50k-$80k);

- Bicycle and pedestrian demand – midterm, higher cost ($75k-$100k);
- Animation/visualization tools – short term, low cost for vpr files (done) to higher cost for 3-D animation ($50k+);
- Documentation, model/planning area expansion, and minor refinements – short term, low cost ($10k-$20k);
- Scenario analysis – short term, low to medium cost ($25k-$50k);
- Model-generated performance measures – short term, low to medium cost ($10k-$25k); and
- Advanced modeling – longer term, higher cost ($100k+)

For the purposes of the above classifications, one could assume short term as being the ongoing model update for use in the 2040 LRTP Update; midterm as over the next 5 years, and long term being over the next 10 years. While the majority of these efforts can and should be addressed in the short term, it is recognized that budgetary and schedule considerations might push some of these out to midterm. Short-term activities not currently funded for GDOT's ongoing model update would require either the MPO to conduct efforts in-house or to engage consultants to complete these efforts (or a combination of both parties working together).

3.4 PEER COMPARISONS

For the purposes of peer model comparisons, we downloaded July 1, 2012 Metropolitan Statistical Area (MSA) population estimates from the U.S. Census web site. Based on size rankings, Cambridge Systematics has developed or worked with several MPO models in areas of similar population size, including Ann Arbor, Michigan; Columbus, Georgia; Gulfport-Biloxi, Mississippi; Mobile, Alabama; Montgomery, Alabama; Naples, Florida; Ocala, Florida; and Tallahassee, Florida.

None of these models is based on recent local household or external intercept travel surveys, although Florida and Georgia DOTs did participate in the 2009 NHTS Add-on survey. The South Alabama Regional Planning Council (Mobile, Alabama) recently took a novel approach by using anonymous cellular data to identify observed flows of HBW, HBO, and nonhome-based trips since they did not have sufficient funds to conduct more traditional surveys.

All of these MPO areas use traditional three- or four-step models with trip generation represented through cross-classification matrices for calculating trip productions. While there are variations among these models on trip purpose stratifications and the demographic attributes cross classified, all nine of these models use comparable approaches to trip generation. All of these models use Gravity Model approaches to trip distribution. The model validation worksheet provided in Appendix A does provide some statistical comparisons between the Savannah model and highway only models for Chattanooga and Macon. While

these areas have a somewhat greater population, the models are of a similar complexity and level of detail.

One-half of these areas includes complete transit modeling capabilities, while the other one-half are "highway-only" models with no transit modeling capabilities. Considering that Savannah has a simplified transit model, one could conclude that the CORE MPO model is comparable to its peers in terms of transit capabilities; however, for reasons noted earlier, we strongly recommend moving towards complete transit modeling capabilities comparable to those found in models for Ann Arbor and the three Florida MPOs.

As noted earlier, time-of-day modeling continues to become more commonplace, even in small- and medium-sized areas. Of the peer models included in this section, only the Gulfport-Biloxi and Ocala models include the ability of modeling time-of-day travel patterns. In many ways, the Gulfport-Biloxi model is quite simplistic though with time-of-day representing perhaps its most impressive feature. Most advanced features of the Ocala model are due to its location as part of a regionwide model for much of Central Florida, including the Orlando MSA and the complexities of modeling its unique travel patterns.

Considerations in Modeling Tourist Travel

One additional consideration not brought up during MPO discussions, but worth considering, is that Savannah differs from many of its peers in terms of its historic street and development patterns, along with an above average amount of tourist related travel. Much of the tourist industry in Savannah is related to its historic district and at this point in time, the model does not include any special treatments for the tourist population. Part of this issue is that there is insufficient survey data on local tourist travel patterns in Savannah.

While the ideal approach to addressing tourist travel would be to consider conducting a tourist survey, there are other models in the U.S. that address similar phenomena and might include some transferable assumptions and parameters that could be added to the Savannah model. Model research documents, such as the earlier referenced *NCHRP Report 735*, are also available that provide considerations on long-distance travelers. Special events models also contain information on tourist related travel patterns.

At a minimum, it would be a good idea to include hotels and motels in the model's socioeconomic data. Our experience in Chattanooga has shown that hotel-motel trip making is essential to proper simulation of travel patterns in areas of significant tourist travel.

4.0 Conclusions

For the most part, the current version of the Savannah/CORE MPO model meets most model validation and sensitivity standards. As with all travel demand models, there are some areas for improvement. There are some undocumented assumptions in the model identified in this report for additional inquiry with GDOT and/or replacement with new data and assumptions. This study largely focused on how to best implement new data, assumptions, and refinements.

This report has identified a number of considerations for refinement of the CORE MPO model, addressing unmet analytical needs, and making the most of limited resources. These refinements range from short-term/inexpensive solutions to more complex/long-term enhancements. Study recommendations essentially outline a potential model improvement plan for the future by documenting and prioritizing unmet needs and shortcomings based on discussions with MPO staff and model evaluations.

Since GDOT is in the midst of updating the Savannah model, this report also provides considerations on items to focus on when the MPO receives the completed model. At a minimum, the MPO should insist on documentation of all assumptions and changes made to the model during the validation process. The MPO could consider an additional post-GDOT model refinement phase for incorporating additional short-range model improvements and assumptions to enhance confidence in model outputs and the testing of alternate scenarios.

As stated in the Executive Summary, a detailed review of the current model and its documentation led to the following key findings on suitability of the existing model:

- Refinements should be made to the highway network, especially area types, screenlines, and assumptions used for speeds and capacities;
- Enhancements are recommended for the traffic analysis zone (TAZ) system, particularly with respect to warehousing and distribution centers;
- Model parameter assumptions are often outdated and in need of updating to more current sources; and
- While model validation and sensitivity appear reasonable, there is little documentation on what changes were made to the model during validation… the MPO should insist on these details from the current model update.

Discussions with MPO staff, evaluation of model limitations, and comparisons with peer models led to a series of recommendations on future model enhancements, also noted in the Executive Summary:

- Many options are available for MPO training and data needs;

- The model should be updated to include complete transit modeling capabilities including transit networks, transit skims, mode choice, transit assignment, and post processing;
- Additional refinements to the freight model are recommended that reflect the importance of the Port of Savannah to the regional economy and local traffic conditions;
- A simplified time-of-day model should be considered to better simulate the impacts of peak period congestion;
- While non-motorized travel is beyond the capabilities of most peer models, the unique walkability of Savannah's historic district merits consideration of at least a simplified approach to bicycle/pedestrian modeling;
- The model should be updated to maximize the use of currently available Cube modeling capabilities such as the application manager and consistent visualization through use of vpr files;
- Relocation of South Carolina external zones is recommended for alternate routing patterns;
- Performance measurements required by MAP-21 legislation should result in additional post-processing capabilities for the regional model; and
- Consideration should be given to targeted modeling of tourist travel, especially within the historic district.

There are other recommendations beyond those listed above provided elsewhere in this report; however, the above bulleted items represent the higher, more immediate priorities for model refinement in the Savannah region.

A. Model Validation Worksheet

COMPARISON SUMMARY

Savannah 2006 Model Validation

Revalidation Run: #1

Date of Model Run: 10/01/12

Results from Savannah model "as is"... don't anticipate running the model with any changes at this point. Validation comments are provided for each model step.

	model run stats
	observed data
	guidelines/other models
	existing model documentation

Trip Generation

52.71% 52.66% 39.14% 56.61%

Comparison of Total Trips by Pu

Purpose	Savannah 2006 Model Run (Files from MPO and Savannah 2006 Cube (Val) Productions	%Productions	Savannah 2006 Model Documentation Savannah 2006 Cube Productions	%Productions	New FDOT Guidelines*	Savannah 2035 CUBE Productions	% Productions	% Change 2006-2035	Available Surveys?	Chattanooga 2007 Model Productions	%Productions	Macon 2008 Model Productions	%Productions
Home-Based Work	171,965	15.54%	n/a	n/a	12-24%	236,099	15.62%	37.29%		244,728	20.19%	109,428	19.65%
Home-Based Other	394,474	35.66%	n/a	n/a	14-28%	524,354	34.68%	32.92%		286,295	23.62%	261,928	47.02%
Home-Based Shop	188,638	17.05%	n/a	n/a	10-20%	271,805	17.98%	44.09%		188,092	15.52%	53,422	9.59%
Non Home-Based	351,176	31.74%	n/a	n/a	20-33%	479,691	31.73%	36.60%		492,790	40.66%	132,243	23.74%
I-I Persons	**1,106,253**	**100.00%**	n/a	n/a		**1,511,949**	**100%**	36.67%		**1,211,905**	**100%**	**557,021**	**100%**
Truck	13,947	9.65%	n/a	n/a		20,248	10.00%	45.18%		n/a		n/a	
Commercial Vehicles	130,597	90.35%	n/a	n/a		182,324	90.00%	39.61%	N/A	n/a		n/a	
I-I Truck-CV	**144,544**	**100.00%**	n/a	n/a		**202,572**	**100.00%**	40.15%		**136,591**		**0**	
Internal-External Pass. Car	91,936	88.66%	n/a	n/a		154,784	86.40%			n/a		n/a	
Internal-External Heavy Trucks	1,998	1.93%	n/a	n/a		3,625	2.02%			n/a		n/a	
Port Direct	2,071	2.00%	n/a	n/a		2,071	1.16%			n/a		n/a	
Port Indirect 1	3,847	3.71%	n/a	n/a		3,847	2.15%			n/a		n/a	
Port Indirect 2	3,845	3.71%	n/a	n/a		14,820	8.27%			n/a		n/a	
Internal-External	**103,697**	**100.00%**	n/a	n/a		**179,147**	**2.02%**			**205,036**		**0**	
TOTAL	1,354,494	-	0	-		1,893,667	-	39.81%					

Aggregate Trip Rates Unit of Measure	2006 Run Savannah	Savannah 2006	New FDOT Guidelines*	Available Surveys?	FHWA Target**
Persons per Household	n/a	2.62	2.0-2.7		n/a
Internal Trips per Household	n/a	10.80	8.0-10.0		8.0-14.0
Internal Trips per Person	n/a	4.10	3.3-4.0	N/A	3.5-4.0
Internal Trips per Employee	n/a	n/a	n/a		n/a
HBW Trips per Employee	n/a	1.20	1.20-1.55		n/a

Base 2006 Savannah	2006 Run Total SE Stats	avannah Model Original Total SE Sta 2006	2035	Census ACS 2006 Est*** Savannah Region	Chatham County	New FDOT Guidelines*
Population	n/a	268,755	368,163	128,418	241,411	
Dwelling Units	n/a	102,617	152,452	59,852	110,190	
Employees	n/a	145,677	198,931	34,086	73,113	
Persons/DU	n/a	2.62	2.41	2.15	2.19	2.0 to 2.7
Emp/Pop	n/a	0.54	0.54	0.27	0.30	0.35 to 0.75

Savannah Region?

Person Trips / Household

Region	Base Year	Person Trip/HH*
Atlanta	2010	8.15
Boise2002 (Boise)	2002	12.86
CFRPM_IV (Orlando)	2000	8.73
Charleston, SC	2003	7.62
CHATT_FR1 (Chattanooga)	2000	8.05
CRTPA (Tallahassee)	2003	9.63
Gainesville	2007	11.05
Knoxville	2000	8.40
MACOG2030cali (South Bend)	2002	7.90
Memphis	2004	8.20
Nashville_TDM (Nashville)	2002	8.59
NERPM (Jacksonville)	2000	8.84
Orlando	2004	7.81
Polk County TPO	2000	8.84
Southeast Florida	2005	8.58
Tampa Bay	2006	9.05
TC2000-TR2 (Treasure Coast)	2000	11.28
FHWA Model Validation & Reasonableness Checking Manual		6.8 to 12.4

Comments: percent HBO trips are somewhat high but many models divide HBO into additional trip purposes. Commercial vehicle and internal-external trips look reasonable. Aggregate trip rates for trips/HH and trips/person are towards the upper end, yet acceptable. HBW trips/employee is at the low end of acceptability while persons/HH is at the high end. ACS comparisons confirm that the persons/HH might be high while the employment/population ratio might also be

**FSUTMS-Cube Framework Phase II: Model Calibration and Validation Standards Final Report, October 2008*

***FHWA Model Validation and Reasonableness Checking Manual, 1*

****2006 American Community Survey 3-Year Estimates, U.S. Census Bureau (Atlanta MSA numbers)*

model run stats
observed data
guidelines/other models
existing model documentation

Savannah 2006 Model Validation

Revalidation Run: #1
Date of Model Run: 10/01/12

Comments: Average trip lengths are somewhat low by most standards. Very small difference between statistics output by model run vs. available model documentation. Percent intrazonal is slightly high for the HBO trip purpose but fine for other trip purposes.

Trip Distribution

Average Trip Length (in	Latest Run	Documentation							
Purpose	2006 Savannah	2006 Savannah	FHWA Target*	New FDOT Guidelines**	Available Surveys?	Census ACS 2006 Est***	2007 Chattanooga	2008 Macon	
Home-Based Work	15.59	15.60	11.2-35.4	12-35		17.37	18.30	22.00	
Home-Based Other	9.43	9.40	10.4-17.3	8-20			12.44	16.90	
Home-Based Shop	10.97	11.00	8.6-18.7	9-19			12.84	16.50	
Non Home-Based	9.90	9.90	8.1-17.1	6-19			14.19	16.60	
I-I Persons	**11.47**	**11.48**							
Commercial Vehicles	12.08	12.10							
Truck	12.23	12.20			N/A			17.19	
I-I Truck-CV	**12.16**	**12.15**					**17.89**		
Commercial Vehicles	18.31	n/a							
Truck	23.18	n/a							
Port Driect	19.85	n/a							
Port Indirect 1	11.70	n/a							
Port Indirect 2	14.96	n/a							
I-E	**17.42**	n/a		**26-58**			**37.38**	**18.73**	
TOTAL	**12.51**	n/a				**-**	**14.53**		

**FHWA Model Validation and Reasonableness Checking Manual, 1998*
***FSUTMS-Cube Framework Phase II: Model Calibration and Validation Standards Final Report, October 2008*
****2006 American Community Survey 3-Year Estimates, U.S. Census Bureau (Chatham County numbers)*

Intrazonal Travel	Latest Run									
	2006 Savannah (Validation-2011)			2006 Savannah Model Documentation			New FDOT Guidelines*	Available Surveys?	2007 Chattanooga	2008 Macon	
Purpose	Total Trips	Intrazonal Trips	% Intrazonal	Total Trips	Intrazonal Trips	% Intrazonal	% Intrazonal		% Intrazonal		
Home-Based Work	171,965	3,541	2.06%	n/a	n/a	n/a	1-4%		1.91%	0.63%	
Home-Based Other	394,474	33,593	8.52%	n/a	n/a	n/a	3-7%		12.97%	2.10%	
Home-Based Shop	188,638	7,360	3.90%	n/a	n/a	n/a	3-9%		12.52%	1.32%	
Non Home-Based	351,176	27,996	7.97%	n/a	n/a	n/a	5-9%		9.61%	2.43%	
I-I Persons	**1,106,254**	**72,489**	**6.55%**	n/a	n/a	n/a					
Commercial Vehicles	130,597	7,369	5.64%	n/a	n/a	n/a					
Truck	13,947	1,048	7.51%	n/a	n/a	n/a				2.08%	
I-I Trucks-Taxi	**144,544**	**8,417**	**5.82%**	n/a	n/a	n/a		n/a	**2.77%**		
Commercial Vehicles	91,936	n/a	n/a	n/a	n/a	n/a					
Truck	1,998	n/a	n/a	n/a	n/a	n/a					
Port Driect	2,071	n/a	n/a	n/a	n/a	n/a					
Port Indirect 1	3,847	n/a	n/a	n/a	n/a	n/a					
Port Indirect 2	3,845	n/a	n/a	n/a	n/a	n/a					
I-E	238,478	n/a	n/a	n/a	n/a	n/a				**0.00%**	

Savannah 2006 Model Validation

Revalidation Run: #1
Date of Model Run: 10/01/12

Comments: Assignment screenline results generally look good with the exception of screenline 13. it's somewhat unclear why there are different sets of screenline summaries… this leads to some confusion.

	model run stats
	observed data
	guidelines/other models
	existing model documentation

Highway Assignment 1 of 2

	Latest Run						
Daily Traffic on Screenlines Screenline***	Savannah 2006 Model Run Total Volume	Savannah 2006 Model Run Total Count	Savannah 2006 Model Run V/C Ratio	Savannah 2006 Document Total Volume	Savannah 2006 Document Total Count	Savannah 2006 Document Volume/Count	New FDOT Guidelines & Standards
1	95,145	100,435	0.95	for some reason, two other sets of screenlines are presented in model documentation; this information is provided below	for some reason, two other sets of screenlines are presented in model documentation; this information is provided below	for some reason, two other sets of screenlines are presented in model documentation; this information is provided below	+/- 10%
2	241,843	248,312	0.97				+/- 10%
3	144,406	154,568	0.93				+/- 10%
4	247,240	252,106	0.98				+/- 10%
5	185,033	188,408	0.98				+/- 10%
6	245,176	258,713	0.95				+/- 10%
7	102,409	104,039	0.98				+/- 10%
9	69,384	64,200	1.08				+/- 15%
13	4,276	1,370	3.12				+/- 20%
36	27,475	*not a screenline but corridor summary*					
Total	1,334,912	1,372,151	0.97				+/-5%

Vehicle Trip Table Summary

	Year 2006	Year 2035	% Change 2006-2035
PCWKT	-	-	
PCWKN	324,108	424,299	30.91%
PCNWT	-	-	
PCNWN	759,406	999,068	31.56%
TKT	-	-	
TKN	25,868	40,642	57.11%
EEPC	67,122	117,098	74.46%
EETK	11,850	20,669	74.42%
Total	1,188,354	1,601,775	34.79%

All Screenlines		2006 Documention					2006 Model Run				
	Screenline Name	Assigned Vol	Traffic Count	V/C	Deviation	Max Allowed Dev	Assigned Vol	Traffic Count	V/C	Deviation	Max Allowed Dev
1	East of the city screenline	80,729	75,110	1.07	7.5%	27.7%	80,729	75,110	1.07	7.5%	27.7%
2	West of the city screenline	185,674	191,156	0.97	-2.9%	19.4%	185,674	191,156	0.97	-2.9%	19.4%
3	Southside Cutline	101,940	104,110	0.98	-2.1%	24.4%	101,940	104,110	0.98	-2.1%	24.4%
4	Midtown Cutline	109,504	112,684	0.97	-2.8%	23.7%	109,504	112,684	0.97	-2.8%	23.7%
Total		477,847	483,060	0.99	-1.1%	13.6%	477,847	483,060	0.99	-1.1%	13.6%

Screenline subset		2006 Documention					2006 Model Run				
	East of the City	Assigned Vol	Traffic Count	V/C	Deviation	Max Allowed Dev	Assigned Vol	Traffic Count	V/C	Deviation	Max Allowed Dev
1	Laroche Ave	5,749	5,600	1.03	2.7%	49.3%	5,749	5,600	1.03	2.7%	49.3%
2	Skidaway Rd	5,595	5,310	1.05	5.4%	50.4%	5,595	5,310	1.05	5.4%	50.4%
3	Diamond Cswy	18,368	14,120	1.30	30.1%	32.9%	18,368	14,120	1.30	30.1%	32.9%
4	Island Exwy	18,912	21,510	0.88	-12.1%	27.4%	18,912	21,510	0.88	-12.1%	27.4%
5	US 80/SR 26	32,104	28,570	1.12	12.4%	24.2%	32,104	28,570	1.12	12.4%	24.2%
Total		80,729	75,110	1.07	7.5%	27.7%	80,729	75,110	1.07	7.5%	27.7%

Screenline subset		2006 Documention					2006 Model Run				
	West of the City	Assigned Vol	Traffic Count	V/C	Deviation	Max Allowed Dev	Assigned Vol	Traffic Count	V/C	Deviation	Max Allowed Dev
1	Abercorn Ext	24,581	24,526	1.00	0.2%	19.1%	24,581	24,526	1.00	0.2%	19.1%
2	I-16 / SR 404	25,389	26,350	0.96	-3.7%	18.5%	25,389	26,350	0.96	-3.7%	18.5%
3	SR 25	8,564	7,328	1.17	16.9%	43.8%	8,564	7,328	1.17	16.9%	43.8%
4	SR 21	35,706	38,380	0.93	-7.0%	21.3%	35,706	38,380	0.93	-7.0%	21.3%
5	Old Louisville Rd	2,443	2,650	0.92	-7.8%	68.3%	2,443	2,650	0.92	-7.8%	68.3%
6	US 80/ SR 26	20,368	19,746	1.03	3.2%	28.4%	20,368	19,746	1.03	3.2%	28.4%
7	I-16 / SR 404	25,195	26,350	0.96	-4.4%	18.5%	25,195	26,350	0.96	-4.4%	18.5%
8	US 17/SR 25	18,864	21,300	0.89	-11.4%	27.5%	18,864	21,300	0.89	-11.4%	27.5%
9	Abercorn Ext	24,563	24,526	1.00	0.2%	19.1%	24,563	24,526	1.00	0.2%	19.1%
Total		185,674	191,156	0.97	-2.9%	19.4%	185,674	191,156	0.97	-2.9%	19.4%

All Screenline		2006 Documention					2006 Model Run				
	Cutline Southside	Assigned Vol	Traffic Count	V/C	Deviation	Max Allowed Dev	Assigned Vol	Traffic Count	V/C	Deviation	Max Allowed Dev
1	Habersham St	10,959	10,070	1.09	8.8%	38.2%	10,959	10,070	1.09	8.8%	38.2%
2	SR 204	39,302	35,600	1.10	10.4%	22.0%	39,302	35,600	1.10	10.4%	22.0%
3	White Bluff Rd	29,245	33,600	0.87	-13.0%	22.6%	29,245	33,600	0.87	-13.0%	22.6%
4	Waters Ave	22,434	24,840	0.90	-9.7%	25.7%	22,434	24,840	0.90	-9.7%	25.7%
Total		101,940	104,110	0.98	-2.1%	24.4%	101,940	104,110	0.98	-2.1%	24.4%

Screenline subset		2006 Documention					2006 Model Run				
	Cutline Midtown	Assigned Vol	Traffic Count	V/C	Deviation	Max Allowed Dev	Assigned Vol	Traffic Count	V/C	Deviation	Max Allowed Dev
1	Bonaventure Rd	2,330	2,100	1.11	11.0%	75.6%	2,330	2,100	1.11	11.0%	75.6%
2	Truman Pwky	10,042	10,650	0.94	-5.7%	27.5%	10,042	10,650	0.94	-5.7%	27.5%
3	MLK Blvd	12,832	10,980	1.17	16.9%	36.7%	12,832	10,980	1.17	16.9%	36.7%
4	Montgomery St	9,533	10,790	0.88	-11.7%	37.0%	9,533	10,790	0.88	-11.7%	37.0%
5	SR 204	8,359	8,375	0.89	-10.8%	39.4%	8,359	9,375	0.89	-10.8%	39.4%
6	Dayton St	5,686	6,137	0.93	-7.4%	47.3%	5,686	6,137	0.93	-7.4%	47.3%
7	Whitaker St	5,926	5,560	1.07	6.6%	49.4%	5,926	5,560	1.07	6.6%	49.4%
8	East Broad St	2,084	1,761	1.18	18.4%	81.6%	2,084	1,761	1.18	18.4%	81.6%
9	Paulsen St	2,127	2,210	0.96	-3.8%	73.9%	2,127	2,210	0.96	-3.8%	73.9%
10	Waters Ave	8,534	8,680	0.98	-1.7%	40.7%	8,534	8,680	0.98	-1.7%	40.7%
11	Bee Rd	4,513	4,970	0.91	-9.2%	51.9%	4,513	4,970	0.91	-9.2%	51.9%
12	Truman Pwky	10,073	10,650	0.95	-5.4%	27.5%	10,073	10,650	0.95	-5.4%	27.5%
13	Buli St	7,192	7,780	0.92	-7.6%	42.7%	7,192	7,780	0.92	-7.6%	42.7%
14	Skidaway Rd	13,547	14,180	0.96	-4.5%	32.9%	13,547	14,180	0.96	-4.5%	32.9%
15	Stiles Ave	6,725	6,860	0.98	-2.0%	45.1%	6,725	6,860	0.98	-2.0%	45.1%
Total		109,504	112,683	0.97	-2.8%	23.7%	109,504	112,683	0.97	-2.8%	23.7%

Savannah 2006 Model Validation

Revalidation
Date of Model Run: 10/01/12

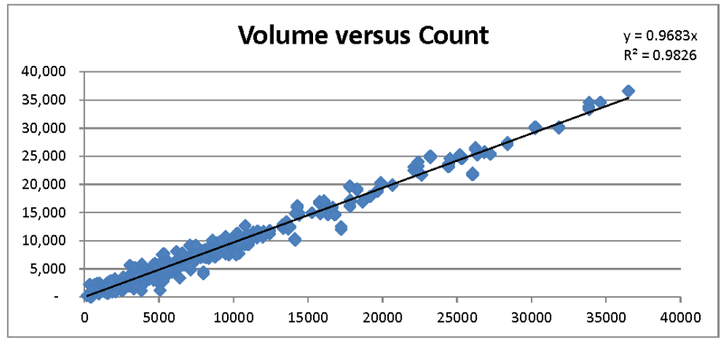
Highway Assignment 2 of 2

Comments: Our estimates of VHT and VMT don't match what has been documented in the PBS&J/GDOT report... could be from post-processing? Not surprisingly, ramps don't validate well.; however, it is surprising that freeways do not validate better. In fact, freeways, exit ramps, and entrance ramps all score a volume/count ratio of 0.83-0.84, meaning that improving one might help the other. Rural roadways validate poorly at a volume/count ratio of 1.53. Percent RMSE is better than most models, with the except of roadways with LT 1k daily trips.

	model run stats
	observed data
	guidelines/other models
	existing model documentatio

Volume-over-Count by FT/AT/NL

		Latest Run			Volumes Over Counts Links w/ Counts % Diff. (+/- 15%-+/-25%)		
		Savannah 2006 Model Run			Savannah 2006 Model Documentation		
FT/AT/NL		Volume	Count	V/C	Volume	Count	V/C
Facility Type	Interstate	1,172,345	1,199,312	0.98	n/a	n/a	n/a
	Freeway	64,549	76,484	0.84	n/a	n/a	n/a
	Expressway	89,569	89,076	1.01	n/a	n/a	n/a
	Parkway	136,805	134,440	1.02	n/a	n/a	n/a
	Freeway to Freeway Ramp	140,161	139,690	1.00	n/a	n/a	n/a
	Freeway Entrance Ramp	95,903	115,270	0.83	n/a	n/a	n/a
	Freeway Exit Ramp	101,811	121,750	0.84	n/a	n/a	n/a
	Principal Arterial - Class I	1,487,989	1,535,800	0.97	n/a	n/a	n/a
	Principal Arterial - Class II	530,293	549,502	0.97	n/a	n/a	n/a
	Minor Arterial - Class I	726,074	742,247	0.98	n/a	n/a	n/a
	Minor Arterial - Class II	167,706	171,948	0.98	n/a	n/a	n/a
	One way arterial	195,308	200,229	0.98	n/a	n/a	n/a
	Major Collector	297,512	302,872	0.98	n/a	n/a	n/a
	Minor Collector	21,346	19,030	1.12	n/a	n/a	n/a
	One way collector	8,776	9,011	0.97	n/a	n/a	n/a
	Rural Roads	5,466	3,570	1.53	n/a	n/a	n/a
	TOTAL	5,241,613	5,410,231	0.97	n/a	n/a	n/a
Area Type	CBD/Very High Density Urban	362,025	379,919	0.95	n/a	n/a	n/a
	High Density Urban	196,667	206,331	0.95	n/a	n/a	n/a
	Medium Density Urban	293,433	295,162	0.99	n/a	n/a	n/a
	Low Density Urban	784,868	822,407	0.95	n/a	n/a	n/a
	Surburban	2,941,685	3,006,417	0.98	n/a	n/a	n/a
	Exurban	628,841	664,285	0.95	n/a	n/a	n/a
	Rural	34,096	35,710	0.95	n/a	n/a	n/a
	TOTAL	5,241,615	5,410,231	0.97	n/a	n/a	n/a
Number of Lanes/ Direction	1	1,565,873	1,622,347	0.97	n/a	n/a	n/a
	2	2,503,975	2,605,948	0.96	n/a	n/a	n/a
	3	1,171,767	1,181,936	0.99	n/a	n/a	n/a
Total		5,241,615	5,410,231	0.97	n/a	n/a	n/a



Vehicle-Miles-Traveled

	New FDOT Guidelines & Standards	2006 Run Savannah	2006 Doc Savannah
VMT		7,733,345	6,659,856
Population		268,755	n/a
Dwelling Unit		102,617	n/a
VMT/HH	60-75	75	64.1
VMT/Person	24-32	29	24.5
VHT		233,432	227,380

Root Mean Square Error

Count Range	New FDOT Guidelines & Standards*	2006 Run Savannah	2006 Doc Savannah
1-5,000	(0 - 5K) 45-100%	22.40%	0.0-1.0k: 62%
5,000-7,000		17.20%	1.0k-2.5k: 23%
7,000-10,000		11.70%	2.5k-5.0k: 18%
5,000-10,000	(5K - 10K) 35-45%		13%
10,000-15,000	(10K - 15K) 27-35%	10.50%	7%
15,000-20,000	(15K - 20K) 25-30%	10.00%	n/a
10,000-20,000			n/a
20,000-25,000		4.50%	n/a
25,000-30,000		6.90%	n/a
20,000-30,000	(20K - 30K) 15-27%	2.30%	n/a
30,000-40,000	(30K-40K) 15--25%		n/a
>40,000			n/a
All Volume Range:	32-39		12%

2006 Documentation RMSE by Facility Type	
Freeways and Expressways	11%
Principal Arterials	9%
Minor Arterials	14%
Collectors	22%
	12%

**FSUTMS-Cube Framework Phase II: Model Calibration and Validation Standards Final Report, October 2008*

Percent Error by Volume Group Volume Range	Typical Lanes	2006 Savannah Model Run	2006 Savannah Document: RMSE	New FDOT Guidelines & Standards*	TMIP** FHWA Accuracy
0 - 1000	2L	163%	62%	+/- 34%	+/- 29-60%
1001 - 2500	4L	59%	23%	+/- 25%	+/- 22-25%
2501 - 5000	6L	40%	18%	+/- 13%	+/- 22%
5001 - 10000	4-6L freeway	31%	13%	+/- 17%	+/- 21%
>10000	6L freeway	18%	7%	+/- 25%	+/- 21%
	8L+ freeway			+/- 25%	+/- 21%
TOTAL					

**FSUTMS-Cube Framework Phase II: Model Calibration and Validation Standards Final Report, October 2008*

***FHWA Model Validation and Reasonableness Checking Manual, 1998*