BOSTON REGION METROPOLITAN PLANNING ORGANIZATION

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WORK PLAN

REGIONAL MODEL ENHANCEMENTS FFY 2019

NOVEMBER 15, 2018

Proposed Action

The Boston Region Metropolitan Planning Organization (MPO) reviews this work plan.

Project Identification

Project Number 7119

Client

Boston Region MPO

Project Supervisors

Principal: Scott Peterson
Manager: Ed Bromage

Funding Source

MPO Planning Contract 105757 and MPO §5303 Contract TBD

Schedule and Budget

Schedule: 12 Months after work commences

Budget: $796,876

Schedule and budget details are shown in Exhibits 1 and 2, respectively.

Background

The regional travel demand forecasting model (regional model) is a key tool that supports the analyses in the Long-Range Transportation Plan (LRTP) and the Transportation Improvement Program (TIP), as well as numerous agency-funded technical studies. The regional model is maintained with the latest population and employment statistics (both existing and forecast), and it represents the latest version of the transportation network (highway, transit, and non-motorized modes) as well as proposed projects and projects for which funding has been committed. Some of the recent benchmark dates and enhancements to the model are as follows:

- Prior to 2009, the regional model was in the EMME software package. In 2009, the Central Transportation Planning Staff (CTPS) began to convert the model from the EMME software package to the TransCAD software package. TransCAD affords more analysis capability options than EMME.
- In 2011, the highway network representation was rebuilt using the latest Massachusetts Department of Transportation (MassDOT) road inventory file (RIF) data.
- In 2012–13, the transit system network representation was completely rebuilt.
- From 2012 to 2015, all demand components of the regional model were rebuilt using the 2011 Massachusetts Household Travel Survey (2011 MTS).
- In a separate effort, under contract to MassDOT, the statewide highway model was updated from a base year of 2000 to 2015 using the RIF file. The update included revisions to allow the model to run in the latest TransCAD software.
- In 2016–17, the statewide highway model and the 2015 regional model were merged into a single modeling system. This enhanced regional model allowed for full representation of the regional commuter rail system as well as the travel market overlaps between Greater Boston and neighboring communities in New Hampshire and Rhode Island.
- In 2017, under contract to MassDOT, transit route systems in Worcester and Springfield were added to the model.
- In 2018, all features of this new modeling system were brought to a common 2016 base.
- Currently, the regional model covers all of Massachusetts, all of Rhode Island, and the southern third of New Hampshire. In total, the model covers 448 communities.

Objective(s)

Key objectives associated with this work plan are as follows:

1. Maintain the enhanced regional model in good working order so it can continue to be used for MPO- and agency-funded projects.
2. Develop an activity based model (ABM) to supplement the current regional model.

3. Research and analyze available data on usage patterns of Transportation Network Companies (TNC), such as Uber and Lyft, to determine how they may be incorporated into the enhanced regional travel model as a distinct mode.
4. Build a smaller, quicker version of the enhanced regional model to allow more timely analyses when screening and ranking projects.
5. Build a response-surface meta model of the regional model to generate forecast intervals (margins of error) for equity analyses and project screening.
6. Investigate other planning tools that could be used for the MPO's certification and project work.

Work Description

The objectives discussed above are reflected in the tasks shown below.

Task 1 Model Support

CTPS's Travel Model Development (TMD) group is principally funded by this work program. In addition to developing modeling tools, the TMD group is responsible for training staff; revising model functionality to address certification or project needs; and investigating and developing new tools. Specific support tasks provided by the group include the following:

Subtask 1.1 Support for Certification Activities

Provide assistance in maintaining a relationship between the TIP projects and the projects coded into the travel model. Assist in augmenting the model to support other certification activities, such as transportation equity analyses and air quality analyses.

Subtask 1.2 TSA Model Application Support

Support CTPS's Transportation Systems Analysis (TSA) group, which conducts scenario planning and analyses for the TIP and LRTP as well as project work for MPO-member agencies. Enhance and document modeling tools and train TSA staff members. Hold joint TMD-TSA Model User's Group meetings several times a year to share model development and application issues. Fund staff participation in vendor-delivered TransCAD software training programs offered by the Caliper Corporation.

Subtask 1.3 MAPC Support

Participate in monthly coordination meetings between CTPS's TMD staff and the planning staff of the Metropolitan Area Planning Council (MAPC). Provide MAPC with data from the CTPS regional model as key inputs to the joint CTPS/MAPC land-use allocation model (Cube Land).

Subtask 1.4 MassDOT Support

Modify and run the enhanced regional model as needed to support MassDOT's project analysis requests. These requests typically call for running the model in a

statewide mode and are more modest than the MassDOT project work, referenced in subtask 1.2, which is handled by the TSA group.

Task 2 Four-Step Model Maintenance

Maintaining the travel model is the key function of the TMD group. From year to year, maintenance may take different forms. For the next fiscal year, these maintenance activities will be as follows:

Subtask 2.1 TransCAD Version 8 Testing

Convert the enhanced regional model from TransCAD 7 to TransCAD 8. This conversion is necessary because Caliper Corporation, the TransCAD vendor, is phasing out support for the dialog box type of user interface currently used by CTPS, having moved to a flowchart-style interface. In addition, there are a variety of functions in TransCAD 8's modeling engine that offer improved performance over TransCAD 7. Converting to TransCAD 8 will require compilation and testing to identify and reprogram elements of the CTPS regional model that are not backwards compatible, as well as staff training. The activities funded under this task are as follows:

1. Compile the TransCAD 7 model in TransCAD 8. Compare TransCAD 7 model results to TransCAD 8 results and document differences.
2. Convert the user interface from the existing dialog box environment to a flowchart environment.
3. Make changes to the model code to ensure that the model is running as intended in TransCAD 8.
4. Train staff on use of the new TransCAD 8 interface.

Subtask 2.2 Future Land Use Scenarios

Create the final enhanced regional model land use inputs. At the direction of MassDOT, the UMass Donahue Institute (UMDI) has created community-level projections of households and employment for the years 2020 to 2040 in five-year increments. CTPS is disaggregating the employment projections to the transportation analysis zones (TAZ) format required by the regional model. In addition, CTPS is working jointly with MAPC to disaggregate households to TAZs. During FFY 2019, CTPS will develop TAZ-level allocations for the years 2025, 2030, and 2035, which are needed for project analyses. In addition, CTPS will be creating projections of the group-quarters population for each of these years and will update the previously interpolated 2016 land use assumptions (2016 is the base-year for the model), based on the new 2020 projections.

Subtask 2.3 Develop a Hierarchical Zone System (Super Zones)

Create an optional hierarchical zone system to speed up run times. Currently, the enhanced regional model has more than 5,800 TAZs, covering 448 communities in Massachusetts, Rhode Island, and New Hampshire. This level of detail is needed for accurate statewide analysis of vehicle-miles/hours traveled (VMT/VHT) and for the preparation of accurate mobile emissions; however, having more zones increases model run times and is not necessary for analyzing projects within the Boston Region MPO area. To reduce run times, a hierarchical zone system will be created by combining TAZs in areas farther away from the MPO area according to community boundaries, thereby creating "Super Zones," while maintaining the current, detailed TAZ system within the MPO area and adjacent communities. The enhanced regional model's user interface and reporting capabilities will be modified to work with this new system and provide users with options regarding when and how to use it.

Subtask 2.4 Revise Station Choice Model

Revise the station choice procedure in the enhanced regional modeling system so that it runs faster by moving more processes to memory and streamlining its allocation functions. The station choice model adjusts the commuter rail and rapid transit assignments, based on the capacity of park-and-ride lots.

Subtask 2.5 Environmental Justice Matrix

Modify the enhanced regional model to produce a new set of environmental justice metrics as required by CTPS's Certification Activities and MPO Support group to analyze the disparate impacts of long-range planning projects on low-income and minority populations. These metrics may include the following: highway and transit travel time to employment centers, hospitals, retail businesses, and educational institutions; congested VMT; average travel times; and mobile emissions by type with exposure matrix.

Subtask 2.6 Model User's Guide Documentation

Create user's guidance documents for portions of the modeling system that are currently undocumented, including some of the newer elements that will be created through this work plan. For example, user guidance is needed on the topics of zone splitting, hierarchical zones, and network windowing. User guidance documentation should be similar in format to a tutorial and used for staff training and as a reference.

Subtask 2.7 Model Technical Documentation

Create or update formalized documents describing model form, methodology, and specifications, including results from statistical estimation and calibration. Currently, technical documentation is required for the following topics: overview of the entire modeling process; transit skimming and assignment settings; trip

distribution; zone splitting; network and trip table windowing; and use of hierarchical zoning.

Products of Task 2
Documentation files

Task 3 Activity Based Model (ABM) Development

Task 3 will complete the model estimation and component testing, the second phase of the ABM development project. Use of ABMs is an approach to modeling regional activity-travel patterns that has been adopted by most of the large MPOs in the US during the past 20 years. ABMs are valued for their ability to provide answers to complex questions such as traveler responses to pricing proposals, time-of-day dynamics, and finer-grained analyses of impacts on individuals and households.

Data development, the first phase of the project, was mostly completed during FFY 2018 and involved extensive processing of the 2011 Massachusetts Travel Survey (2011 MTS) to create variables for model structures. Estimation and component testing uses these variables, along with model network travel times and costs, to create a set of models that can predict the travel decisions of residents in the region, based on changes in socioeconomic and land use inputs and transportation system level of service. The ABM design includes 20 model components, each of which has its own estimation and testing subtask. It is anticipated that the final phases of the ABM project—system integration, validation, documentation, and staff training—will be carried out after FFY 2019.

Products of Task 3
Source code, data input, and technical documentation of model estimation and testing results

Task 4 Four-Step Model Lite

Currently, on CTPS's two most powerful computers, model run times are between 12 and 15 hours. On the lesser machines, run times are between 22 and 28 hours. To help with project screening and high-level alternatives analyses, users have requested a faster, lighter version of the enhanced regional model that can be run in less than 30 minutes. Development of this version will involve creating Super Zones, described above under Task 2.3, for the entire model region. For each Super Zone, highway- and transit-weighted accessibility metrics will be created, such as highway VMT and VHT, transit revenues, and mode shares. Users will be allowed to make changes to a select set of key inputs, namely zonal households and auto ownership; parking cost and supply; transit accessibility (includes service frequency); transit fares; transit park-and-ride lot costs; and auto operating costs and tolls. This "model lite" will run from the existing TransCAD model databases, so updates to the larger model will be included in the "lite" version. A separate user interface and reporting capabilities will also be created in TransCAD.

Products of Task 4

"Model Lite" software and user's interface, a user's guide, and technical documentation

Task 5 Tool to Provide Forecasting Interval Estimates

This task will create an add-on component to the enhanced regional model that will allow CTPS to quantify forecasting uncertainty, as needed for social equity analyses. Specifically, the tool should enable CTPS to ascertain whether the impacts of a proposed project, plan, or policy would have a disparate impact on minority or low-income communities beyond the margin of forecasting error in the model.

The method proposed is a response-surface model, which would be derived from the enhanced regional model and used to estimate forecasting confidence intervals around each of the output metrics needed for the disparate impacts analysis. The subtasks that make up this effort are as follows: defining key input and output variables; running the regional model multiple times to generate sample output data using different combinations of inputs; estimating model response coefficients; and generating statistical distributions for each output variable. The resultant tool could also be used to provide ranges of outputs or forecasting intervals for other types of analyses typically performed with the regional model, such as project screening.

Product of Task 5

A model, implemented in a Python Notebook file, which will include implementation source code, input and output graphs, and user instructions

Task 6 Other Modeling Methods

This task will investigate other modeling tools in the public domain that could be useful in project analysis and certification work. Of particular interest is the "STOPS" model developed by the Federal Transit Administration, which can be used to examine transit service area changes and/or transit operation changes. CTPS previously had two staff members attend STOPS training and would like to investigate further the potential for STOPS project application in the Boston Region MPO area. In addition, there may be other tools which the TMD group, funded under this task, would explore and evaluate to address specific needs related to certification activities or project evaluations.

Product of Task 6

A brief technical memo discussing CTPS's findings, focusing on cases for which STOPS would seem to be useful

Task 7 Study and Analysis of Transportation Network Companies

Address the knowledge gaps regarding TNCs (such as Lyft and Uber) by analyzing currently available sources and conducting background research on how other regions of the country are analyzing and modeling TNCs. Thus far, TNCs have been reluctant to share data about their usage patterns, leaving CTPS and peer agencies throughout the US with little empirical data upon which to base planning decisions or to update regional travel models. These services did not exist in Boston when the 2011 MTS was conducted, yet in 2018 they represent a significant and growing share of traffic in certain locations during certain times of day. Recently, computer science researchers at Northeastern University (NEU) conducted a study of TNC trips in Boston proper and were able to collect a significant amount of travel data, which could be mined to approximate trip generation and travel patterns.

Subtask 7.1 Process NEU's TNC data

CTPS has already begun to process this data; however, there are many millions of records in the NEU database and each data record is very detailed. In this subtask, CTPS staff will continue processing the data with the intent of creating a demand profile by time of day and day of the week for the NEU study area.

Subtask 7.2 TNC Research

CTPS staff will review studies published by the Transportation Research Board, the Federal Highway Administration's Travel Model Improvement Program, and other sources for guidance. In addition, CTPS staff will contact other large MPOs to understand how they are studying and responding to this new travel mode.

Products of Task 7

Subtask 7.1 will produce a database consisting of TNC demand data for the NEU study area, organized by the same zones used in the regional travel model, but covering a smaller area centered on Boston. The database will be organized by hour of the day and day of the week. Subtask 7.2 will result in a long-term plan for how to incorporate TNCs into the regional planning process.

Exhibit 1
ESTIMATED SCHEDULE
Regional Model Enhancements - FFY2019

Task	Month 1	2	3	4	5	6	7	8	9	10	11	12
1. Model Support												
2. Four-Step Model Maintenance												
3. Activity Based Model (ABM) Development												
4. Four-Step Model Lite												
5. Tool to Provide Forecasting Interval Estimates												
6. Other Modeling Methods												
7. Study and Analysis of Transportation Network Companies												

Exhibit 2
ESTIMATED COST
Regional Model Enhancements - FFY2019

Direct Salary and Overhead	**$796,876**

Task	Person-Weeks						Direct Salary	Overhead (99.00%)	Total Cost
	M-1	P-5	P-4	P-3	P-1	Total			
1. Model Support	9.0	9.0	4.0	4.0	6.2	32.2	$50,824	$50,316	$101,140
2. Four-Step Model Maintenance	5.0	8.0	5.0	5.0	9.0	32.0	$46,824	$46,356	$93,180
3. Activity Based Model (ABM) Development	12.0	32.0	16.0	14.0	12.0	86.0	$136,546	$135,181	$271,727
4. Four-Step Model Lite	8.0	12.0	6.0	5.0	8.0	39.0	$60,667	$60,061	$120,728
5. Tool to Provide Forecasting Interval Estimates	5.0	12.0	7.0	6.0	9.0	39.0	$58,761	$58,173	$116,934
6. Other Modeling Methods	3.0	6.0	3.0	3.0	0.0	15.0	$25,312	$25,059	$50,372
7. Study and Analysis of Transportation Network Companies	2.0	5.0	3.0	3.0	0.0	13.0	$21,506	$21,291	$42,796
Total	44.0	84.0	44.0	40.0	44.2	256.2	$400,440	$396,436	$796,876

Other Direct Costs	**$0**

TOTAL COST	**$796,876**

Funding

MPO Planning Contract 105757 and MPO §5303 Contract TBD