BOSTON REGION METROPOLITAN PLANNING ORGANIZATION

Stephanie Pollack, MassDOT Secretary and CEO and MPO Chair
Karl H. Quackenbush, Executive Director, MPO Staff

MEMORANDUM

DATE **January 7, 2016**

TO **Boston Region Metropolitan Planning Organization**

FROM **Karl H. Quackenbush**
CTPS Executive Director

RE **Work Program for: Modeling Transit Capacity Constraints**

Action Required

Review and approval

Proposed Motion

That the Boston Region Metropolitan Planning Organization, upon the recommendation of the Massachusetts Department of Transportation, vote to approve the work program for Modeling Transit Capacity Constraints presented in this memorandum

Project Identification

Unified Planning Work Program Classification

Technical Support/Operations Analysis Projects

CTPS Project Number

11405

Client

Massachusetts Department of Transportation (MassDOT), Office of Transportation Planning
Project Supervisors: Scott Hamwey

CTPS Project Supervisors

Principal: Ed Bromage
Manager: Jieping Li

Funding

MassDOT §5303 Contract #88429

Impact on MPO Work

The MPO staff has sufficient resources to complete this work in a capable and timely manner. By undertaking this work, the MPO staff will neither delay the completion of nor reduce the quality of any work in the UPWP.

Background

The modeled area of the MPO's regional travel demand model set consists of the 101 MPO municipalities and the 63 municipalities that surround the MPO region. Within the modeled area, the representation of the transit system includes: all MBTA (Massachusetts Bay Transportation Authority) services (ferry, commuter rail, rapid transit, bus rapid transit, inner and outer express bus, local bus, and trolley); other RTAs' bus services; private-carrier services; Logan bus and shuttle services; and downtown shuttle services. The MPO region's transit system operates at or near capacity at various times on weekdays.

The constraints on the transit system can be caused by any or all of the following four factors:

- The parking supply at park-and-ride locations on the transit system
- A station's capacity to accommodate the demand (people using the station)
- The ability of the transit vehicle, train set, or train passenger cars operating on the transit route to accommodate the demand (people using that transit service)
- The frequency of transit vehicles along a route in a given time period and the ability of those vehicles to accommodate the demand at the transit stations (or stops) along the route

The regional travel demand model represents an average weekday in the spring, and temporally splits the demand for all person-trips regardless of transportation mode into four time periods:

- AM peak (6:01 AM – 9:00 AM)
- Midday (9:01 AM – 3:00 PM)
- PM peak (3:01 PM – 6:00 PM)
- Nighttime (6:01 PM – 6:00AM)

For the assignment step used in the MPO's travel demand model of the transit system, with the exception of users of park-and-ride lots, all transit trips are assigned to the "best transit route" regardless of capacity constraints. The "best transit route" is the one that has the lowest generalized cost. The generalized costs are defined as the costs calculated based on the value of travelers' time, out-of-pocket costs, in-vehicle travel times, and out-of-vehicle travel times. However, the model does not

explicitly constrain the supply of the transit station, route, or line to the demand that it was expected to have within the time periods of CTPS's modeling process.

The modeling process does not constrain station travel demand, but this demand constraint is not easily or usually incorporated into a regional modeling assignment process because individual vehicle or train set capacity is too fine a level of detail to be considered in the regional modeling process. However, the route capacity over a given time period (as described above), which has not been included in CTPS's modeling process, should be considered, and will be evaluated in this project.

CTPS's modeling process considers parking availability at transit stations; this constraint is also represented in the MPO's current Long-Range Transportation Plan, *Charting Progress to 2040*. The modeling process redirects park-and-ride lot users to alternate parking lots if the primary (preferred) lot is at capacity. Also, if no reasonable alternative lots are available, the model then examines other travel modes and reassigns the trip to a different mode.

Objective

The goal of this work is to develop a methodology that allows the Boston Region MPO's regional travel demand model to accurately reflect transit capacity constraints. The methodology should allow transit capacity constraints to be incorporated into the modeling process through an assignment method that simulates how people identify and react to congestion in the transit system. This reaction could take the form of any one of the following choices:

- Selecting a different transit route
- Selecting a different travel mode
- Changing the time of the trip

Work Description

Task 1 Review and Evaluate Current Transportation Modeling Practices

This task will consists of a literature review of current practices of travel-demand modeling. CTPS will examine webpages and published material from the US Department of Transportation, the Transportation Research Board, and large urban area MPOs that are comparable to the Boston Region MPO. CTPS will also examine published material from software vendors.

The regional model software (TransCAD) that CTPS currently uses for the MPO's travel demand model provides various methodologies for transit capacity

modeling. These methodologies include a stochastic user equilibrium process.[1] Currently, CTPS does not use a stochastic assignment process, so implementation of this methodology would require some restructuring of the transit assignment process. However, TransCAD methodology offers the option of applying capacity constraints on a route level, and Caliper Corporation (the TransCAD vendor) has a software product (TransModeler) that has the capability of applying transit capacity constraints on a microlevel assignment; this product may be evaluated as part of this task. CTPS may also research the SATURN model, which is used in the United Kingdom to model the London transit system.

Product of Task 1

An informal document (which will be incorporated into the final memo as part of Task 5) that describes current transit capacity modeling practices

Task 2 Test and Select New Modeling Methodologies

Based on the literature review performed in Task 1, CTPS will select one or more methodologies for incorporating transit capacity constraints into its modeling process through an assignment method that simulates how people identify and react to congestion in the transit system. CTPS will then program and test the methodologies in the transit assignment process, and will consider the following criteria for selecting which methodology (or methodologies) to use in future modeling:

- Ease of implementation
- Availability of needed input data
- Inclusion of a temporal breakdown
- Realistic consideration of individual decision variables
- Responsiveness of a methodology to increases in transit congestion

Product of Task 2

Selection of one or more methodologies (for future incorporation into the modeling process)

Task 3 Obtain Data on Transit Capacity and Observed Ridership by Mode

CTPS will obtain systemwide data on theoretical capacity and observed ridership by time of day from the MBTA. These capacities will be added to the current

[1] The stochastic user equilibrium process involves performing multipath assignment (multiple paths are considered for going from one point to another). These models aim to account for variations in driver perceptions and are flexible enough to allow drivers to choose routes based on their differing perceptions. Such models assign trips to alternative paths by assigning probabilities. These probabilities represent the likelihood of moving from one node to another using a particular link.

model's variable coding by adding additional data fields to the route system data layer.

Product of Task 3

Systemwide capacity and ridership data

Task 4 Test Route-Capacity Modeling Methodologies

CTPS will run up to three route-capacity methodologies through the transit assignment process for the base year and for the forecast year 2040. CTPS will also perform stress tests on each methodology by increasing demand and/or decreasing route capacity. These tests will be conducted for the entire transit system. The results of the tests will be used later to update the transit assignment process (not part of this scope of work).

Product of Task 4

An informal document summarizing the evaluation of the results of this task, including the recommendation of an update to the transit assignment process

Task 5 Select a Methodology and Produce a Technical Memorandum

CTPS will review each of the tested methodologies based on the evaluation criteria defined above, and on the differences in travel patterns between the different methodologies (from Task 4). CTPS will then select one methodology for possible implementation in the regional travel demand model set. If none of the tested methodologies has been found to be an improvement over CTPS's current modeling methodologies, further study may be recommended. CTPS will then produce a technical memorandum that documents the results of this review and the results of Tasks 1 through 4.

Product of Task 5

Technical memorandum

Estimated Schedule

It is estimated that this project will be completed 11 weeks after work commences. The proposed schedule, by task, is shown in Exhibit 1.

Estimated Cost

The total cost of this project is estimated to be $44,000. This includes the cost of 14.8 person-weeks of staff time and overhead at the rate of 98.88 percent. A detailed breakdown of estimated costs is presented in Exhibit 2.

KQ/EJB/SK/sap/sk

Exhibit 1
ESTIMATED SCHEDULE
Modeling Transit Capacity Constraints

Task	Week 1	2	3	4	5	6	7	8	9	10	11
1. Review and Evaluate Current Transportation Modeling Practices											
2. Test and Select New Modeling Methodologies											
3. Collect Data on Transit Capacity and Observed Ridership by Mode											
4. Test Route-Capacity Modeling Methodologies											
5. Select a Methodology and Produce a Technical Memorandum											

Exhibit 2
ESTIMATED COST
Modeling Transit Capacity Constraints

Direct Salary and Overhead	**$44,000**

Task	Person-Weeks M-1	P-5	P-4	Total	Direct Salary	Overhead (98.88%)	Total Cost
1. Review and Evaluate Current Transportation Modeling Practices	0.5	0.3	1.0	1.8	$2,732	$2,701	$5,433
2. Test and Select New Modeling Methodologies	0.5	0.3	1.5	2.3	$3,395	$3,357	$6,752
3. Collect Data on Transit Capacity and Observed Ridership by Mode	0.5	0.5	2.1	3.1	$4,532	$4,482	$9,014
4. Test Route-Capacity Modeling Methodologies	0.5	0.6	3.0	4.1	$5,934	$5,867	$11,801
5. Select a Methodology and Produce a Technical Memorandum	1.0	1.0	1.5	3.5	$5,531	$5,469	$11,000
Total	3.0	2.7	9.1	14.8	$22,124	$21,876	$44,000

Other Direct Costs	**$0**

TOTAL COST	**$44,000**

Funding

MassDOT §5303 Contract #88429