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TECHNICAL MEMORANDUM

To: Michael Behrendt, Town Planner, Durham, NH
Steve Pesci, Special Projects Director, University of New Hampshire
From: Dirk Grotenhuis PE; Ben Swanson; Austin Feula
Subject: UNH – Town of Durham AM Peak Traffic Model Calibration 2013
Date: 4 November 2013

In October 2007 the Town of Durham and the University of New Hampshire initiated the development of a detailed AM peak hour traffic micro-simulation model to help inform land use and transportation infrastructure planning in town and throughout the UNH campus. RSG initially constructed and calibrated this model in 2009 with 2008 AM peak hour traffic count, land use, and roadway network data. To ensure the model continues to represent current conditions, RSG has obtained 2013 traffic count, land use, and roadway information and has recalibrated the model to these current conditions. This technical memorandum documents the 2013 model calibration process.

The Durham Traffic Model

The UNH - Town of Durham AM Peak Traffic Model (the model) is an important analytical tool for evaluating future land uses and transportation improvements. The model can be used to investigate a variety of important planning issues, including evaluating the traffic impacts of development proposals and understanding how proposed transportation improvements will affect local traffic patterns.

This integrated traffic model incorporates a wealth of information on land use and travel behavior in Durham and processes this information to provide estimates of travel patterns associated with land use and/or transportation changes. In addition, the model has an attractive interface that enables users to "see" how traffic travels through the local roadway network in response to land use or transportation improvement changes.

The model represents AM peak hour traffic flow on the Durham street network. While common time periods for analysis also include the weekday PM and Saturday mid-day peak hours, the weekday AM peak hour was originally selected due to the overlapping commuting and school-related traffic and an understanding that University faculty and staff typically arrive in a concentrated time period before 8:30 AM but depart over a several hour period in the afternoon. With additional data collection and analysis the model can be calibrated to weekday PM peak hour conditions or to another time period of interest.

The model includes all major roadways and local streets in downtown Durham and on the UNH campus. Model network road links are coded to represent road types differentiated by functional class (e.g. arterial, collector, local) and incorporate information on road capacity and operating speed. The model includes intersection controls (i.e. stops, signals, roundabouts), lane designations, circulation restrictions, and turn restrictions. The model also includes detailed information on traffic signal timing, phasing, and sequencing. Wildcat Transit and Campus Connector bus services are modeled in the network, reflecting route, stop, and frequency of the existing services.

The UNH - Durham AM Traffic model is an origin/destination micro-simulation model, within which traffic is generated between discrete Transportation Analysis Zones (TAZs), which are discrete areas of similar traffic generation characteristic. Within the model boundaries, 76 unique TAZs are defined. For each of these TAZs land use and parking data are enumerated and used, along with traffic count data, to inform the overall trip generation characteristics of each zone. Vehicle traffic between zones is generated based on complimentary demands between the various zones origin and destination characteristics. Traffic is routed between zones using dynamic traffic assignment (DTA) algorithms which factor in the shortest paths between zone pairs as well as historically simulated delays along all potential routes.

In order to ensure the continued relevance of such models, it is considered standard practice to update traffic models every 3-5 years. A fresh set of traffic counts is necessary for recalibration. Model updates also require updating land use and the transportation network information to reflect current conditions. The original model was developed in 2009 with AM peak hour data collected in 2008, and this effort recalibrates the model to 2013 AM peak hour conditions.

Figure 1: Durham Traffic Model Road Network

Updated Land Uses

Between the initial conception of the traffic model in 2009, and the updated traffic model in 2013, many land use changes have occurred in Durham and on the UNH campus. These land use changes include: the development of the Cottages student housing complex on Technology Drive, the conversion of the New England Center Hotel to on-campus student housing, and the conversion of a travel lane along Pettee Brook Lane to additional on-street downtown parking. A complete list of land use changes included in the 2013 model update is included in the report appendix.

Updated Roadway Network

Similarly to land uses, many traffic control and roadway changes have occurred between 2009 and 2013. These changes play a major role in the routing of vehicles through the traffic model, and thus need to be updated to most accurately identify current traffic flow patterns. Changes to the Durham roadway network between 2009 and 2013 are listed in the figure below.

Figure 2: Roadway network changes between 2009 and 2013

Location	Description
Downtown and UNH campus	25 mph speed limit on all roadways
Main Street/North Drive Intersection	Roundabout Installed
Pettee Brook Lane	Reduced to single lane (except at southbound to Main Street)
Madbury Road/Garrison Ave Intersection	Installed an all-way stop
Madbury Road/Pettee Brook Lane Intersection	Southbound approach on Madbury yields to Pettee Brook Lane traffic
Madbury Road (Between Main Street and Pettee Brook Lane)	Reduced to single lane
Main Street/Madbury Road Intersection	Westbound approach on Main Street changed to stop controlled
Mill Road/McDaniel Drive Intersection	Installed an all-way stop
Quad Way/Main Street Intersection	Allowed right-turn movement from Quad Way onto Main Street
Main Street/College Road	Pedestrian phase reduced to 15 seconds
Academic Way (Between Mitchell Way and Arts Way)	Changed to a one-way in the westbound direction
Arts Way (Between Academic Way and McDaniel Drive)	Constructed (One-way in the southbound direction)
Madbury Road/Garrison Ave Intersection	Installed an all-way stop
Madbury Road (Between Edgewood Road and Bagdad Road)	Installed speed tables
Edgewood Road (Between Madbury Road and Emerson Road)	Installed speed tables
South Drive/Waterworks Road Intersection	Installed an all-way stop
Bagdad Road/Nobel K Peterson Drive Intersection	Installed Speed Table on Bagdad Road eastbound approach

Updated Count Set

In order to keep the model as up to date and accurate as possible traffic counts need to be updated every 3-5 years. A total of 62 intersections were counted during the AM peak travel period over a 2 day period in April while UNH and Durham schools were in session. The model was re-calibrated to match these traffic counts.

On Tuesday April 16, 2013 and Wednesday April 17, 2013 a total of 62 intersections were counted in Durham, NH. Additionally, during the same time period, 6 automatic traffic recorders were placed at strategic locations throughout town. By having all counts on two consecutive days with similar traffic levels it was possible to balance traffic between intersections within close proximity to each other. By performing all traffic counts over a 2 day span with RSG transportation engineers present the entire time and with an excellent staff of temporary employees, counts were ensured to be as accurate as possible.

Software Platform Conversion

As part of the 2013 updates to the Durham & UNH Microsimulation traffic model, we have converted the model platform from the Paramics software program that the original model was created in, to the TransModeler software program. Over the past five years, new traffic simulation programs have gained significant popularity and additional capabilities in origin/destination microsimulation modeling, causing Paramics to lose headway in the industry. The TransModeler program is produced by the Caliper Corporation and is currently at the forefront of origin/destination microsimulation modeling.

Caliper also produces the TransCAD regional traffic and transportation modeling software, which is the platform for the New Hampshire Seacoast Regional Traffic Model. TransCAD has long been a dominant player in regional traffic modeling and the creation of TransModeler now allows for more streamlined extension of regional modeling to microsimulation at the local level. This connection, along with the high functionality of the TransModeler program itself, is likely keep momentum in the industry moving towards TransModeler. Prior to converting the Durham Traffic Model to the TransModeler platform, RSG successfully implemented a major micro-simulation model in TransModeler for the Chittenden County Regional Planning Commission in Vermont to evaluate potential infrastructure alternatives for the Williston, Vermont and Essex Junction, Vermont area, and found TransModeler to have an intuitive layout, diverse reporting, and solid modeling functionality.

Now having successfully implemented several origin/destination models in TransModeler, including the updated Durham Traffic Model, we are confident this update will help ensure state of the art functionality for the model is carried forward into the future.

Updated Calibration Metrics

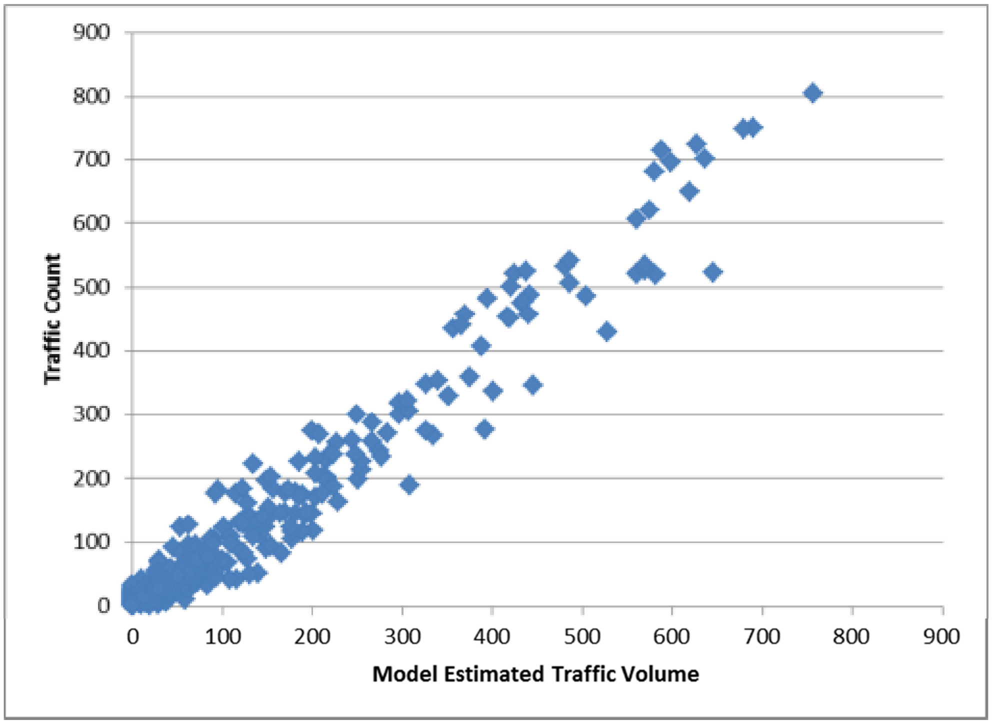
The model is calibrated to 389 traffic movements conducted over the AM peak period (7:15AM-8:15AM) from April 2013. Additionally, the model is calibrated to 6 automatic traffic recorders placed in strategic locations throughout Durham. It was confirmed that during these counts there were no special events, Oyster River School District or UNH breaks, holidays, or non-standard schedules. A total of 62 individual intersections were counted[1].

Following standard traffic analysis procedures in New Hampshire, raw morning peak hour traffic counts have been adjusted to reflect design hour volume (DHV) conditions in 2013 using a monthly adjustment factor based on the average peak hour of the peak month for NHDOT count station #133021, which is located on US 4, east of NH 108, in Durham, NH. This adjustment increases count volumes upward by 5%.

Figure 3 shows the distribution of model output traffic volumes - following calibration efforts to reflect updated TAZ trip generation characteristics and roadway changes - compared to design hour traffic volume data from our April 2013 counts. A 45-degree line represents a perfect correlation between the model output and the traffic counts.

[1] Each intersection turning movement count generates multiple calibration counts. For example, a count at the intersection of 2 roadways where all turns are permitted from all approaches generates a total of 12 individual counts to be used in calibration (4 approaches X 3 turns (left, through, right) per approach).

Figure 3: Distribution of Traffic Counts vs. Model Output



The final calibrated model exceeds nationally-accepted calibration standards for traffic models. There are two levels of calibration standards that the model has been compared to. The first level relates to the standards that are conventionally applied to travel demand models. These standards have been developed by the Federal Highway Administration (FHWA) to provide a threshold of quality for transportation models used for regional transportation planning. Figure 4 shows the model performance relative to the recommended FHWA standards for traffic volumes.

Figure 4: Model Calibration Relative to Recommended Calibration Thresholds for Regional Travel Demand Models

	Recommended	**Current Model**
Root Mean Squared Error	<40%	30.4%
Coefficient of Correlation (r)	>= 0.88	0.98
Percent Error (Region)	+/- 5.0%	0.7%

Additional standards have been developed specifically for micro-simulation travel models. These standards were first published in 2004 by the Transportation Research Board (TRB), a branch of the National Science Foundation1. The TRB standards rely upon the GEH statistic, which is an empirical measure of fit used to compare errors across roadways with largely different traffic flows. The GEH statistic is computed as follows:

$$GEH = \sqrt{\frac{(ModelVolume - CountVolume)^2}{0.5 * (ModelVolume + CountVolume)}}$$

[1] "Traffic Analysis Toolbox Volume III: Guidelines for Applying Traffic Microsimulation Software". FHWA-HRT-04-040. June 2004.

Figure 5 shows the performance of the Durham-UNH model relative to recommended standard for the GEH statistic.

Figure 5: Model Performance Relative to Calibration Standards for Microsimulation Models

	GEH by Movement		
	<5	5-->10	>10
Recommended	>85%	<=15%	0%
Durham-UNH Model	85.4%	14.6%	0%

Next Steps

The UNH – Town of Durham AM Traffic Model is considered well-calibrated according to published standards of the traffic engineering profession. Through a thorough updating process and high quality AM peak hour traffic data collected in April 2013, the Durham Traffic Model retains the high quality with which it was initially was created in 2009. With 2013 updates to the model, it is ready to be used for planning studies as directed by the Town of Durham and the University of New Hampshire for years to come and has recently been used to assess traffic and air quality impacts associated with a proposed roundabout at the Main Street/Pettee Brook Lane/Quad Way intersection. The results of this analysis were submitted to the Town of Durham and UNH in a separate memorandum.

As previously noted, the model is currently calibrated to represent weekday AM peak hour conditions, which is one of three common time periods used for traffic analysis - the two others being the Weekday PM and the Saturday mid-day peak hours. The Town of Durham and the University of New Hampshire have discussed expansion of the model to include weekday PM peak hour analysis capabilities. This expansion could be achieved with the existing model roadway network and zone structure but would require additional traffic data collection and creation of a PM peak hour origin/destination matrix. An expanded PM peak hour model would provide additional insights into traffic operational changes that may be more pronounced during the afternoon peak period. Given recent development in Durham, expected downtown growth, and evolving traffic dynamics, the University and Town should consider this investment to enable a full range of traffic impact assessments. However, regardless of any potential expansion to other time periods, the AM peak hour model faithfully replicates current AM peak hour conditions and is a valuable tool for evaluating future land use developments and transportation improvements.

Please feel free to contact us with any questions.