

Exhibit A
Project Scope of Work and Budget

Introduction

The following scope of work is presented as the proposed work plan for the TRM Service Bureau and Model Team for the budget year July 1, 2011 – June 30, 2012. The primary efforts outlined in this scope are intended to focus the efforts of the Service Bureau and Model Team on beginning development of a v6 model for the Triangle region with various enhancements. During this budget year work will continue on investigating and developing specifications for a v7 model. Refer to Appendix A for an overall vision for v6 and v7 models.

Several assumptions are made within the context of this scope.

1. Each signatory agency's one half FTE contribution may include staff time from people other than their TRM Team member, but the TRM Team member will play a key role and other staff must be adequately trained to meet the needs of the TRM Team.
2. All TRM staff representing the signatory agencies will, as needed, work on site at ITRE, including any third person who is providing services in the name of a signatory agency. This enables the Team to work together on issues that require the input of multiple team members and reduces the tendency for team members to be reassigned to other tasks in their home offices.
3. The TRM Program Manager will assign tasks with associated deliverables and target dates. TRM Team members will agree to take responsibility for specific tasks and will be held accountable for completion of those tasks. The responsible team member (stakeholder and TRM Service Bureau) will be responsible for **monthly** reporting on progress via an email attachment including 1) status, 2) changes in anticipated completion dates, 3) reasons for change, and 4) hours spent on model development work for the month reported.
4. Signatory agencies will commit one half FTE per agency to the completion of the list of tasks outlined in this work plan. The TRM Program Manager will assume responsibility for providing adequate work to meet this obligation by specifying the task description, deliverables, and person hours required. This information will be provided at least quarterly and will be sufficient to fully incorporate the one half FTE required of each agency.
5. All intermediate and final products of this work program belong to the four stakeholders (NCDOT, CAMPO, DCHC, and Triangle Transit) and these will be delivered to the stakeholders in a form and via media acceptable to each stakeholder

at the end of the contract year or before. The products include: model files including input files; scripts and program source code; all technical memoranda; estimation data file inputs and outputs; technical reports and user guides.

Note on model version names: the following version names will be used in this scope of work consistent with model team recommendations (for detailed TRM name history, please refer to Appendix B “TRM History” section).

- **TRM v5:** Based on structure of v4-2008 with revisions to model specifications and using 2006 household survey and 2006 on board transit survey data for estimating model components with an expanded study area [v5 TAZ system]. The enhancements requested by the stakeholders have been included. (see Appendix B “TRM History” for detailed list of enhancements) This version will be used for the Alternatives Analysis and Air Quality Conformity Analysis for the 2040 Long Range Transportation Plans.
- **TRM v6:** Updated and enhanced trip based model enhancing the v5 model.
- **TRM v7:** New tour based or activity based model designed to address policy testing needs not sufficiently addressed by TRM v6.

1 Development of v6 Model

Objective:

To design and specify enhancements to the v5 model to be called v6. All enhancements will be specified and estimated using the most recently collected survey data for the Triangle region.

Previous Work:

Stakeholders identified policies to be tested with new models during 2009/2010, and list of enhancements for v6 during 2010/2011.

Proposed Activities:

Initial investigations for enhancements listed are necessary for two reasons:

- 1) To determine if making the enhancement will be worth the effort involved in order to analyze our region's policy issues
- 2) If we decide to make the enhancement, to determine the best approach.

1.1 Develop an improved commercial vehicle model (CVM)

The commercial vehicle model (CVM) in the existing TRM v5 model is inherited from the old Tranplan model developed in 1990's. The model parameters were derived using the 1995 Triad Commercial Vehicle Travel Survey. About 500 commercial vehicles were surveyed and information about 2600 trips was collected in the survey. Since then the CVM basically has had no change in model structure and no update of model parameters. With a new commercial vehicle survey conducted for the first time in the Triangle Region in 2010, it is time to revisit the old CVM and update it with the new survey data. The following sub-sections detail the steps and related tasks.

1.1.1 Design/specify an improved commercial vehicle model

- a) Investigate commercial vehicle models used in other metropolitan areas focusing on recently developed models
Recently developed MPO trip-based commercial vehicle models will be reviewed. These modeling techniques will be assessed along with the availability of required data as well as other resources under the setting of the Triangle Region. Recommendation of a specific technique will be made based on the assessment.

- b) Investigate stakeholder's policy analysis needs for a commercial vehicle model
Questionnaires will be designed and distributed to the four stakeholder agencies to understand their policy analysis needs for the new commercial vehicle model. If necessary, a brainstorming meeting may be held.
- c) Analyze 2010 Triangle commercial vehicle survey data
Triangle commercial vehicle survey data will be quickly scanned to investigate the availability of data items needed for different modeling techniques. The analysis of the survey data at this stage is apparently a high-level overview.
- d) Identify other data needs and available sources
In addition to the commercial vehicle survey data, other data are also needed for developing a CVM, which can include household and population data and employment data. Households and population may need to be classified into income groups and employment into several industry classes. DMV commercial vehicle registration data will be reviewed to identify useable information for the establishments and commercial vehicles surveyed from the modeling perspective.

Other useful data may include Freight Analysis Framework version 3 (FAF3) and Vehicle Inventory and Use Survey (VIUS) data. VIUS has been discontinued since 2002, but the 2002 version of the data is not too old and may still be useful.

Vehicle classification count data is another important data set, which will be used for model calibration and validation. As of early 2008, NCDOT had a set of vehicle classification counts at 724 locations statewide. Of these, about 70 are within the TRM study area. Counts at each location are classified into the thirteen FHWA vehicle classifications. Most of the counts are at county boundaries, so they can help with model validation for cross-county flows. NCDOT will be contacted for newer, additional classification counts, if available, and project classification counts taken by NCDOT during 2005 and 2010 will also be used.

- e) Develop model performance targets
Model performance targets for calibration and validation will be developed in cooperation with the stakeholder partners based on available data identified in item d above and model specification in item f below.
- f) Provide recommended model specifications

With different types of modeling techniques, data needs, and other required resources reviewed and evaluated, the selected modeling technique along with the initial recommended model specification will be proposed and provided to the technical team for review and comments. With feedback from the team, the final CVM model specification will be determined. As a note, the modeling technique selected and the model specification determined will have impact on some of the tasks following, especially model estimation and calibration. It also impacts the time and effort needed.

An initial review of some existing commercial vehicle models in North America conducted by TRMSB in late 2008 and early 2009 recommended three options for the new trip-based TRM CVM:

- Low Option: Use existing TRM CVM structure with trucks being split into medium and heavy-duty classes
- Medium Option: Based on the low option, add one more dimension to the model, i.e., two trip purpose groups (moving goods and providing services)
- High Option: Based on the low option, segment the model more finely by using a scheme of six trip purpose categories (or called activity types) as shown below:
 1. Urban freight vehicles
 2. Business and personal service vehicles
 3. Public service vehicles
 4. Safety and utility vehicles
 5. Construction vehicles
 6. Package, product, and mail delivery vehicles

This preliminary recommendation will be revisited and re-evaluated since commercial vehicle survey data was not available at that time and other required data was not evaluated.

Deliverable:

Technical memorandum summarizing modeling approaches used in practice, findings of the initial analysis of Triangle commercial vehicle survey data, and recommended modeling technique and detailed specification for the new commercial vehicle model

Est. start date: 7/1/2011

Est. end date: 8/22/2011

1.1.2 Clean and process commercial vehicle survey data

In the 2010 Triangle Region Commercial Vehicle Survey, 1,552 vehicles from 500 establishments were surveyed. Of the surveyed vehicles, 649 vehicles did not make any trips on the survey days and the other 903 vehicles made a total of 6,431 trips. Detailed information about the establishments, vehicles, and trips were collected in the survey.

a) Apply logic checks to data records to find records needing repair

Our experience with the 2006 Household Travel Survey data and Transit Onboard Survey data indicates that survey data are prone to errors. Logic checks will be carried out on the commercial vehicle survey data by following a few pre-established rules. Examples can include correctness check of establishment geocoding, trip end geocoding, sequential trip timing and location, establishment and vehicle attributes, etc. It is anticipated that computer programs may need to be developed to automate the checking (and very likely correcting) process following the pre-established rules, which can save a lot of time otherwise spent processing manually.

Again, due to the lack of a formal documentation for the commercial vehicle survey, understanding, processing, and analyzing the survey data may have to wait until the details of the survey methodology and assumptions are sorted out and well understood.

b) Repair data records with problems and document any assumptions

c) Link commercial vehicle trips where necessary

Linking trips with short stops in between may be more logical for modeling and improve modeling accuracy. The types of short stops can include getting gas at gas stations, shifts between successive drivers, lunches, short breaks, and so on.

d) Weight and expand the survey data to represent the regional commercial vehicle population

It is anticipated that weighting and expansion will be based on establishment size (i.e. number of employees), geographic location (e.g. county), and perhaps industry class (NAICS or SIC). This will be investigated along with the model specification. The old weighting and expansion factors developed by NuStats will

be revisited and new factors will be developed if assessed necessary.

- e) Prepare any derived variables needed for estimating models
Not all data elements needed for model development are readily available from the survey. Some need to be derived, for example; time-of-day classification, industry classification, trip purpose grouping (or activity type), etc.
- f) Prepare other data needed for developing the CV model
Other data needed can include, but are not limited to, household and population data and employment data. Households and population may need to be classified into income groups and employment into several industry classes. What extra data elements are needed and how data should be prepared will be investigated along with model specification. Other data that may be identified as useful for the model such as FAF3, VIUS, and classification counts will also be prepared.
- g) Prepare data in the format ready to use for model estimation and calibration

Deliverable:

Cleaned and processed data files ready to use for model estimation. Documentation of data processing process, methods, and any assumptions made.

Est. start date: 8/22/2011

Est. end date: 9/27/2011

1.1.3 Estimate model components in recommended specification

- a) Estimate the specified model using the 2010 survey data and other data as identified

The new trip-based CV model will be stratified by vehicle size group and trip purpose group. Vehicle size groups can be defined by appropriately regrouping the thirteen FHWA vehicle classification types for the Triangle Region. One scheme can be autos/pick-ups, light trucks, medium trucks, and heavy trucks. Trip purposes can be classified into moving goods and providing services, or even finer classifications if data support them. An appropriate market segmentation scheme can improve the explanatory power of a model; in general, trip making characteristics of commercial vehicles vary by vehicle size and by trip purpose.

Major steps of developing a trip-based CV model are outlined as follows:

1) Trip generation

Daily trip rates will be derived from the 2010 CV survey. It is anticipated that the rates will be classified further by employment type or household income group, in addition to vehicle size and trip purpose. ANOVA test will be performed to check the reasonableness of classification and help with re-classification. Trip rates developed from the survey will be compared with the rates used in other MPO models as well as with those in the FHWA Quick Response Freight Manual II. Adjustments will be made if determined to be necessary.

Trip rates multiplied by number of employees and households/population will generate number of CV trips for each TAZ on an average day. Zonal productions and attractions will be equal.

2) Trip distribution

Trip distribution will use either the Gravity Model as used in v5 or a destination choice model (if survey data support one). Decisions will be made later. Trips will be distributed by two time periods of day, peak and off-peak. This is consistent with the existing trip distribution model in v5. Time-of-day factors will be derived from the CV survey data.

For the gravity model, different friction factor functions will be tested and the best one will be selected. Calibration of gravity model parameter(s) will use an iterative fitting approach to match model estimated average trip length and/or trip length frequency distribution to observed ones derived from the CV survey.

Biogeme will be used for estimation of destination choice (DC) models. Different model specifications will be tested for DC model utility functions. Model fitting statistical measures will be evaluated.

Both observed trip lengths (as derived from the survey) and model estimated trip lengths will be compared with other regions for a reasonableness check.

3) Time of day

CV trip interchanges will be classified into times of day before integration with passenger trips for trip assignment. In this step, the off-peak trip interchange matrix created in Trip Distribution will remain unchanged, but the peak trip matrix will be further divided into morning peak and evening peak by AM-peak/PM-peak split factors. Again, AM-peak/PM-peak split factors will be derived from the CV survey data.

4) Trip assignment

Eventually, the CV trip matrices will join passenger car trip matrices for traffic assignment using the MMA approach. Highway links that prohibit heavy trucks will be excluded from assignment of heavy trucks. Supposedly, where not all lanes of a highway link allow heavy (or even light) trucks, e.g. the leftmost lane on I-40, those truck-prohibited lanes should be excluded from assignment. However, implementing this may have some technical challenges on the current TransCAD platform, since traffic assignment in TransCAD is link-based, rather than lane-based which is most often seen in simulation models. An alternative way is to set up small-vehicle only links where heavy trucks are prohibited. This concept is similar to setting up HOV links in the current TRM model.

5) IE/EI and EE trip estimation

IE/EI and EE trips are a significant part of commercial vehicle trips, especially for truck trips. The existing TRM CV model estimates IE/EI and EE CV trips based on traffic counts at external stations. This approach needs to be revisited and improved. While the 2010 CV survey captured part of the IE/EI CV trips, other data sources such as FAF3 or Transearch data may need to be used, especially for medium and heavy trucks. EE trips will rely even more on those data sources for model development and validation. If the NC Statewide model is made available soon, it can be a great source for EE trip estimation.

Deliverable:

Technical memorandum describing model estimation and including data used for estimation, model coefficient estimation and statistical tests applied.

Est. start date: 9/28/2011

Est. end date: 11/29/2011

1.1.4 Prepare model components for application

- a) Develop computer program to implement the model
TransCAD GISDK script will be developed to implement the trip-based CV model.
- b) Prepare model inputs for model application
- c) Run model and test application

Deliverables:

Computer program that implements the model. Interim technical memorandum describing input and output files of each model component

Est. start date: 11/30/2011

Est. end date: 12/14/2011

1.1.5 Calibrate model components

- a) Prepare calibration targets for model
 - 1) Number of trips by trip purpose and vehicle type
 - 2) Average trip lengths and trip length frequency distribution by trip purpose and vehicle type
 - 3) CV highway assignment targets, such as % deviation and RMSE by functional class, volume group, as well as total
- b) Calibrate the model against calibration targets
 - 1) It is anticipated that calibration efforts will be involved in all the model development steps to bring model results as close to the targets as possible.

Deliverables:

Calibrated model and technical memorandum documenting development of calibration targets, model performance and any adjustments made to improve model performance

Est. start date: 1/23/2012

Est. end date: 3/22/2012

1.1.6 Validate model using 2010 classification traffic counts

- a) Develop validation data including classification counts
- b) Check validation data and repair or remove data pieces where necessary
- c) Compare model performance to validation data
- d) Adjust the model to improve its performance

Deliverable:

Validated model and technical memorandum describing development of model validation data, comparisons of model performance to validation data, and any adjustments made to improve model performance

Est. start date: 3/22/2012

Est. end date: 4/16/2012

1.1.7 Prepare overall model documentation for commercial vehicle model

- a) Interim technical memoranda will be combined to create documentation for the commercial vehicle model to be included in overall v6 model documentation

Deliverable:

Commercial vehicle model documentation section of v6 model documentation

Est. start date: 4/16/2012

Est. end date: 5/29/2012

	Task Description	Person Days
1.1	Develop a New Commercial Vehicle Model for the Triangle Region	173
1.1.1 a	Design/specify an improved commercial vehicle model – investigation	9
1.1.1 b-e	Design/specify an improved commercial vehicle model – develop specification	9
1.1.2	Clean and process commercial vehicle survey data	26
1.1.3	Estimate model components in recommended specification	43
1.1.4	Prepare model components for application	11
1.1.5	Calibrate model components	43

1.1.6	Validate model using classification counts collected during 2010	17
1.1.7 a	Training	4
1.1.7 b	Model documentation	11

1.2 *Improved highway network procedures*

The highway links in TRMv5 are classified into 125 facility types, and each facility type has its own capacity, and free flow speed. A facility type is defined based on link attributes, i.e. the number of lanes, posted speed, median/left turn lanes and special characteristics (for example, if it is an HOV lane). The Service Bureau has suggested for a long time to study the possibility to reduce the number of facility types because some facility types have pretty close capacities. Fewer facility types will be easier to manage and will help avoid errors in highway network coding. The current facility types are not explicitly related to area type, and investigations are needed to study if they should be related.

Although 125 facility types were defined in TRMv5, they still cannot cover all the possible combinations of link attributes. In order to prevent facility types from growing beyond the current 125, a temporary solution has been employed. In the development of previous TRM models, when a new combination of link attributes appeared, it was classified as an existing facility type that had similar link attributes. This is the reason why there are only 125 facility types, but 223 records in the facility type definition table. Most of the new records were added based merely on personal judgment without any studies due to schedule pressure. This facility type definition table will be cleaned in TRMv6. Another possible solution is to develop formulas to calculate the free flow speeds and capacities, and these continuous formulas would replace the discrete look-up tables. This approach should be explored for TRM v6.

The capacities of facility types used in TRMv5 were calculated in 2006 using the software package HCS+. It has been questioned why these capacities are generally higher than the capacities used before. TRMv6 will revisit the calculation of capacities based on HCM 2010. The free flow speeds of facility types were not updated in TRMv4 or TRMv5. They could be updated if the Congestion Management projects in the two MPOs or AirSage could provide needed information.

Like most planning models, TRMv5 did not consider intersection delays when calculating path travel times during traffic assignment. However, intersection delays often comprise a considerable portion of total travel time in urban areas. TRMSB will investigate the possibility to include the intersection delays in TRMv6.

Link attributes change as development patterns change from rural to suburban and urban patterns in future years. Failure to update the link attributes in the future year leads to an over-estimate of link capacity, and under-estimate of congestion. Efforts are needed to study how to develop an off-model GIS approach to modify the link attributes systematically for future year model runs.

1.2.1 Definition of facility types

- a) Collect reports and review the facility type definitions in other travel demand models.
- b) Study the possibility to simplify the facility types and to include area type in the facility type definition.
- c) Discuss the suggested facility types.
- d) Finalize the facility type definition table.
- e) Document the work on defining facility types.

Deliverable:

New facility type definition table, technical memorandum on the definition of facility types.

Est. start date: 7/1/2011

Est. end date: 9/21/2011

ID	Task Description	Person Days
1.2.1	Definition of facility types	28
a)	Collect reports and review the facility type definitions in four other travel demand models.	10
b)	Study the possibility to simplify the facility types and to include area type in the facility type definition.	5
c)	Discuss the suggested facility types.	9

d)	Finalize the facility type definition table.	2
e)	Documentation	2

1.2.2 Update of link free flow speeds

- a) Search for data sources to support the update of link free flow speeds.
- b) Clean the data sets.
- c) Analyze the data and study the possibility to develop formulas to calculate free flow speeds for different facility types.
- d) Discuss the suggested free flow speeds.
- e) Compare the new free flow speeds with the free flow speeds used in TRMv5.
- f) Test the new free flow speeds in TRMv5. Compare the results with those based on old free flow speeds, and evaluate the impact of modified free flow speeds to highway assignment.
- g) Finalize the update of free flow speeds.
- h) Document the work on updating free flow speeds.

Deliverable:

New link free flow speed table, technical memorandum on the update of link free flow speeds.

Est. start date: 9/21/2011

Est. end date: 10/20/2011

ID	Task Description	Person Days
1.2.2	Update of link free flow speeds	50
a)	Search for data sources to support the update of link free flow speeds	6
b)	Clean the data sets	10
c)	Analyze the data and suggest the free flow speeds for different facility types	10
d)	Discuss the suggested free flow speeds incl. preparing and reviewing materials	8
e)	Compare the new free flow speeds with those in v5	2
f)	Test the new free flow speeds in TRMv5. Compare the results with those based on old free flow speeds, and evaluate the impact of modified free flow speeds to highway assignment	7
g)	Finalize the update of free flow speeds.	5

h)	Documentation	2
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1.2.3 Calculation of link capacities

- a) Determine the approaches and parameters used in the calculation of capacities, including the study of the possibility to develop formulas to calculate the capacities for different facility types.
- b) Discuss the suggested parameters and approaches.
- c) Calculate the capacities based on HCM 2010.
- d) Compare the new capacities with the capacities used in TRMv5.
- e) Test the new capacities in TRMv5. Compare the results with those based on old capacities, and evaluate the impact of modified capacities to highway assignment.
- f) Finalize the capacity calculations.
- g) Document the work on calculating link capacities.

Deliverable:

New link capacity table, technical memorandum on the calculation of link capacities.

Est. start date: 10/20/2011

Est. end date: 1/11/2012

ID	Task Description	Person Days
1.2.3	Calculation of link capacities	36
a)	Determine the approaches and parameters used in the calculation of capacities.	5
b)	Discuss the suggested approaches and parameters incl. preparing and reviewing materials.	8
c)	Calculate the capacities based on HCM 2010.	8
d)	Compare the new capacities with the capacities used in TRMv5.	1
e)	Test the new capacities in TRMv5. Compare the results with those based on old capacities, and evaluate the impact of modified capacities to highway assignment.	7
f)	Finalize the capacity calculations.	5
g)	Documentation	2

1.2.4 Investigation of intersection delays

- a) Investigate other region's approach and experience with including intersection delay in the highway network
- b) Determine data sources available to develop network inputs
- c) Make recommendation regarding whether to add intersection delay to TRM v6
- d) If recommended, develop intersection delay modeling method

Note:

The time estimate does not include the time to code intersection delays in the network.

Deliverable:

Technical memorandum documenting investigations and recommendations

Est. start date: 5/18/2012

Est. end date: 6/30/2012

ID	Task Description	Person Days
1.2.4	Investigation of intersection delays	23
a)	Investigate other region's approach and experience with including intersection delay in the highway network	7
b)	Determine data sources available to develop network inputs	3
c)	Make recommendation regarding whether to add intersection delay to v6	5
d)	If recommended, develop intersection delay modeling method	5
e)	Documentation	3

1.2.5 Develop GIS approach to changing future road characteristics

- a) Investigate other region's approach and experience with off model GIS approach to changing future road characteristics.
- b) Design the approach to changing future road characteristics.
- c) Discuss the suggested approach.
- d) Test the suggested approach in TRMv5, and evaluate the impact of changing future road characteristics.
- e) Finalize the approach to changing future road characteristics.
- f) Document the work on development of GIS approach to changing future road

characteristics.

Deliverable:

Technical memorandum on the development of GIS approach to changing future road characteristics.

Est. start date: 3/12/2012

Est. end date: 6/14/2012

ID	Task Description	Person Days
1.2.5	Develop GIS approach to changing future road characteristics	34
a)	Investigate other region's approach and experience with off model GIS approach to changing future road characteristics.	3
b)	Design the approach to changing future road characteristics.	5
c)	Discuss the suggested approach including preparing materials	8
d)	Test the suggested approach in TRM v5, and evaluate the impact of changing future road characteristics.	10
e)	Finalize the approach to changing future road characteristics.	5
f)	Documentation	3

1.3 *Investigations and improvements to highway traffic assignment*

The TRM employs a standard user equilibrium method for highway traffic assignment. There are other and newer methods for performing highway traffic assignment that are available in TransCAD that may converge to equilibrium more quickly or provide better results. This task will set up and test several alternative methods and they will be evaluated for feasibility and desirability for inclusion in the v6 model. At least two methods will be tested: the Conjugate direction Frank-Wolfe (CFW) user equilibrium method, and the Origin User Equilibrium (OUE) method. This task includes setting up TransCAD 6.0, because it is anticipated this platform will be used for the v6 TRM, and it expands the memory available for TransCAD procedures as a 64 bit application.

1.3.1 Set up and test highway assignment methods

- a) Set up TransCAD 6.0 to run the TRM v5 in a 64 bit operating environment
- b) Set up test scenario based on v5 2035 sensitivity test scenario
- c) Design evaluation tests and determine the measures that will be used to evaluate

- assignment methods and to establish appropriate convergence criteria
- d) Set up and run test of CFW user equilibrium method and prepare reports of performance
 - e) Set up and run test of OUE method and prepare reports of performance
 - f) Prepare overall report and recommendation for v6 model

Deliverable:

Technical memoranda for sub tasks a-e and final report summarizing findings, and recommended method for highway trip assignment, all scenarios tested and modified script files.

Est. start date: 10/20/2011

Est. end date: 12/15/2011

ID	Task Description	Person Days
1.3.1	Investigations and improvements to highway traffic assignments	16
a)	Setup TransCAD 6.0 to run TRM v5	3
b)	Setup test scenario based on v5 2035 sensitivity test scenario	4
c)	Design evaluation tests and determine measures to evaluate assignment methods and establish appropriate convergence criteria	3
d)	Set up and run test of CFW method and prepare reports of performance	1
e)	Set up and run test of OUE method and prepare reports of performance	1
f)	Documentation	4

1.3.2 Implement recommended assignment method

- a) Edit model script and input files as needed to implement assignment method including warm start option if appropriate
- b) Test model setup and revise until it performs as expected

Deliverables:

Model script and input files for applying new assignment method and test setup files. Technical memorandum documenting performance of new assignment method.

Est. start date: 12/15/2011

Est. end date: 1/18/2012

ID	Task Description	Person Days
1.3.2	Implement recommended assignment method	8
a)	Edit model script and input files as needed to implement assignment method including warm start option if appropriate	1
b)	Test model setup and revise until it performs as expected	6
c)	Documentation	1

1.4 Investigate ways to optimize model runtime performance and implement recommended methods

Initial runs of the v5 model took twenty six hours to run on model computers at the Service Bureau. The team identified some possible opportunities to shorten this model run time and there may be others. Efforts to optimize model runtime performance will not change model results, just shorten the time needed to complete model runs. Shortening model runtimes will enable staff to be more productive when developing and testing alternatives for long range plans and other analysis work.

Work on this task will take place in two phases. The first phase will test several suggestions for shortening model runtimes. These are: to remove matrix to binary and binary to matrix file conversions, and run all the Fortran programs with TransCAD matrix file inputs, and to only run mode choice calculations once for destination choice and mode choice. Other possibilities to save runtime will also be tested including using TransCAD procedures for a task done by Fortran programs, and application of advanced Fortran programming features such as multi-threading and Fortran Math Kernel Library functions for speeding up program execution. The second phase will make all changes to application programs and model script to implement changes that save runtime.

1.4.1 Measure model component running time, and determine if component can be optimized

- a) Measure running time for each component of the v5 model using the 2005 scenario
- b) Modify one Fortran program to read TransCAD matrix files and compare runtime

- to runtime with binary file input to determine if program performance degrades beyond time spent in matrix to binary conversions.
- c) Modify mode choice Fortran program to read logsums calculated for destination choice and apply them to person trip tables output from the non-motorized model while preserving parking capacity constraint calculations
 - d) Set up and run test of TransCAD application to substitute for one Fortran program
 - e) Explore advanced Fortran compiler features

Deliverable:

Interim technical memorandum describing the results of investigation and testing of optimization approaches, all modified programs and script files.

Est. start date: 1/11/2012

Est. end date: 2/2/2012

ID	Task Description	Person Days
1.4.1	Identify model components that take most running time & determine if procedures can be optimized	18
a)	Measure running time for each component of the v5 model using the 2005 scenario	2
b)	Modify one Fortran program to read TransCAD matrix files & compare running times	2
c)	Modify mode choice Fortran program to read logsums calculated for destination choice	5
d)	Set up and run test of TransCAD application to substitute for one Fortran program	5
e)	Explore advanced Fortran compiler features	2
f)	Document interim findings in technical memorandum	2

1.4.2 Cleanup and finalize programs for application

- a) Make final edits to incorporate program changes that reduce runtimes in overall model (four Fortran programs plus model script)
- b) Test program changes to make sure they work as expected and revise programs until they produce correct results
- c) Document all findings in technical memorandum

Deliverable:

Technical memorandum documenting program optimizations, results of testing and level of improvements in performance achieved by the optimizations. Revised program files and model script.

Est. start date: 2/2/2012

Est. end date: 2/29/2012

ID	Task Description	Person Days
1.4.2	Cleanup and finalize programs for application	25
a)	Make final edits to incorporate program changes that reduce runtimes in overall model (4 Fortran programs plus model script)	8
b)	Test and revise programs until they produce correct results	15
c)	Documentation	2

1.5 Develop an improved parking constraint model

Purpose: Improve parking constraint model to better address regional policy issues.

Objective: Identify parking related policy issues that TRM v.5 parking constraint model is not yet capable of addressing, evaluate other regional model practice, develop recommended v.6 improvement approach according to our regional policy need, design model specifications, and design data collection plan; develop v.6 parking constraint with new approach.

Stakeholder partners expect parking policies to have a more important role in evaluating future transit projects. Having a more robust tool to test the impact of parking policies, particularly on college campuses, is a desired feature. The three major universities control parking facilities on their campuses and can set policies for them. UNC has limited the growth of parking on campus and Duke University has expressed interest in

less expansion of on campus parking and more emphasis on alternative modes of travel such as carpooling and transit. There is potential for similar policies at NCSU. Being able to test parking policies on university campuses is particularly of interest for future New Starts transit evaluations, because the universities are the current largest transit market in the region. The three central business districts are to some extent subject to parking policies set by local governments for government owned facilities.

TRM v.5 parking constraint model:

In TRM v.5 development, stakeholders identified parking analysis sub-area (PASA) for year 2005, 2010 and future year models.

Parking prices (or permit prices for employees/students) are collected by stakeholders for each PASA. Average parking costs per auto vehicle trip per traveler by user type (work trip, student attending university trip, and other) are estimated and applied by trip purpose and PASA for peak period in mode choice. (Parking cost is also used, as part of general cost, into LogSum calculation as one input for destination choice model.) TRM v.5 parking costs are trip purpose and location (PASA) specific, much more accurate than TRM v.4's simple costs (which were also out of date).

Parking space inventory data were collected by stakeholders. Parking spaces are allocated to trip purpose for each PASA, the resulting parking capacities are developed and applied to each PASA for the peak period in the mode choice model. The parking capacity constraint is implemented using the so-called shadow price approach: An iterative process incorporating a pre-set shadow price step value by purpose for each PASA. If the peak total auto vehicle trips attracted to a PASA exceeds the capacity, the shadow prices will be applied and continue to increase iteratively until the final total auto vehicle trips are within the capacity.

Such approach improves the model's responsiveness to policy control in terms of using parking pricing and setting a limit on number of parking spaces, even parking spaces allocated according to parking facility use duration (e.g., work and university student trip usually are of relatively longer duration while HBSshop/HBO/NHNW, relatively shorter-duration). Such an approach also enables us to test policy scenarios, e.g., for the purpose of encouraging mode change from driving alone to car pool, car pool to taking transit, or even making non-motorized trips.

However, the TRM v.5 parking constraint model needs further improvements; while it models the mode choice with respect to parking cost and capacity constraint, it still lacks traveler components on trip making choice, destination choice, and especially parking location choice in response to actual out-of-pocket cost (with or without subsidy; long term permit can be considered the best proxy) - not the parking price posted. Average costs are applied to all travelers for the same trip purpose, without differentiating type of traveler (e.g., their income level).

Without observed traveler side info, we were not able to know the travelers' choice sensitivity with respect to parking cost and parking capacity constraint (reflected by shadow price). Currently, v.5 assumes that the travelers' mode choice sensitivity with regard to parking cost is the same to the general cost due to lack of contrary evidence. Further, it may be better to model the parking capacity constraint by using a continuous "dynamic" shadow price function based on the percent use of parking capacity of a purpose in a PASA. E.g. the more demand exceeds capacity for a PASA, the higher the shadow price (vs. the v5 stepwise function) – analogous to the concept of the volume delay function in highway assignment.

Review and evaluate recent development of other regional approach with respect to parking behavior model and corresponding data requirement will help us to catch up on current trends and learn from the best up-to-date practice.

Reviewing others' data collection practice will help us budget our desired parking behavior data collecting effort.

It is also important to search and collect parking cost sensitivity info in any existing study on whether travelers have the same sensitivity facing parking price change as any monetary cost change (e.g., gas price, operating cost and so on). Travel sensitivity can be reflected in mode choice, how likely travelers would abandon auto and turn to transit, or more likely to carpool.

In 2009, TRMSB has already provided stakeholders with a summary of parking related model practice then available. Most often practice in the whole country is to apply parking cost as part of general cost in the mode choice process. Only a few MPOs have developed relatively sophisticated parking models estimating/forecasting parking price and spaces, and most of them do not have parking capacity constraint. No one

has a model based on user side info such as actual out-of-pocket cost, parking location choice, mode choice and so on.

The best and most suitable approach will be identified and recommended based on our needs will be provided for stakeholders' review. The TRM v.5 parking constraint model was developed based on the available data and time.

The recommended improvement cannot be developed without further data collection on detailed travelers' parking behavior for both revealed and stated preferences. A data collection plan will be developed; traveler's parking behavior info will be collected once stakeholders have approved the recommended v.6 improvement approach. Data collection cost will be estimated and provided to stakeholders. A survey consultant will be hired by a stakeholder partner to conduct the survey, while TRM SB will provide advice, including pilot and final survey data QA/QC and analysis.

With new data, parking behavior can be better modeled, which in turn will improve TRM capability of addressing parking related issues in our study area more reliably and accurately. The preliminary v.6 approach and specification will be developed for stakeholders' approval.

Survey data will be analyzed for parking related behavior. Survey data and other input data will be processed and prepared for estimation use.

With stakeholders' approval of v.6 parking cost/capacity constraint model specification, the model will be estimated, calibrated and validated (depending on data availability). The new model will be implemented into the model stream with updated TransCAD script/Fortran program, input/output structure, and finalized parameters.

Final documentation on the entire v.6 parking model will be provided to stakeholders and other users, and as a brief training session if desired.

1.5.1 Review TRM v.5 parking cost/capacity constraint model

ID	Task Description	Person Days
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1.5.1	Review TRM v.5 parking cost/capacity constraint model	6
a)	Review EC's list of regional parking behavior related policy issues	1
b)	Review v.5 parking cost related specifications [e.g., mode choice utility functions, destination choice model used LogSum term, cost coefficients used] and identify aspects that can be improved, and are associated with regional policy issues	3
c)	Review v.5 parking capacity related specifications and identify aspects can be improved, that are associated with regional policy issues	1
d)	Documentation	1

Deliverable:

Technical memorandum documenting specifications that can be improved particularly associated with regional parking behavior related policies regarding: 1) Parking cost/price and traveler's behavior response; 2) Parking capacity and traveler's behavior response.

Est. start date: 8/1/2011

Est. end date: 8/16/2011

1.5.2 Investigation and recommendation of v.6 approach

1.5.2	Investigation and recommendation of v.6 approach	17
a)	Review, evaluate/assess practice of three other regional models (approach and technique) and corresponding data requirement	5
b)	Collect info on existing studies regarding traveler parking behavior sensitivity (especially in terms of mode change - particularly important to Triangle region's policy)	5
c)	Provide recommended preliminary v.6 improvement approach and data requirement, and data collection budget	5
d)	Documentation	2

Deliverable:

Technical memorandum summarizing: 1) review, investigate and evaluation result of parking cost and capacity constraint model practices, traveler behavior sensitivity and corresponding data needed; 2) Best practice that can be borrowed (most suited to help with the Triangle region's prominent policy issues); 3) Provide recommended v.6 improved approach options and desired data respectively; and 4) Preliminary estimate of data collection budget options

Est. start date: 8/17/2011

Est. end date: 10/4/2011

1.5.3 Design v.6 parking constraint model specification

ID	Task Description	Person Days
1.5.3	Design v.6 improvement specification	27
a)	Design parking cost related model structure specification	5
b)	Design parking cost related function specification	5
c)	Identify needed parking cost related input data	2
d)	Design parking capacity related model structure specification	5
e)	Design parking capacity related function specification	5
f)	Identify needed parking capacity related input data	2
g)	Prepare preliminary design specification for stakeholders approval	3

Deliverable:

Technical memorandum summarizing v.6 parking cost/capacity constraint model specification for stakeholders' approval

Est. start date: 10/5/2011

Est. end date: 12/21/2011

1.5.4 Concept design of data collection approach

ID	Task Description	Person Days
1.5.4	Concept design of data collection approach	14
a)	Identify specific data elements needed based on stakeholder's approved preliminary recommended v.6 improvement approach and data collection option	5
b)	Concept design corresponding to data collection approach [possible but not limited to type of data, source of data collection]	5
c)	Estimate data collection budget	2
d)	Document	2

Deliverable:

Technical memorandum summarizing: 1) Final data elements to be collected based on stakeholder approved v.6 preliminary improvement approach and data collection option; 2) Brief concept design of data collection approach; and 3) Final estimated data collection budget

Est. start date: 12/22/2011

Est. end date: 1/18/2012

1.5.5 Advice on data collection management

1.5.5	Data collection management	22
a)	Review data collection procedure	2
b)	Review sample plan	2
c)	Review survey instruments	2
d)	Review preliminary design for stakeholders approval	2
e)	Advice for management of pilot data collection [including but not limited to signing contract, overseeing survey consulting firm process, communication, issue resolving, budget/time control]	2
f)	QAQC and analyze pilot data; provide feedback to survey consultant	5
g)	Advice for management of full data collection [including but not limited to overseeing survey consulting firm process, communication, issue resolving, budget/time control; final training]	2
h)	QAQC full survey data; provide feedback to survey consultant	5

Deliverables:

A. By survey consulting firm:

- 1) Survey designs (sample plan, instrument etc.)
- 2) Pilot survey report on details and issues
- 3) Full survey report (usual survey contents)
- 4) Complete final cleaned/Geo-coded full survey and pilot survey data, fully expanded/weighted, ready to use; with complete data dictionary
- 5) Training session to stakeholders

B. By TRM team:

Technical memoranda on

- 1) Pilot survey procedure/instrument and data QA/QC issues and suggested resolution
- 2) Pilot survey data analysis result
- 3) Full survey data QAQC issues and resolutions

Est. start date: 3/8/2012

Est. end date: 6/30/2012

1.6 **TAZ modifications**

The Triangle Region has experienced rapid development, and the TAZ system used in TRMv5 needs further modifications to meet the modeling need. It was found that 564 out of 2579 TAZs (i.e., 22%) do not match the borders of 2010 census tracts or block groups. Most of the TAZs are in places that were more rural in character (or at least, non-residential) in 2000, and no longer are (e.g. western Cary). The mismatches pose problems in using census data in the TRM model development, for example, preparing the SE data, and validating the model using journey-to-work flow data.

The two MPOs are working on the TAZ delineation in support of the Census Transportation Planning Products (CTPP). The work should be completed in 3 months once the process is started. The new TAZ delineation will be used for the CTPP 5-year tabulation (2006 through 2010 ACS records). Therefore, the task of TAZ modifications ensures the TRM model can take full advantage of census bureau data that will be reported at the "census TAZ" level, and only needing to make minimal adjustments to make it fit the model TAZs. In addition, the model TAZ modifications can be consolidated with TAZ delineation to save the efforts involved.

Some stakeholders expect TRMSB to use the new TAZ system once it is ready to improve TRMv5 (called TRMv5a). If time allows, TRMv5a will be used for the development of 2040 LRTPs in fall 2012.

The major subtasks involved in this task include:

- a) Review the TAZ delineation
- b) Provide TAZ delineation suggestions to the two MPOs from the modeling point of view
- c) Modify the TAZ boundaries
- d) Check and assign new IDs to TAZs
- e) Develop a correspondence table
- f) Modify or add centroid connectors in the highway network
- g) Check and assign new IDs to centroids

Note:

Assumes the MPOs will spend their own staff time determining the TAZ delineation.

Deliverable:

New TAZ system that conforms to the 2010 census geography, TAZ correspondence table and highway network that is consistent with the new TAZ system, all modified input files and modified script file

Est. start date: 7/1/2011

Est. end date: 9/21/2011

ID	Task Description	Person Days
1.6	TAZ modifications	37
a)	Review the TAZ delineation	4
b)	Provide TAZ delineation suggestions to the two MPOs from modeling standpoint	4
c)	Modify the TAZ boundaries	15
d)	Check and assign new IDs to TAZs	2
e)	Develop the correspondence table	3
f)	Modify or add centroid connectors in highway network	7
g)	Check and assign new IDs to centroids	2

1.7 Modifications of Socio-Economic Data and Socio-Economic Models

In TRMv5, the master socio-economic (SE) data file provides data on households, population and mean income for each TAZ. The SE Models used such data to estimate the distribution of households by income group, size of household, number of workers, number of children, and number of automobiles. Both the SE data and the SE Models need to be modified in TRMv6 due to the following reasons.

- TAZ system will be modified in TRMv6 (as described in Task 1.6)
- The 2010 SE data in TRMv5 is developed by growing the SE data from 2005 to 2010, and using 2010 census as the control total at the county level. Therefore, the distribution of population within a county might be different from the census. The quality of the 2010 SE data can be greatly improved if the 2010 census data can be directly used. SE data is the basis of a travel demand model, and it is critical to make it as good as possible.
- The SE Models in TRMv5 were developed based on the 2000 census. The 2010 census and the newly released ACS data (for example, the 2005-2009 ACS 5-

year PUMS files released on Feb. 08, 2011) make it possible to improve the SE Models.

1.7.1 Creation of the 2010 base year SE data

- a) Check the 2010 SE data provided by the two MPOs, including checking the basic logic and plotting thematic maps. If issues are found, contact the MPOs to address the issues.
- b) Assemble the 2010 SE data and put it in the format that the TRMv5 can read
- c) Update other fields (such as K-12 school enrollment and average block size) in the 2010 SE data when possible

Note:

Assumes the MPOs will spend their own staff time to create the 2010 SE data from the 2010 census.

Deliverable:

New 2010 SE data ready to be used by TRMv6

Est. start date: 9/21/2011

Est. end date: 11/17/2011

ID	Task Description	Person Days
1.7.1	Creation of 2010 base year SE data	23
a)	Check 2010 SE data provided by MPOs, including checking logic and plotting thematic maps, and correct any issues found	17
b)	Assemble 2010 SE data and put in TRM format	1
c)	Update other fields (such as enrollment and average block size) where possible	5

1.7.2 Estimation of SE Models

- a) Determine the income ranges of the four income groups (Low, Medium-Low, Medium-High and High). The income ranges will be determined so that the households in the same income groups have similar population characteristics and drive patterns. The 2010 census and 2006 Household Survey report income in different ranges, and inflation must be considered.
- b) Search for the best data set and create the household income group distribution table, which describes the distribution of household income groups in a TAZ

- given a zonal mean income.
- c) Search for the best data set and create the household size distribution table, which describes the distribution of household size in a TAZ given a zonal average household size.
 - d) Search for the best data set and create seed table for the joint distribution of household income group and household size.
 - e) Search for the best data set and create the worker distribution table, which describes the distribution of the number of workers in households given household income group and household size.
 - f) Search for the best data set and create the vehicle distribution table, which describes the distribution of the number of vehicles in households given household income group, household size and the number of workers.
 - g) Search for the best data set and create the child distribution table, which describes the distribution of the number of children in households given household income group, household size and the number of workers.
 - h) Review of model products by team members

Deliverable:

The updated input files in the program folder (“INCPCT.txt”, “SIZEPCT.TXT”, “PCTINCSZ.txt”, “GWRPCT.txt”, “AUTOPCT.txt”, “GCHPCT.txt”) and all estimation data files.

Est. start date: 11/17/2011

Est. end date: 1/11/2012

ID	Task Description	Person Days
1.7.2	Estimation of SE models	22
a)	Determine income ranges	2
b)	Determine the best data set and create household income group distribution table	2
c)	Determine the best data set and create household size distribution table	2
d)	Determine the best data set and create household size by income seed table	2
e)	Determine the best data set and create worker distribution table	2
f)	Determine the best data set and create vehicle distribution table	2
g)	Determine the best data set and create child distribution table	2
h)	Review model products by team members, including preparing and reviewing	8

	the materials	
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1.7.3 Calibration of SE Models

- a) Run the SE models and compare the results to the re-expanded 2006 Household Survey.
- b) At the regional level, plot figures to compare the modeled (from the SE models) and the observed (from the re-expanded 2006 Household Survey) distribution of household by income group, household size, number of workers, number of vehicles, number of children, and strata.
- c) At the county level, plot figures to compare the modeled and the observed distribution of household by income group, household size, number of workers, number of vehicles, number of children, and strata.
- d) Address the problems found in the comparison or figures.
- e) Document the development of SE Models.
- f) Review model calibration results by team members

Deliverable:

Technical memorandum on the development of SE Models and input files used for calibration.

Est. start date: 1/11/2012

Est. end date: 3/8/2012

ID	Task Description	Person Days
1.7.3	Calibration of SE models	27
a)	Run SE models and compare results to re-expanded 2006 HH survey	2
b)	Plot regional modeled & observed household distributions by all dimensions	2
c)	Plot county level modeled & observed household distribution by all dimensions	4
d)	Address any problems found in modeled to observed comparisons	10
e)	Documentation	3
f)	Review model calibration results by team members, including preparing and reviewing the materials	6

1.8 *Model estimation and calibration*

TRMv6 has many improvements over TRMv5, for example, improved TAZ system, SE data, networks, SE Models, trip attraction models, and parking models. Due to these improvements, some of the components in TRMv6 need to be adjusted or re-estimated.

1.8.1 Processing of the 2006 household survey data

Since the TAZ system is changed in TRMv6, the addresses in the 2006 Household Survey need to be assigned new TAZ IDs. In TRMv5, the 2006 Household Survey was weighted to match the joint distribution of households by county and income group, as well as the joint distribution of households by household size and the number of vehicles. All the joint distribution information was from the 2000 census. The 2006 Household Survey was then expanded to match the total number of households in the 2005 SE data. In TRMv6, the 2006 Household Survey will be weighted and expanded in the same way, but using the joint distribution information from the 2010 census and the total number of households in the 2010 SE data. The processed 2006 Household Survey data will be the critical data set to the development of TRMv6.

- a) Geocode the 2006 Household Survey to match the TRMv6 TAZ system. Make sure all the corresponding tables are updated with new TAZ IDs.
- b) Search for the best data set in the 2010 census and develop the joint distribution of household by county and income group.
- c) Search for the best data set in the 2010 census and develop the joint distribution of household by household size and the number of vehicles.
- d) Weight and expand the 2006 Household Survey.
- e) Prepare the cleaned 2006 Household Survey data set for team use.
- f) Document the work on weighing and expansion of the 2006 Household Survey.

Deliverable:

Cleaned 2006 Household Survey data set for TRMv6 model development, and technical memorandum on weighing and expansion of the 2006 Household Survey and estimation data files.

Est. start date: 11/17/2011

Est. end date: 12/12/2011

ID	Task Description	Person Days
1.8.1	Processing 2006 household survey data	15
a)	Update geocoding of TAZs to match v6 TAZ system	4
b)	Develop the joint distribution of household by county and income group based on the 2010 census	2
c)	Develop the joint distribution of household by household size and the number of vehicles	2
d)	Weight and expand the 2006 household survey	4
e)	Prepare cleaned 2006 household survey dataset for team use	1
f)	Documentation	2

1.8.2 Processing of the 2006 transit on board survey data

In TRMv5, the 2006 Transit On Board Survey was expanded to the 2006 average weekday ridership by route. To calibrate the mode choice models in TRMv6, the 2006 Transit On Board Survey needs to be expanded to the 2010 average weekday ridership. Since the TAZ system is changed in TRMv6, the addresses in the 2006 Transit On Board Survey need to be assigned with new TAZ IDs in order to get the observed transit trip table. Some of the addresses in the 2006 Transit On Board Survey were only geocoded to TAZs instead of XY coordinates, therefore it will take longer to assign these addresses to correct TAZs. It has been found that some of the addresses were geocoded into wrong TAZs in the current 2006 Transit On Board Survey data set, efforts are needed to remove obvious geocoding errors.

- a) Process the raw ridership data provided by the MPOs to get the 2010 average weekday ridership. Currently, TRMSB has the raw ridership from Jan. 2010 to Jun. 2010 from several transit agencies.
- b) Document the work on processing the raw ridership data.
- c) Expand the 2006 Transit On Board Survey to the 2010 average weekday ridership.
- d) Geocode the 2006 Transit On Board Survey to match the TRMv6 TAZ system, including correcting obvious geocoding errors.
- e) Prepare the cleaned 2006 Transit On Board Survey data set for team use.
- f) Prepare the observed transit trip table.

- g) Document the work on expansion and geocoding of the 2006 Transit On Board Survey.

Deliverable:

Cleaned 2006 Transit On Board Survey data set, technical memorandum on the processing of the raw ridership data, and technical memorandum on expansion and geocoding of the 2006 Transit On Board Survey.

Est. start date: 12/12/2011

Est. end date: 1/3/2012

ID	Task Description	Person Days
1.8.2	Processing of 2006 transit on board survey data	19
a)	Process the raw ridership data provided by the MPOs to obtain 2010 average weekday ridership	2
b)	Document processing of raw ridership data	1
c)	Expand the 2006 transit on board survey to the 2010 average weekday ridership	2
d)	Geocode the 2006 transit on board survey to match v6 TAZ system including correcting obvious geocoding errors	10
e)	Prepare cleaned 2006 transit on board survey data set for team use	1
f)	Prepare observed transit trip table	1
g)	Document work on expansion and geocoding of 2006 transit on board survey	2

1.8.3 Calibration and/or estimation of trip production models

In TRMv6, some important input files will be improved (such as SE data, TAZ system and networks), the SE Models will be updated, and the observed data set (2006 Household Survey) will be re-weighted and re-expanded. Therefore, efforts are needed to check if the trip production models in TRMv5 still work well in TRMv6, and estimation and calibration might be necessary.

- a) Adjust the trip generation script to fit the TRMv6 TAZ system.
- b) Prepare the observed trip generation numbers from the updated 2006 Household Survey.
- c) Model estimation and calibration for Trip Generation Models. There are 6 trip

purposes and each trip purpose has 3 models (by person type).

d) Document the work on calibration and/or estimation of Trip Production Models.

Note:

The time estimate does not include the time to develop the trip attraction model (Task 1.8.4)

Deliverable:

New parameters for Trip Generation Models, and technical memorandum on the calibration and/or estimation of Trip Generation Models and data files used.

Est. start date: 12/12/2011

Est. end date: 2/13/2012

ID	Task Description	Person Days
1.8.3	Calibration and/or estimation of trip production models	53
a)	Adjust trip generation script to fit the v6 TAZ system	1
b)	Prepare observed trip generation targets from updated 2006 HH survey	4
c)	Model estimation and calibration for trip generation models for 6 purposes by 3 person types	40
d)	Documentation	8

1.8.4 Develop improved destination choice - attraction share model

The purpose of this task is to improve v.5 destination choice - attraction share model. The objective is for v.6 to better model trip distribution by household strata and trip purpose. In other words, improve the accuracy of trip attraction allocation by purpose to appropriate destinations for each of the five household strata used in TRM. This effort is separate and distinct from estimating the spatial distribution of trips. This task will include searching for and choosing an appropriate model specification. Estimating the distribution of trips in task 1.8.5 will estimate models for which the specification was established in v5.

TRM v.5 attraction share model distribution results will be reviewed and compared to observed data [most likely 2006HIS]. Summary of findings will be documented.

TRM v.5 destination choice – attraction share model specifications will be reviewed and evaluated, issues will be identified for further improvement.

Practice of other regional models will be reviewed, evaluated and assessed (approach, policy issues relevant to ours, and specifications, especially performance results). The best approach (can be combined from multiple sources) will be selected based on professional judgment. A preliminary recommendation will be provided for stakeholders' review.

Once v.6 approach is approved, model specification will be designed and estimated. Data will be analyzed to establish the relationship between trip attractions by travelers from certain HH strata to destination characteristics (transportation related info, economic activities and so on). Estimation data and other input data will be identified and prepared. The improved approach will be implemented in the model stream by updating TransCAD script/Fortran programs, and input/output structure.

The model will be estimated (best estimation chosen based on statistical tests and professional judgment on behavior), model results will be calibrated to targets when necessary. If any validation data are available, such data will be processed and model results will be validated. Finally, any final adjustment/revision will be incorporated into the model stream.

Final product will be a technical memorandum that documents entire above process and model performance; and a completely updated ready-to-use destination-attraction share model (including TransCAD scripts, Fortran programs, input data files and finalized parameters).

Below is the initial estimate of resources needed in terms of person days by detail tasks.

1.8.4.1 Review TRM v.5 destination choice - attraction share model

ID	Task Description	Person Days
1.8.4.1	Review TRM v.5	10-15
a)	Prepare 2006HIS - observed distribution at county level by HH strata, trip purpose	
	A. Year 2005 data (main work completed; need final check); OR	1

	B. Year 2010 data - process Create 2010 distribution tables by purpose, HH strata using 2010 Expansion- Weight factor	3
b)	Prepare v.5 modeled distribution data, and compare to 2006HIS observed:	
	A. Year 2005 comparison (Attraction % share by county for each HH strata by trip purpose) OR	2
	B. Year 2010 comparison	5
c)	Review TRM v.5 model attraction model specification - Review: TransCAD scripts and Fortran programs, LogSum term, accessibility function, other explanatory variables and form, and - Identify issues. Currently, we know at least some specification in the accessibility function needs to be improved, but a thorough evaluation is needed	5
d)	Documentation	2

Deliverable:

Technical memorandum documenting 1) review of v.5 destination choice – attraction model distribution performance and issues; and 2) review of v.5 model approach/specification issues that need to be improved, and data files prepared for analysis.

Est. start date: 8/1/2011

Est. end date: 8/12/2011

1.8.4.2 Investigate employment categories and special generator employment definitions

Employment categories used in the Triangle Regional Model were developed by NCDOT during the 1960s. They were based on travel surveys conducted during the 1960s and were appropriate for models developed subsequently; particularly for urban areas that did not collect updated survey data. Over time many aspects of the economy have greatly changed; particularly large increases in service employment relative to other categories. The Triangle collected household survey data in 2006 from 5,000 plus households using state of the practice survey techniques. This rich data set provides an opportunity to find out what the data tells us about how to group employment by type of business and by occupation in order to best account for variations in travel behavior.

The current version of the Triangle Regional Model contains four types of special

generators: universities, hospitals, RDU airport and shopping centers. These account for differences in the number and types of trips that may be attracted to these uses. The current special generators were developed for a different model structure than the v5 model structure. Also the definition of “shopping center” is not well understood and could be improved. The special generators in the v5 TRM need to be evaluated and if needed the relationships to other land uses in the model need to be updated.

Another consideration is for the challenges that different ways of grouping employment may present to staff that both inventory employment and forecast it for long range plan analysis. The quality of the employment inventories and forecasts determines in part the quality of travel forecasts. Employment groupings should be evaluated for ease and dependability of forecasting in order to increase confidence in forecasts.

The task objective will be to improve the modeling of trip attractions and the distribution of trips from productions to attractions. Actual work tasks will utilize already cleaned survey activity and trip records. Proposed work tasks are as follows. First perform a brief literature review to learn if similar efforts elsewhere have suggested ways to group employment that could be tested with the Triangle data. Second separate trips to places with employment into two groups: workers going to their place of work, and customers going to workplaces to conduct business. After examining the data, groupings will be developed that appear to fit patterns in the data for each group based on NAICS codes for places of employment. Each grouping that is developed will be compared to the existing model employment grouping for each trip purpose in the v5 model. Third groupings that seem to be promising will be evaluated for ease of forecasting. Fourth it will be determined if existing special generators show trip patterns significantly different from groupings identified as promising. If they do, relationships will be developed between trip making to establishments in the promising grouping and the special generators. In the course of this work a definition of shopping center will be developed based on the survey results.

Deliverables:

1. 2 Technical memos; one for employment categories and one for special generators with the results of the literature review, and results of analyzing the survey data
2. Final report with recommended employment groupings and special generators
3. Data files used for analysis

Est. start date: 7/20/2011

Est. end date: 9/14/2011

ID	Task Description	Person Days
1.8.4.2	Investigate employment categories and special generator employment definitions	22
a)	Literature review	3
b)	Develop employment groupings	10
c)	Evaluate forecasting difficulty	2
d)	Special generator analysis	5
e)	Documentation	2

1.8.4.3 Investigation and recommendation

ID	Task Description	Person Days
1.8.4.3	Investigation and recommendation	15
a)	Investigate, review and evaluate practices by three other regional MPOs for allocating trip attractions by household strata (not necessarily exact same definition) particularly those using destination choice model Identify best practice based on the performance and policy relevancy to TRM study area	5
b)	Develop preliminary v.6 improved approach based on the investigation	5
c)	Documentation	5

Deliverable:

Technical memorandum summarizing: 1) Review, investigation and evaluation result of destination choice attraction model practices, 2) Best practice that can be borrowed; and 3) Provide recommended v.6 improved approach, including describing the benefits of the new specification.

Est. start date: 8/15/2011

Est. end date: 9/26/2011

1.8.4.4 Design v.6 attraction share model specification

1.8.4.5 Develop implement specification

1.8.4.6 Prepare estimation data

ID	Task Description	Person Days
1.8.4.4	Design v.6 attraction share model specification	12
a)	Design model structure specification	5
b)	Design function specification	5
c)	Identify input data needed	2
1.8.4.5	Develop implement specification	30
a)	Revise Fortran program	20
b)	Revise TransCAD script	5
c)	Revise input/output structure	5
1.8.4.6	Prepare estimation data	25
a)	Identify estimation data sources	2
b)	Analyze data - distribution behavior Establish relationship between trip attractions of traveler from certain HH strata by trip purpose and destination characteristics, whether transportation related, or economic activities (employment type and/or other characteristics)	10
c)	Prepare 2006HIS estimation data in needed format/structure [e.g. Biogeme input]	5
d)	Prepare any other source estimation data	5
e)	Documentation for Tasks 1.8.4.4-1.8.4.6	3

Deliverables:

- 1) Technical memorandum summarizing a) v.6 model specification; and b) relationship between trip attraction and destination characteristics to be modeled;
- 2) Updated model stream including TransCAD script and Fortran program - ready for estimation;
- 3) Ready-to-use model estimation data and other input files

Est. start date: 9/27/2011

Est. end date: 2/8/2012

1.8.4.7 Estimate model using new specification

1.8.4.8 Calibrate model

ID	Task Description	Person Days
1.8.4.7	Estimate model with new specification	20
a)	Estimate model	15
b)	Evaluate estimation performance (statistical tests) and select the best ones based on professional judgment	5
1.8.4.8	Calibrate model	22
a)	Prepare calibration target data [mostly likely 2006HIS]	2
b)	Review model distribution result vs. target	5
c)	Calibrate model specification (adjust parameters, and/or even function forms, when necessary)	15

Deliverables:

- 1) Technical memorandum documents estimation and calibration process, with statistical test results; and distribution results performance
- 2) Calibrated model (parameters, any input files)

Est. start date: 2/9/2012

Est. end date: 4/6/2012

1.8.5 Calibration and/or Estimation of Destination Choice Models

- a) Adjust the destination choice model script to fit the TRMv6 TAZ system.
- b) Incorporate the congested travel times from TRMv5 2010 model to TRMv6 to create the skim files.
- c) Prepare the observed trip length distribution from the updated 2006 Household Survey, and document the work.
- d) Model estimation and calibration for Destination Choice Models. There are 6 trip purposes and each trip purpose has 5 models (by strata).

- e) Document the work on calibration and/or estimation of Destination Choice Models.

Note:

The time estimate does not include the time to investigate employment categories & special generator definitions (Task 1.8.4.2)

Deliverable:

New parameters for Destination Choice Models, technical memorandum on the observed trip length distribution, and technical memorandum on the calibration and/or estimation of Destination Choice Models, all files prepared for data analysis.

Est. start date: 4/23/2012

Est. end date: 6/30/2012

ID	Task Description	Person Days
1.8.5	Calibration and/or estimation of destination choice models	81
a)	Adjust the destination choice model script to fit v6 TAZ system	1
b)	Incorporate congested travel times from v5 2010 model to v6 to create skim files	2
c)	Prepare observed trip length distribution from updated 2006 HH survey & document	6
d)	Model estimation and calibration for destination choice models for 6 trip purposes by 5 strata (30 models)	60
e)	Documentation	12

1.8.9 Obtain and Process the 2010 AWDT

TRMv5 used about 660 2010 project counts and about 2500 2009 AWDT traffic counts to validate the 2010 model, since the 2010 AWDT traffic counts were not available when the TRMv5 was developed. Efforts are needed to collect and process the 2010 AWDT for TRMv6 highway calibration.

- a) Collect and process the factored 2010 coverage count average week day traffic.

Deliverable:

2010 AWDT traffic counts.

Est. start date: 7/1/2011

Est. end date: 7/15/2011

ID	Task Description	Person Days
1.8.9	Obtain and process the factored 2010 average weekday traffic counts	3
a)	Obtain and process the factored 2010 coverage count data AWDT	3

1.9 ***Investigate and implement improvements to area type calculations used in v6***

Area type models are used to classify zones or network links into urban, suburban, and rural classes for purposes of determining, for example bus speeds. If the area type calculations for zones are different on the two sides of highway links then automated methods may not be able to determine the appropriate area type for a link. This will create area type designations that change from link to link or that are different on the two sides of a divided highway and otherwise appear to not be smooth or worse yet, random. It is suggested to develop a method to model area types based on nearest neighbor zones or buffer analysis that will yield smoother, more intuitive area types.

Work on this task will begin with gathering a few examples of approaches developed recently such as one presented at the 2011 Planning Applications Conference. These will be summarized and any that seem promising will be selected for testing in the TRM. Second tests will be prepared using TRM inputs. Third if any of the tests are successful, then the approach will be programmed for application in the v5 model.

Deliverables:

Technical memoranda for the three sub tasks and a final short report summarizing the findings of the tests performed and a description of the area type measure developed for the v5 model. All inputs and resulting data tables will be provided.

Est. start date: 1/19/2012

Est. end date: 3/22/2012

ID	Task Description	Person Days
1.9	Investigate and implement to improvements to area type calculations used in v6	19

a)	Collect examples of area type calculation methods	2
b)	Setup and perform tests	5
c)	Program application and test	10
d)	Documentation	2

1.10 ***Develop improved transit network procedures***

The TRM v5 uses automated procedures to represent walk access to bus stops and rail stations that are consistent with Guidelines for Network Representation of Transit Access, State-of-the-Practice Summaryⁱ prepared in 1998. There may be opportunities to improve the procedures now in use in v5. In particular, TransCAD provides what is referred to in the TransCAD manual as “a GIS-based approach for adding non-transit links.”ⁱⁱⁱ It is proposed to investigate whether this approach could improve the representation of walk access to transit. If the GIS-based approach is not recommended to replace the traditional approach, then it is proposed to determine if there are opportunities to improve the existing approach to represent walk access to transit. The existing approach does not guarantee that all TAZs with a portion of the zone within one half mile walk distance of the stop will be connected for transit access. It is recommended that any revised approach connect all zones with area within 0.5 mile of a transit stop.

1.10.1 **Investigate and recommend approach to improve walk link creation for transit network**

- a) Obtain several examples of walk link procedures used in other regions
- b) Investigate available geographic databases for the Triangle region and determine if any can be used for creating walk access to transit stops using the TransCAD GIS based approach
- c) Set up and test the TransCAD GIS based approach to create walk access to transit stops including building route system on an enhanced highway network and using an existing highway network.
- d) Compare zone accessibility to transit for the existing approach and the GIS based approach
- e) If the GIS based approach does not provide improvements in the representation of transit accessibility, then determine if improvements can be made to the existing approach by buffering TAZ polygons for each stop.

- f) A recommended approach for improving the representation of transit accessibility will be prepared.

Deliverable:

Technical memorandum reporting the results of testing the GIS based approach and comparisons to existing walk link procedures. If the GIS based approach does not show improvements over the existing approach, then the results of building buffers for each stop will be reported. All maps and test files will be included in the deliverable.

Est. start date: 3/28/2012

Est. end date: 5/17/2012

ID	Task Description	Person Days
1.10.1	Investigate and recommend approach to improve walk link creation for transit network	16
a)	Obtain several examples of walk link generation procedures used in other regions	2
b)	Investigate geographic databases available for the Triangle & determine suitability for use with TransCAD GIS based approach	2
c)	Setup and test TransCAD GIS based approach to creating walk links using v6 highway network and including building route system on enhanced highway network	5
d)	Compare transit accessibility using existing approach & GIS based approach	3
e)	If GIS based approach does not improve representation of transit accessibility, then determine if improvements to existing procedures are possible	2
f)	Documentation	2

1.10.2 Edit model script to implement changes to transit access approach based on recommendation developed in 1.10.1

- a) Edit model script to apply new approach to represent transit accessibility
- b) Test new script and modify until it works as expected.

Deliverable:

New model script ready for application and any needed additional model input files.

Est. start date: 5/23/2012

Est. end date: 8/1/2012

ID	Task Description	Person Days
1.10.2	Edit model script to implement changes to transit access approach	20
a)	Edit model script to apply new approach to represent transit accessibility	5
b)	Test new script and modify it until it works as expected	15

1.11 ***Prepare commercial vehicle survey documentation***

- a) Prepare survey documentation for the Greater Triangle Region Commercial Vehicle Survey conducted during 2009 and 2010
- b) Prepare statistics for key variables in survey data to include in documentation.

Deliverable:

Survey documentation report

Est. start date: 8/8/2011

Est. end date: 8/19/2011

ID	Task Description	Person Days
1.11	Prepare commercial vehicle survey documentation	10
a)	Prepare survey documentation for Greater Triangle Commercial Vehicle Survey	5
b)	Prepare statistics for key variables in survey data	5

2 Develop v7 work plan

A work plan for developing a v7 model will be prepared based on the white paper produced in 2011 and on recommendations of an expert panel anticipated to be convened in the fall of 2011 and direction to be provided by the Model Team and Executive Committee. It is expected that the v7 model will be an entirely new model regardless of structure or approach. The work plan for v7 will lay out all tasks needed to develop the new v7 model from model specification to final documentation. Levels of effort and schedules for all tasks will be prepared. It is expected that the work plan will form the basis for annual work plans during the development of v7.

Subtasks with level of effort are shown below. The level of effort assumes that staff understands the tasks required to specify and estimate choice models, but not tasks to develop new data structures and tasks to program new model applications.

Deliverable:

Technical memorandum summarizing model development approaches used by others, description of proposed approach for v7, detailed task list, schedule and resource allocation to accomplish the work program.

Est. start date: 1/25/2012

Est. end date: 2/21/2012

ID	Task Description	Person Days
2	Develop v7 work plan	20
a)	Obtain example model development work plans	5
b)	Develop task list for v7	5
c)	Schedule tasks and resources	5
d)	Prepare report in draft form for review and in final form after review	5

3 Development of strategic data collection plan for Triangle Region

Developing and calibrating travel models requires local survey data that in many cases is both expensive and time consuming to collect. Some of the data collected become obsolete over time and need to be collected again. A data collection plan linked to model development cycles allows funding agencies to anticipate expenditures on data collection and insures that appropriate and up to date data is available for model development.

The Triangle Region has invested substantial resources in data collection over the past two decades, but rapid rates of growth experienced in the Triangle lead to survey data becoming out of date. Travel behavior is also changing as new technologies become available such as internet shopping and teleworking. Periodically collecting travel behavior data insures that models are developed with up to date relationships.

Techniques for collecting data tend to improve over time as well improving the quality of the data collected for model development.

This work element includes the following subtasks.

- a) Develop a list of anticipated model enhancements and future models that may require data collection.
- b) Develop a list of past and future data collection efforts tied to the list developed in the first subtask. This list will also include preparation and project management tasks necessary to accomplish the data collection.
- c) Schedule data collection efforts so data is available for model development tasks and is collected at appropriate intervals. The level of effort assumes staff is familiar with data collection techniques and project management. It also assumes that the technical memo/report will be provided in draft form for comments and then will be revised to become a final report document.

Deliverable:

Technical memorandum/report document listing future model components projected to require data collection, and data to be collected with a schedule for each data collection effort.

Est. start date: 9/6/2011

Est. end date: 9/19/2011

ID	Task Description	Person Days
3	Development of strategic data collection plan for Triangle Region	10
a)	Develop list of future model enhancements & future models	1
b)	Develop list of data collection efforts needed to support future model enhancements & model development	2
c)	Schedule data collection efforts	2
d)	Prepare technical memorandum/report in draft and final form after review	5

4 Assistance with model application for developing the 2040 Long Range Transportation Plan

The TRM Service Bureau and/or Model Team will provide assistance for the MPOs and NCDOT during development of the 2040 LRTPs. This will include assistance with

setting up and running the TRM, interpreting results and debugging when problems are encountered.

Previous work:

None

5 Technical Assistance with TRM model application on as needed basis

TRM Service Bureau staff will provide technical assistance for stakeholder partners on an as needed basis when they are applying the TRM. This will include providing model files and documentation to contractors working on the behalf of stakeholder partners. It will also include answering questions and providing assistance when problems arise.

6 Develop System for Maintaining Highway and Transit Networks

Up to date high quality highway and transit networks are critical to high quality models like the TRM. Therefore, it is important to maintain the TRM highway and transit network, and keep the link and route attributes up-to-date. Maintenance includes checking for errors (such as errors in roadway geometry, number of lanes, posted speed), and updating the network when new projects are completed and documenting sources of updated information. This task requires effort by many agencies coordinated by the TRM Service Bureau. Further discussion of rules and responsibilities, and automation tool development is needed, and a maintenance plan will be created as part of this task.

ID	Task Description	Person Days
6	Develop System for Maintaining Highway and Transit Networks	10
a)	Hold meeting to develop roles and responsibilities	1
b)	Develop concept for automation tools	4
c)	Prepare draft plan and distribute for comments	4
d)	Prepare final maintenance plan	1

Deliverable:

Highway and transit network maintenance plan with concept for automation tools.

Est. start date: 6/1/2012

Est. end date: 6/30/2012

7 TRM Team Meetings

TRM Team Meetings will be held monthly on the 3rd Thursday of each month unless there are no items to discuss.

8 TRM Executive Committee Meetings

Executive Committee meetings will be held every other month on Tuesday afternoons, or as designated by executive committee members.

9 Quarterly Progress Reports

Quarterly progress reports will be prepared in October, January, April, and July.

Appendix A

Vision for Developing the v6 and v7 Models

Policy Testing Needs Identified by Stakeholder Partners

Policy Testing Needs Identified by EC 10/20/2009	Part of Model?
1. Dynamic Tolls	Part of model
2. Greenhouse gas – land use change (Urban Sim)	Part of model
3. Peak spreading (a result)	Part of model
4. Parking constraint in CBD and elsewhere	Part of model
5. Environmental Justice (EJ) impacts (a result)	Analysis done outside model
6. Change mix of land uses within TAZs & consider design of land uses	Part of model
7. TDM policies	Analysis done outside model
8. ITS	Analysis done outside model
9. Making decisions on modal investments	Analysis done outside model

Suggested Elements of New Models or Work Programs

Suggested Elements	In v6	In v7	Invest.	Notes
1. Improved Commercial Vehicle Model	X			DCHC #1
2. Improved Transit Assignment		X		DCHC #2
3a. Static Traffic Assignment Improvements	X		X	DCHC #3
3b. Dynamic Traffic Assignment		X		DCHC #3
4. Area Type Sub-model		X		DCHC #4
5. Population Synthesizer		X		DCHC #5
6. Trip Attraction and Destination Choice Sub-model	X			DCHC #6
7. University Student Trip Model		X		DCHC #7
8. Walk Access - Transit Link		X		DCHC #8
9. Employment Category and Special Trip Generators		X		DCHC #9
10. System Optimization	X			DCHC #10
11. Time of Day Model		X		DCHC #11
12. Parking Survey and/or Behavior Study		X	X	DCHC #12

				Tri. req.	Tran.
13a. Link Capacity Calculation			X	DCHC #13	CAMPO req.
13b. Intersection Delay			X	DCHC #13	
14. HBW Journey or Tour Based Model		X			
15. Strategic data collection plan			X	MPO req.	
16. TAZ review			X		

stakeholder direction. It is expected the v7 model will be used for 2050 LRTP development starting in 2018. This will address policy testing needs that require consideration of how travelers change their daily schedules in response to policies intended to reduce peak congestion.

Fiscal Year	TRM v.7 Enhancement	Notes
Year 1 July 1, 2011 - June 30, 2012	Stakeholders agree on concept for v.7 1) Convene expert panel 2) Develop work plan for v.7 model development	[See detailed task list in the scope for more information on individual tasks]
Year 2 July 1, 2012 - June 30, 2013	Investigation/specification of model structure and components: 1) population synthesizer, 2) tour/activity scheduler, 3) router.	
Year 3 July 1, 2013 - June 30, 2014	Investigate/specify and develop data structures. Determine best data structures for storing, processing and updating model elements. Approaches will be sought that maximize analyst productivity and model runtime performance. Available data will be prepared in the chosen data structure.	
Year 4 July 1, 2014 - June 30, 2015	Modify programs as needed to implement the chosen model specification including: 1) population synthesizer, 2) tour/activity scheduler, 3) router. Model component programs may be borrowed and adapted for use in the Triangle region.	
Year 5 July 1, 2015 - June 30, 2016	Estimate models and implement. Recent survey data will be used to estimate model components specified during year one [population synthesizer, tour/activity scheduler, router].	
Year 6 July 1, 2016 - June 30, 2017	Model calibration and validation. Initial model will be applied and any problems will be noted and addressed. This process will be iterated until all problems discovered have been addressed. The model will then be validated to observed conditions.	

Conceptual Schedule for Model Development

Model Task	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
v6						
Investigate/specify enhancements	█					
Develop enhancements	█	█				
Calibration & validation			█			
v7						
Specify model components		█	█			
Specify data structures			█			
Modify programs			█	█		
Estimate models					█	
Calibration & validation						█

Appendix B

TRM History

Version - Release Year [Delivered Time]	Key Features Enhancements vs. Previous Version	Base Year	Use
v.1 - 2006 [Not to Stakeholder]	TTA New Start model converted to the TransCad platform with a 2002 base year as delivered by the contractor [Parsons Brinckerhoff] in Fall of 2006	2002	
v.2- 2006 [delivered 12/2006]	Revised and calibrated/validated to 2005 base year highway data only	2005	
v.3 - 2007 [β test version delivered 4/2007]	1. Updated mode choice ASC calibration using 2006 Household Interview Survey and 2006 Transit On Board Survey data 2. Repaired trip generation program and 3. Revised 2005 Socio Economic data provided by the MPOs.	2005	1) Transit Infrastructure Blueprint, 2) the Chapel Hill Long Range Transit Plan, 3) the Orange County Greenhouse Gas project and 4) the Deficiency and Needs Analysis for the 2035 Long Range Transportation Plans.
v.4 - 2008 [Delivered 1/2008; approved spring; adopted 8/2008]	Improved v3-2007 ready for application and including HOV/HOT and toll capabilities.	2005	1) Alternatives Analysis and 2) Air Quality Conformity Analysis for the 2035 Long Range Transportation Plans.

Version - Release Year [Delivered Time]	Key Features Enhancements vs. Previous Version	Base Year	Use
v.5 - 2011 [Planned to deliver 6/2011]	<p>New:</p> <ol style="list-style-type: none"> 1. Parking capacity constraint 2. Airport trip making model 3. Bicycle and pedestrian travel submodels through trip distribution. 4. External station forecasts methodology. 5. Hourly capacity and traffic assignment 6. Use of Logsum in destination choice 7. Stratified utility coefficients by income in mode choice: 8. Summit analysis for FTA New Start analysis. [planned] 9. An off model GIS approach to forecast changes in road characteristics over time as rural areas become more urbanized [planned] 10. Travel by people from outside the region on transit. [planned] <p>Improved:</p> <ol style="list-style-type: none"> 1. Parking cost model improved; New: capacity constraint components added 2. Bus speed model: adjusted and validated vs. 2006 bus schedules. 3. Revise Federal Functional Class. Federal Functional Class has been updated in the 2010 v5 model to be consistent with NCDOT updates. [planned] <p>Investigated: Cost of Auto Travel [e.g. gas price component]</p>	2005	

Appendix C

TRM Calibration and Validation Statistics

Triangle Regional Model components will be calibrated and validated to the following targets. These tests based on local and national targets will be used to evaluate the quality of model components.

Calibration/validation Statistics

Model Inputs

Model demographic data inputs will be checked against benchmarks at a regional level for persons/household, employment/population ratio, and autos/household. Plots of persons per household and household income by zone (TAZ) will be compared to census values. A report will document all findings.

Model highway and transit networks will be checked for reasonableness and the results will be reported. Maps of various network characteristics (area types, lanes, speeds, counts, screenlines, and transit routes by company) will be plotted to aid in the checks and to document the process used. The transit on board survey data will be assigned by access mode to the transit network and comparisons of transfer rates and assignments by transit line and company will be made to determine if problems exist. The results will be reported.

Model output from the household and person model (workers, non-workers, and children), and by household strata will be compared to census and other data for the region and sub region levels as appropriate (county and district) depending on the availability of data. This comparison will be documented in a report.

Trip Generation

Work trips per worker match survey work trips per worker

Ratio of region wide trip productions to trip attractions by trip purpose +/- 10%

Summaries comparing observed and model estimated trips by trip purpose will be prepared

Daily trips by trip purpose will be compared to determine if proportions of daily travel by purpose match survey data and proportions from other areas (benchmarks)

Overall trip rates by trip purpose will be compared to those reported for other areas

Trip productions per household and per capita will be compared to standard reasonable ranges

Summary comparisons will be made at the region, county, and district levels

Work trip attractions will be compared to total employment, K-12 school trips will be compared to total school enrollments, and shopping trips will be compared to total retail employment

Trip Distribution

Percent Deviation of Average Trip Length (minutes) for all trip purposes +/- 5%

District to district comparisons will be made of observed and model estimated trips. Trip length frequency distributions by time and distance will be prepared by trip purpose by strata. Coincidence ratios will be prepared for the trip length frequency distributions with a target of >70% coincidence.

Percent intra zonal trips by purpose will be compared to benchmarks.

Mode Choice

All trip purposes will match observed mode shares for auto and transit modes (+/- 2%), though not for transit by access mode to avoid over calibrating

Summaries by trip purpose will be prepared comparing observed mode shares to model estimated mode shares. Work trip mode shares will be compared to census (CTPP) mode share data. District summaries will be prepared. Auto occupancies will be compared to survey auto occupancies. Mean transit trip lengths will be compared to observed and these will be expected to fall within +/- 5%. Parameters will be compared to acceptable ranges.

Validation Statistics*

Vehicle Miles Traveled (VMT) by Federal Functional Class (based on links with counts)

Functional Class	Target % Deviation
Freeway	7%
Principal Arterial	10%
Minor Arterial	10%
Collector	15%
Local	15%
Total	5%

Screenline Comparison

Screenline Name	Target % Deviation
I-85	10%
I-40	10%
Wake/Durham County Line	10%

Cutline Comparison

Cutline Name	Target % Deviation
SW Durham	15%
Durham	15%
Johnston County	15%
Chatham County	15%
North Raleigh	15%
Eastern Wake	15%
US 1 South	15%
North Wake	15%
US 70	15%

* All traffic counts used for validation will be factored in a consistent way

* If unable to match this best practice target, then a secondary check will be performed based on the overall volume of the cutline

Percent Difference of Total Traffic Count Volume and Total Model Assigned Volumes by County and Area Type

Summary Level	% Difference Target (+/-)
<i>County</i>	
Durham	10%
Orange	10%
Wake	10%
Chatham	10%
Harnett	10%
Johnston	10%
Nash	10%
Franklin	10%
Granville	10%
Person	10%
<i>Area Type</i>	
Urban	10%
Suburban	10%
Rural	10%

Percent Difference of Model Estimated Daily Traffic Volumes by Federal Functional Class

Federal Functional Class	FHWA Target (+/-)	TRM Target (+/-)
Freeway	7%	5%
Principal Arterial	10%	8%
Minor Arterial	15%	10%
Collector	25%	15%
Local	25%	15%

Percent Difference of Model Estimated Daily Traffic Volumes by Volume Group

Volume Group	Target % Deviation
1 -1000	55%
1001 – 2500	50%
2501 – 5000	30%
5001 – 10000	25%
10001 – 25000	20%
25001 – 50000	15%
>= 50001	10%
Total	5%

R-Square for Region wide Estimated Volumes vs. Traffic Counts

Target $R^2 \geq 0.88$

Root Mean Square Error (RMSE) of Estimated Traffic Volumes

Target RMSE $\leq 35\%$

Evaluation of Peak Period Assignments for AM and PM Peak Periods

Screenline Comparison AM and PM Peak

Screenline Name	Target % Deviation
I-85	10%
I-40	10%
Wake/Durham County Line	10%

Cutline Comparison AM and PM Peak

Cutline Name	Target % Deviation
SW Durham	15%
Durham	15%
Johnston County	15%
Chatham County	15%
North Raleigh	15%

Eastern Wake	15%
US 1 South	15%
North Wake	15%
US 70	15%

* If unable to match this best practice target, then a secondary check will be performed based on the overall volume of the cutline

AM and PM Peak Period Percent Difference of Total Traffic Count Volume and Total Model Assigned Volumes by County and Area Type Based on Links with Hourly Traffic Counts

Summary Level	% Difference Target (+/-)
<i>County</i>	
Durham	10%
Orange	10%
Wake	10%
Chatham	10%
Harnett	10%
Johnston	10%
Nash	10%
Franklin	10%
Granville	10%
Person	10%
<i>Area Type</i>	
Urban	10%
Suburban	10%
Rural	10%

Overall average speeds will be reported for AM peak, PM peak and off peak periods.

Transit Ridership Assigned

Total transit riders target +/- 5%

Target for individual companies +/- 10%

ⁱ SG Associates, Inc., Volpe National Transportation Systems Center, *Guidelines for Network Representation of Transit Access, State-of-the-Practice Summary*, FHWA, FTA, U.S. DOT and EPA, June, 1998 on Travel Model Improvement Program website

ⁱⁱ *Travel Demand Modeling with TransCAD 5.0, User's Guide*, Caliper Corp., Newton, MA, 2007, p. 291

Triangle Regional Model Service Bureau

Justification for Supplies and Materials

Plotter supplies are needed to support project plotting requirements.

Purchase of computers

The following computers were purchased in August of 2003:

ITRE157

ITRE159

ITRE161

These computers will be at least eight years old at replacement and are older than their expected useful life of (four to five years). Replacing the computers will also improve stakeholder staff productivity while working at the TRM Service Bureau by upgrading their computers to current basic performance levels. Model runs that take twenty six hours on existing computers can be expected to take eleven on new computers. Each existing computer has 1GB of RAM, an 80GB disk drive, and a CD ROM reader. With model runs consuming 28GB of disk space, the data storage is not sufficient. Also most software and data products are now being made available on DVD due to the additional capacity these provide, and the existing computers cannot read them.

The following computer was purchased in February of 2006:

ITRE221

This computer will be five and one half years old at replacement and is older than its expected useful life. This machine is used as the shared storage machine and is therefore in continuous use, and the team depends on it to gain access to shared files and to version control. Replacing the computer will ensure a reliable server resource is available.

Justification for Travel

Travel includes fees to cover project related training beneficial to the development of staff on the project.

Justification for Current Services

Current services covers the cost of long distance telephone communication, and the cost of printing documents if needed.

Justification for Contracted Services

On-call technical assistance provides a way for the Service Bureau to obtain advice from technical experts in the field of travel forecasting. This enables the Service Bureau to learn how to appropriately implement new procedures consistent with national practice and experience.

Justification for Other Fixed Charges

The maintenance of TransCAD software requires a \$1000 per year maintenance fee.

**DCHC STAKEHOLDER BUDGET
TRIANGLE REGIONAL MODEL SERVICE BUREAU
BUDGET FOR YEAR 9: July 1, 2011 to June 30, 2012**

Budget Items	Description of Level of Effort	Budget FY 2011-12
Salaries and Wages (Personnel) *		
Project Director	1.25 % effort for 12 mo	\$ 1,564
Program Manager	25 % effort for 12 mo	\$ 22,763
Senior Research Associate	25 % effort for 12 mo	\$ 19,678
Senior Research Associate	25 % effort for 12 mo	\$ 19,496
Research Associate	12.5 % effort for 12 mo	\$ 6,829
Graduate Intern	50 % /sem; 100 % summer	\$ -
SUBTOTAL PERSONNEL		\$ 70,330
Staff Benefits		
Staff (28%)		\$ 19,692
Graduate Intern1 (15%)		\$ -
SUBTOTAL STAFF BENEFITS		\$ 19,692
TOTAL PERSONNEL & BENEFITS		\$ 90,022
Supplies and Materials		
(Supplies, plotter paper, plotter ink)		\$ 250
Purchase replacement computers		\$ 2,000
Travel		
In State		\$ 138
Out of State		\$ -
Training		\$ 750
Current Services		
Communications (long distance)		\$ 37
Printing and Binding		\$ 25
Contracted Services		
On-call technical assistance		\$ 6,250
Fixed Charges		
Rental of Equipment/State Vehicles		\$ 125
Other Fixed Charges (software maintenance fees, \$1,000/yr/key)		\$ 1,250
Student Aid / Tuition Remission		
In State		\$ -
Subcontract		
		\$ -
TOTAL OTHER DIRECT COSTS		\$ 10,825
Facilities & Administrative Costs		
20% of MTDC **		\$ 20,169
TOTAL BUDGET		\$ 121,016

* Uses a 3% growth factor/yr

** 20% based on one contract through the Master Agreement between NCSU-ITRE and NCDOT.

Exhibit A.1
Percentage of Effort Estimate by Task

Triangle Regional Model

LABOR		HOURS BY PERSONNEL AND TASK																Total Hours	Total Cost
		Triangle Regional Model Service Bureau - DCHC																	
TRM Service Bureau staff assigned	Raw Direct Labor Hourly Rate	1.1 Commercial Veh. Model	1.2 & 1.3 Highway Network Procedures	1.4 Optimize Model Runtime	1.5 Improve Parking Consistiana Model	1.6 TAZ Modifications	1.7 Monthly SE Data & Models	1.8 Model Estimation & Calibration	1.9 Improve Area Type Calculations	1.10 Improve Transit Network Process	2. Develop v1 Work Plan	3. Develop Strategic Data Collection Plan	4. LRTP Assistance	5. Oversight & Reporting	6. Technical Assistance	7. Develop Network Model			
Estimated Level of Effort by Task																			
Project Director	\$60.16	0	0	0	0	0	0	0	0	0	0	0	0	26	0	0	26	\$1,564	
Program Manager	\$43.78	0	0	41	0	0	0	157.75	0	0	46.25	23	23	194.5	23	11.5	520	\$22,763	
Senior Research Associate	\$37.84	0	0	0	198.75	0	0	251.75	0	0	0	0	23	35	11.5	0	520	\$19,678	
Senior Research Associate	\$37.49	400	0	0	0	0	0	74	0	0	0	0	0	34.5	11.5	0	520	\$19,496	
Research Associate	\$26.27	0	64.5	0	0	17.875	29.875	107.5	0	0	0	0	11.5	17.25	5.75	5.75	260	\$6,829	
NCDOT Staff																		0	
CAMPO Staff																		0	
DCHC Staff		0	418	115	0	0	0	61	165	138	0	0	0	78	0	0	975		
Total Hours TRM Service Bureau		400	64.5	41	198.75	17.875	29.875	591	0	0	46.25	23	57.5	307.25	51.75	17.25	1846		
Total Hours Stakeholder Staff		0	418	115	0	0	0	61	165	138	0	0	0	78	0	0	975		
Total Task Hours		400	482.5	156	198.75	17.875	29.875	652	165	138	46.25	23	57.5	385.25	51.75	17.25	2821		
Personnel cost by task		\$14,997	\$1,694	\$1,795	\$7,521	\$469	\$785	\$22,030	\$0	\$0	\$2,025	\$1,007	\$2,179	\$13,149	\$2,024	\$654		\$70,330	
Fringe Benefits @ 28%		\$4,199	\$474	\$503	\$2,105	\$132	\$220	\$6,168	\$0	\$1	\$567	\$282	\$610	\$3,682	\$567	\$183		\$19,692	
Total Labor with Fringe		\$19,196	\$2,168	\$2,297	\$9,626	\$601	\$1,004	\$28,199	\$0	\$1	\$2,591	\$1,289	\$2,789	\$16,831	\$2,591	\$838		\$90,022	
REIMBURSEABLE EXPENSES																			
Description																	Total Cost		
Supplies and Materials																			
(Photocopying, plotter paper, plotter ink)																	\$250		
Purchase replacement computers (4)																	\$2,000		
Travel																			
In State																	\$138		
Out of State																	\$0		
Training																	\$750		
Current Services																			
Communications (long distance)																	\$37		
Printing and Binding																	\$25		
Contracted Services																			
On-call technical assistance																	\$6,250		
Fixed Charges																			
Rental of Equipment/State																			
Vehicles																	\$125		
Other Fixed Charges (software maintenance fees, \$1,000/yr/key)																	\$1,250		
Student Aid / Tuition Remission																			
In State																	\$0		
Total Reimbursable Expenses																	\$10,825		
Subcontractors																	\$0		
Facilities & Administrative Costs																			
20% of MTDC **																	\$20,169		
Total Hours																	1846		
Grand Total Labor																	\$90,022		
Grand Total Subcontractors																	\$0		
Grand Total Reimbursables																	\$10,825		
Total Cost																	\$121,016		

Exhibit A.2
Schedule Effort by Task, Subtask and Timeline

Schedule

FY 2011/2012

Task	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June
1 v6 Model												
1.1 Develop an improved commercial vehicle model												
1.1.1 Design/specify improved commercial vehicle model												
1.1.2 Clean & process commercial vehicle survey data												
1.1.3 & 1.1.4 Estimate model components & prepare application												
1.1.5 & 1.1.6 Calibration & validation of model												
1.1.7 Model documentation												
1.2 Improved highway network procedures												
1.2.1 Definition of facility types												
1.2.2 Update link free flow speeds												
1.2.3 Calculation of link capacities												
1.2.4 Investigation of intersection delays												
1.2.5 Develop GIS approach to changing future road chars.												
1.3 Improve Highway Traffic Assignment												
1.3.1 Set up & test assignment methods												
1.3.2 Implement recommended method												
1.4 Investigate runtime optimization & implement												
1.5 Develop an improved parking constraint model												
1.5.1 & 1.5.2 Review, investigation & recommend v6 approach												
1.5.3 Design v6 parking constraint model specification												
1.5.4 Design data collection approach												
1.5.5 Advice on data collection management												
1.6 TAZ modifications												
1.7 Modifications of socio-economic data and models												
1.7.1 Create 2010 base year SE data												
1.7.2 Estimation of SE models												
1.7.3 Calibration of SE models												
1.8 Model estimation and calibration												
1.8.1 & 1.8.2 Process survey data												
1.8.3 Calibration and/or estimation of trip production models												
1.8.4 Improve destination choice attraction share model												
1.8.4.1 Review v5 model												
1.8.4.2 Investigate employment categories & spec. generators												
1.8.4.3 Investigation & recommendation												
1.8.4.4, 1.8.4.5, 1.8.4.6 Design specification & prepare data												
1.8.4.7, 1.8.4.8 Estimate & calibrate new specification model												
1.8.5 Calibration and/or estimation of destination choice models												

EXHIBIT B
Federal Regulatory and Programmatic Requirements
For Federal Flow-through Funding

By signing this Development/Services Agreement, the University Official certifies that to the best of his/her knowledge, University is in compliance with the applicable regulatory requirements listed below. University agrees to immediately report to Sponsor any change in its compliance status. University agrees to flow these requirements down to Subrecipients at any tier as appropriate. See Appendix B of the Federal Demonstration Partnership Operating Procedures (<http://thefdp.org/>) for a complete description of the following: (CFR is "Code of Federal Regulations", USC is "United States Code", E.O. is Executive Order)

1. Regulations implementing E. O. 12549 & 12689, "Debarment and Suspension."
2. ¹Prohibitions against lobbying as set forth in 31 USC 1352 and 18 USC 1913.
3. Nondiscrimination statutes on the basis of race, color, national origin, sex, blindness, handicap or age.
4. Regulations for the Clean Air Act, 42 USC 7401.
5. Regulations for the Clean Water Act 33 USC 1251, as implemented by E.O. 11738.
6. National Scenic Rivers Act of 1968, 16 USC 1271.
7. E.O. 11246, "Equal Employment Opportunity," as amended by E.O. 11375, and 41 CFR part 60.
8. In accordance with OMB Circular A-129, University is not delinquent on any Federal debt.
9. ²Copeland "Anti-Kickback" Act (18 U.S.C. 874 and 40 U.S.C. 276c)
10. ²Davis-Bacon Act, as amended (40 U.S.C. 276a to a-7)
11. ²Contract Work Hours and Safety Standards Act (40 U.S.C. 327-333)
12. ³Program Fraud Civil Remedies Act of 1986, 49 USC 3801 and 5307 and 49 CFR part 31.
13. ⁴Utilization of small businesses, minority-owned firms, and women's business enterprises, whenever possible through participation in North Carolina's statewide Historically Underutilized Businesses (HUB) Program⁵
14. 41 USC 22 No member of the US Congress or the NC General Assembly is entitled to any share of the Agreement or any benefit arising there from.
15. Compliance with Single Audit Act of 1984, P.L. 98-502, and the Single Audit Act Amendments of 1996, 31, USC 503, 1111, and 7501 *et seq.*, and E.O. 8248 and 11541, OMB Circular A-133.

The U.S. Federal Government as the prime sponsor of this agreement, retains rights to inventions, data, and copyrighted deliverables created under this agreement, as prescribed in the following clauses of the Federal Acquisition Regulation:

52.227-11 Patent Rights - Retention by the Contractor (Short Form) (Jun 1997)

52.227-14 Rights in Data - General (Jun 1987)

Footnotes:

¹ Applies only to awards of \$100,000 or greater.

² Applies only to awards and subawards for construction that are valued at \$2,000 or greater.

³ Applies to Federal assistance awards from the Federal Transit Authority (FTA)

⁴ 23 U.S.C. 324; 42 U.S.C. 2000d, *et seq.*; 49 U.S.C 1615

⁵ NC General Statutes No. 143-48 and 143-128 and NC E.O. No. 150

Exhibit C, Summary of University Insurance Policies



RISK MANAGEMENT DIVISION

Wayne Goodwin | Commission of Insurance

Tim Bradley | Assistant State Fire Marshal

CERTIFICATE OF COVERAGE

CERTIFICATE HOLDER: For Information Purposes Only

Insurer: State of North Carolina

Authorization: Public Officers & Employee Liability Insurance Commission of North Carolina and the General Statutes of North Carolina, Sections §143-291 to §143-305.

Period: July 1, 2011 until June 30, 2012

Coverage: A) Tort Claims against Departments, Agencies, and Employees
B) Excess Liability for State Employees
C) Workers Compensation.

Limits A) \$1,000,000 for Tort claims against the State
B) \$10,000,000 for claims against state employees
C) Statutory Limits for Workers' Compensation

Description: North Carolina State University; and its employees, officers, agents, as covered by the Defense of State Employees as per NCGS § 143-300.2.

Administrator: Department Insurance - Risk Management Division
Public Officers & Employees Liability Insurance Commission
1202 Mail Service Center
Raleigh, NC 27699-1202

Note: This Certificate is for informational purposes only and does not alter any provision of the Tort Claims or Defense of State Employees General Statutes of the State.

Verified By:

Joseph D. Rippard, CPCU
Risk Manager

POL&IC-Certificate doc



Risk Management

*Wayne Goodwin | Commissioner of Insurance
Tim Bradley | Assistant State Fire Marshal*

July 5, 2011

Mr. Matthew K. Ronning
Associate Vice Chancellor for Research Administration
Research Administration/SPARCS
North Carolina State University
Campus Box 7514
Administrative Services Building I
Raleigh, NC 27695-7514

Dear Mr. Ronning:

The purpose of this letter is to provide certification of various insurance coverages for North Carolina State University.

Property insurance is provided on a replacement cost basis by the State Property Fire Insurance Fund, a State self-insurance fund. This coverage is provided on a continuous basis and renews on July 1 of each year. We do not use policy numbers. Instead, we refer to the University's department/division number, which is 60005003.

In regard to general liability, the State of North Carolina claims sovereign immunity and therefore cannot be sued without its permission. However, by statute (Chapter 143, Article 31), the State has waived its sovereign immunity against suits for negligence of its employees or agents resulting from bodily injury or property damage. The State has waived its immunity up to a limit of \$1,000,000 per claim. The North Carolina Industrial Commission is constituted a court for the purpose of hearing and passing upon tort claims against departments, institutions or agencies.

Excess liability coverage is provided for State employees, through a private insurance company, for losses resulting in bodily injury and property damage in the performance of their jobs. The limit of liability is \$10,000,000 per occurrence.

Page Two
Matthew K. Ronning
North Carolina State University

The State maintains a boiler and machinery policy written through the Hartford Steam Boiler Inspection and Insurance Company. The renewal date for this policy is January 12 and the limit of coverage is \$25,000,000 for each accident with a \$5,000 deductible (certain equipment may carry a higher deductible).

Automobile liability insurance for state-owned vehicles is provided by Travelers. The bodily injury and property damage limits for this coverage is \$1,000,000 per person and \$10,000,000 per occurrence. This policy renewal date is July 1.

Public Employee Dishonesty coverage is written through Fidelity and Deposit Company of Maryland with a \$1,000,000 limit. The policy renews on January 6.

The State of North Carolina is self-insured for the payment of Workers Compensation claims.

Sincerely,

L. Jack Cooke, CPCU
Director of Risk Management



CERTIFICATE OF LIABILITY INSURANCE

OP ID: KK

DATE (MM/DD/YYYY)

06/23/11

THIS CERTIFICATE IS ISSUED AS A MATTER OF INFORMATION ONLY AND CONFERS NO RIGHTS UPON THE CERTIFICATE HOLDER. THIS CERTIFICATE DOES NOT AFFIRMATIVELY OR NEGATIVELY AMEND, EXTEND OR ALTER THE COVERAGE AFFORDED BY THE POLICIES BELOW. THIS CERTIFICATE OF INSURANCE DOES NOT CONSTITUTE A CONTRACT BETWEEN THE ISSUING INSURER(S), AUTHORIZED REPRESENTATIVE OR PRODUCER, AND THE CERTIFICATE HOLDER.

IMPORTANT: If the certificate holder is an ADDITIONAL INSURED, the policy(ies) must be endorsed. If SUBROGATION IS WAIVED, subject to the terms and conditions of the policy, certain policies may require an endorsement. A statement on this certificate does not confer rights to the certificate holder in lieu of such endorsement(s).

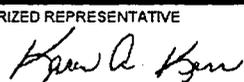
PRODUCER NC Assoc. of Ins. Agents, Inc. P. O. Box 1165 Cary, NC 27512 Karen A. Kerr, AAI, CISR, CPIW		919-828-4371 919-821-3172	CONTACT NAME: PHONE (A/C No. Ext): FAX (A/C No.): E-MAIL ADDRESS: PRODUCER CUSTOMER ID #: AUTOR-1
INSURED State of North Carolina Attn: Joe Rippard 1202 Mail Service Center Raleigh, NC 27699-1202		INSURER(S) AFFORDING COVERAGE INSURER A: Travelers Property Casualty INSURER B: INSURER C: INSURER D: INSURER E: INSURER F:	
		NAIC #	

COVERAGES **CERTIFICATE NUMBER:** **REVISION NUMBER:**

THIS IS TO CERTIFY THAT THE POLICIES OF INSURANCE LISTED BELOW HAVE BEEN ISSUED TO THE INSURED NAMED ABOVE FOR THE POLICY PERIOD INDICATED. NOTWITHSTANDING ANY REQUIREMENT, TERM OR CONDITION OF ANY CONTRACT OR OTHER DOCUMENT WITH RESPECT TO WHICH THIS CERTIFICATE MAY BE ISSUED OR MAY PERTAIN, THE INSURANCE AFFORDED BY THE POLICIES DESCRIBED HEREIN IS SUBJECT TO ALL THE TERMS, EXCLUSIONS AND CONDITIONS OF SUCH POLICIES. LIMITS SHOWN MAY HAVE BEEN REDUCED BY PAID CLAIMS.

INSR LTR	TYPE OF INSURANCE	ADDL INSR	SUBR WVD	POLICY NUMBER	POLICY EFF (MM/DD/YYYY)	POLICY EXP (MM/DD/YYYY)	LIMITS
	GENERAL LIABILITY <input type="checkbox"/> COMMERCIAL GENERAL LIABILITY <input type="checkbox"/> CLAIMS-MADE <input type="checkbox"/> OCCUR GENL AGGREGATE LIMIT APPLIES PER <input type="checkbox"/> POLICY <input type="checkbox"/> PRO-JECT <input type="checkbox"/> LOC						EACH OCCURRENCE \$ DAMAGE TO RENTED PREMISES (Ea occurrence) \$ MED EXP (Any one person) \$ PERSONAL & ADV INJURY \$ GENERAL AGGREGATE \$ PRODUCTS - COMP/OP AGG \$ \$
A	<input checked="" type="checkbox"/> ANY AUTO <input type="checkbox"/> ALL OWNED AUTOS <input type="checkbox"/> SCHEDULED AUTOS <input type="checkbox"/> HIRED AUTOS <input type="checkbox"/> NON-OWNED AUTOS			TRJCAP104T600-TIL-11	07/01/11	07/01/12	COMBINED SINGLE LIMIT (Ea accident) \$ BODILY INJURY (Per person) \$ BODILY INJURY (Per accident) \$ PROPERTY DAMAGE (Per accident) \$ BI/PD per person \$ 1,000,000 BI/PD per acc. \$ 10,000,000
	UMBRELLA LIAB <input type="checkbox"/> OCCUR EXCESS LIAB <input type="checkbox"/> CLAIMS-MADE DEDUCTIBLE RETENTION \$						EACH OCCURRENCE \$ AGGREGATE \$ \$ \$
	WORKERS COMPENSATION AND EMPLOYERS' LIABILITY ANY PROPRIETOR/PARTNER/EXECUTIVE OFFICER/MEMBER EXCLUDED? (Mandatory in NH) If yes, describe under DESCRIPTION OF OPERATIONS below Y/N <input type="checkbox"/> N/A						<input type="checkbox"/> WC STATU-TORY LIMITS <input type="checkbox"/> OTH-ER E.L. EACH ACCIDENT \$ E.L. DISEASE - EA EMPLOYEE \$ E.L. DISEASE - POLICY LIMIT \$
A	Hired Physical Damage			TRJCAP449J9525TIL-11	07/01/11	07/01/12	

DESCRIPTION OF OPERATIONS / LOCATIONS / VEHICLES (Attach ACORD 101, Additional Remarks Schedule, if more space is required)
 Hired Physical Damage Limits: \$25,000 Limit applies except;
 \$40,000 Limit applies to vehicles with GVW >10,000 LBS.

CERTIFICATE HOLDER NCDEPTO NC Dept. of Insurance Attn: Joe Rippard 1202 Mail Service Center Raleigh, NC 27699-1202	CANCELLATION SHOULD ANY OF THE ABOVE DESCRIBED POLICIES BE CANCELLED BEFORE THE EXPIRATION DATE THEREOF, NOTICE WILL BE DELIVERED IN ACCORDANCE WITH THE POLICY PROVISIONS. AUTHORIZED REPRESENTATIVE 
--	--

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RISK MANAGEMENT DIVISION

Wayne Goodwin | Commission of Insurance

Tim Bradley | Assistant State Fire Marshal

CERTIFICATE OF COVERAGE

CERTIFICATE HOLDER: For Information Purposes Only

Insurer: State of North Carolina

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Period: July 1, 2011 until June 30, 2012

Coverage: A) Tort Claims against Departments, Agencies, and Employees
B) Excess Liability for State Employees
C) Workers Compensation.

Limits A) \$1,000,000 for Tort claims against the State
B) \$10,000,000 for claims against state employees
C) Statutory Limits for Workers' Compensation

Description: North Carolina State University; and its employees, officers, agents, as covered by the Defense of State Employees as per NCGS § 143-300.2.

Administrator: Department Insurance - Risk Management Division
Public Officers & Employees Liability Insurance Commission
1202 Mail Service Center
Raleigh, NC 27699-1202

Note: This Certificate is for informational purposes only and does not alter any provision of the Tort Claims or Defense of State Employees General Statutes of the State.

A handwritten signature in black ink, appearing to read "Joseph D. Rippard".

Verified By:

Joseph D. Rippard, CPCU
Risk Manager

POL&IC-Certificate doc



Risk Management

*Wayne Goodwin | Commissioner of Insurance
Tim Bradley | Assistant State Fire Marshal*

July 5, 2011

Mr. Matthew K. Ronning
Associate Vice Chancellor for Research Administration
Research Administration/SPARCS
North Carolina State University
Campus Box 7514
Administrative Services Building I
Raleigh, NC 27695-7514

Dear Mr. Ronning:

The purpose of this letter is to provide certification of various insurance coverages for North Carolina State University.

Property insurance is provided on a replacement cost basis by the State Property Fire Insurance Fund, a State self-insurance fund. This coverage is provided on a continuous basis and renews on July 1 of each year. We do not use policy numbers. Instead, we refer to the University's department/division number, which is 60005003.

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Excess liability coverage is provided for State employees, through a private insurance company, for losses resulting in bodily injury and property damage in the performance of their jobs. The limit of liability is \$10,000,000 per occurrence.

Page Two
Matthew K. Ronning
North Carolina State University

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Sincerely,

L. Jack Cooke, CPCU
Director of Risk Management



CERTIFICATE OF LIABILITY INSURANCE

OP ID: KK

DATE (MM/DD/YYYY)

06/23/11

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IMPORTANT: If the certificate holder is an ADDITIONAL INSURED, the policy(ies) must be endorsed. If SUBROGATION IS WAIVED, subject to the terms and conditions of the policy, certain policies may require an endorsement. A statement on this certificate does not confer rights to the certificate holder in lieu of such endorsement(s).

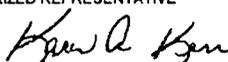
PRODUCER NC Assoc. of Ins. Agents, Inc. P. O. Box 1165 Cary, NC 27512 Karen A. Kerr, AAI, CISR, CPIW		919-828-4371 919-821-3172	CONTACT NAME _____ PHONE (A/C, No, Ext): _____ FAX (A/C, No): _____ E-MAIL ADDRESS: _____ PRODUCER CUSTOMER ID #: AUTOR-1	
INSURED State of North Carolina Attn: Joe Rippard 1202 Mail Service Center Raleigh, NC 27699-1202		INSURER(S) AFFORDING COVERAGE INSURER A: Travelers Property Casualty INSURER B: _____ INSURER C: _____ INSURER D: _____ INSURER E: _____ INSURER F: _____		NAIC # _____

COVERAGES **CERTIFICATE NUMBER:** **REVISION NUMBER:**

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INSR LTR	TYPE OF INSURANCE	ADDL INSR	SUBR WVD	POLICY NUMBER	POLICY EFF (MM/DD/YYYY)	POLICY EXP (MM/DD/YYYY)	LIMITS
	GENERAL LIABILITY <input type="checkbox"/> COMMERCIAL GENERAL LIABILITY <input type="checkbox"/> CLAIMS-MADE <input type="checkbox"/> OCCUR _____ GENL AGGREGATE LIMIT APPLIES PER <input type="checkbox"/> POLICY <input type="checkbox"/> PROJECT <input type="checkbox"/> LOC						EACH OCCURRENCE \$ DAMAGE TO RENTED PREMISES (Ea occurrence) \$ MED EXP (Any one person) \$ PERSONAL & ADV INJURY \$ GENERAL AGGREGATE \$ PRODUCTS - COM/OP AGG \$ _____ \$
A	AUTOMOBILE LIABILITY <input checked="" type="checkbox"/> ANY AUTO <input type="checkbox"/> ALL OWNED AUTOS <input type="checkbox"/> SCHEDULED AUTOS <input type="checkbox"/> HIRED AUTOS <input type="checkbox"/> NON-OWNED AUTOS			TRJCAP104T600-TIL-11	07/01/11	07/01/12	COMBINED SINGLE LIMIT (Ea accident) \$ BODILY INJURY (Per person) \$ BODILY INJURY (Per accident) \$ PROPERTY DAMAGE (Per accident) \$ BI/PPD per person \$ 1,000,000 BI/PPD per acc. \$ 10,000,000
	UMBRELLA LIAB <input type="checkbox"/> OCCUR EXCESS LIAB <input type="checkbox"/> CLAIMS-MADE DEDUCTIBLE RETENTION \$						EACH OCCURRENCE \$ AGGREGATE \$ _____ \$ _____ \$
	WORKERS COMPENSATION AND EMPLOYERS' LIABILITY ANY PROPRIETOR/PARTNER/EXECUTIVE OFFICER/MEMBER EXCLUDED? (Mandatory in NH) If yes, describe under DESCRIPTION OF OPERATIONS below.	Y/N	N/A				<input type="checkbox"/> WC STAT-TORY LIMITS <input type="checkbox"/> OTHER E.L. EACH ACCIDENT \$ E.L. DISEASE - EA EMPLOYEE \$ E.L. DISEASE - POLICY LIMIT \$
A	Hired Physical Damage			TRJCAP449J9525TIL-11	07/01/11	07/01/12	

DESCRIPTION OF OPERATIONS / LOCATIONS / VEHICLES (Attach ACORD 101, Additional Remarks Schedule, if more space is required)
 Hired Physical Damage Limits: \$25,000 Limit applies except;
 \$40,000 Limit applies to vehicles with GVW >10,000 LBS.

CERTIFICATE HOLDER NCDEPTO NC Dept. of Insurance Attn: Joe Rippard 1202 Mail Service Center Raleigh, NC 27699-1202		CANCELLATION SHOULD ANY OF THE ABOVE DESCRIBED POLICIES BE CANCELLED BEFORE THE EXPIRATION DATE THEREOF, NOTICE WILL BE DELIVERED IN ACCORDANCE WITH THE POLICY PROVISIONS. AUTHORIZED REPRESENTATIVE 	
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