

SOUTH JERSEY TRANSPORTATION PLANNING ORGANIZATION

RESOLUTION 1006-19: Approving the Selection of Consultant for the FY 2011-2012 SJTPO Model Improvement Initiative Project

WHEREAS, the South Jersey Transportation Planning Organization (SJTPO) is the Metropolitan Planning Organization (MPO) designated under Federal law for the southern region of New Jersey including Atlantic, Cape May, Cumberland, and Salem Counties; and

WHEREAS, the Fiscal Year 2011-2012 SJTPO Unified Planning Work Program includes Federal Highway Administration and Federal Transit Administration planning funds for this project; and

WHEREAS, the Selection Committee recommends Techniquest Corporation, a Certified Disadvantaged Business Enterprise (DBE)/Emerging Small Business Enterprise (ESBE), in association with URS Consultants; and

NOW THEREFORE BE IT RESOLVED, that the Policy Board of the South Jersey Transportation Planning Organization hereby approves the above selection for the FY 2011-2012 SJTPO Model Improvement Initiative Project, with a maximum fee of \$514,265; and,


BE IT FURTHER RESOLVED, that the Policy Board authorizes the Executive Director to execute scope of work and cost modifications to the original contract amount, provided that funding is available and such modifications have been approved by the NJDOT.

BE IT FURTHER RESOLVED, that the Policy Board requests that the South Jersey Transportation Authority execute the appropriate contractual arrangements with the consultant on behalf of the SJTPO.

BE IT FURTHER RESOLVED that it is anticipated that a contract modification will be considered later in 2010 to fully fund the June 7, 2010 URS scope of work.

Certification

I hereby certify that the foregoing is a correct and true copy of a resolution adopted by the Policy Board of the South Jersey Transportation Planning Organization at its meeting of June 28, 2010.


Louis N. Magazzu, Secretary/Treasurer



TECHNICAL APPROACH

Project Understanding

The South Jersey Transportation Planning Organization (SJTPO) developed and maintains the South Jersey Travel Demand Model (SJTDM). The SJTDM is an important tool for a number of federal government mandated programs such as annual air-quality conformity analysis and long range regional transportation plan for the SJTPO region as well as other local transportation planning efforts. The SJTDM was originally developed in the late 1990's in MINUTP and has gone through several enhancements between 2000 and 2006. The latest SJTDM Model (version 115) operates under the TP+/MINUTP platform with a few standalone FORTRAN and CLIPPER programs. All model execution and post-processing for PPAQ/PPSUITE are handled under CENTRAL, a graphical user interface (GUI).

With the current RFP, SJTPO initiates a major multi-phase multi-year model improvement program that is expected to last until June of 2012. This RFP specifically calls for two main Phases:

1. Migration of the current SJTDM to the new modeling platform CUBE/Voyager, training of SJTPO staff, and additional traffic counts data collection, and
2. Model enhancement, calibration/validation and training

SJTPO is also undertaking several other model related work programs that will provide input to the model enhancements and improvements phase. Two new work programs via separate efforts include the development of demographic and socioeconomic data forecasts and a new household survey. Both efforts are expected to be completed by April 2011, just before the commencement of the model enhancement phase under this project. SJTPO will also retain a peer reviewer to guide the model migration and model enhancement processes.

URS has assembled an outstanding group of individuals well experienced in travel demand model development and applications including model migration to new platforms. Several of these individuals have worked directly with SJTDM and are very familiar with the model structure and programs minimizing any learning curve. **Tushar K. Patel, PE**, our designated Project Manager for this assignment, has over 24 years of experience in travel demand forecasting including model conversions, model development and model enhancements. URS staff has **experience in model migration** from TRANPLAN to TP+ and TP+ to CUBE/Voyager or TransCAD and from EMME/2 to VISUM. To support our modeling practice, URS has licenses for all of the latest travel demand modeling packages (e.g., Cube Voyager/TP+, VISUM, TransCAD, EMME/2) as well as for a series of support programs for specialized applications.

Mr. Wade White our team member from Whitehouse Group, also brings a wealth of experience in model migration to CUBE/ Voyager, having been the **lead analyst for Citilabs** - before starting his own company. His model migration experience includes MPO models throughout the country – including all MPO and District Models in Florida (26 Models), Los Angeles, Houston, and St. Louis among others. Mr. White was the **lead trainer** for the North Jersey Transportation Authority's (NJTPA) new model (**NJRTM-E**) which was converted from TRANPLAN to



CUBE/Voyager by a team led by URS. Wade has worked on a number of model enhancement projects in his 16 years of professional experience.

Resource System Group will lead the mode choice development using information from the new Households Survey and available transit on-board survey data. RSG staff has work with NJ Transit on number of transit modeling projects including collection of transit survey and stated preference surveys. Most recently they are involved with New Brunswick BRT study. RSG staff has developed many mode choice-models and migrated regional models from older platforms to new software including CUBE/Voyager.

TechniQuest, a certified DBE will lead the traffic data collection task. TechniQuest holds a NJDOT data collection On-Call contract for South Jersey Region and is involved in numerous data collection efforts in central and south Jersey. They will collect automatic traffic recorder counts and turning movement counts at location decided by SJTPO staff. We are also proposing to collect speed and delay on major roadways during summer and non-summer peak periods.

The following sections provide details on our understanding of the current SJTDM Model and provide our approach for each task identified in the RFP.

PHASE I – Model Migration & Traffic Data Collection

Under Phase I, the selected consultant will undertake two primary tasks: A. Model migration to the CUBE/Voyager platform and B. Additional traffic data collection. It is anticipated that the new data collected under this task will support the model enhancements and improvements phase of the project.

TASK I.A MODEL MIGRATION, INSTALLATION & TRAINING

It is our understanding that SJTPO decided to migrate the existing TP+/MINUTP model to a newer software platform CUBE/Voyager to take advantage of the recent advances in travel modeling software and computing power. Under this task, URS Team will convert the SJTDM to the CUBE/Voyager platform, oversee installation of the new package and model on SJTPO computers and provide training on the migrated model to SJTPO staff.

Migrating a model from a legacy platform to a more modern platform can have many benefits as well as challenges. Typically there are two forms of model conversion:

- Hard Conversion- reproducing the logic and values of a model to the greatest extent feasible
- Soft Conversion- reproducing the logic of the current model structure but taking advantage of some of the features of the newer platform without a strict adherence to current practice/results

Generally the best approach is to initially perform a hard conversion to assure that the logic of the model is correctly translated to the new platform. In this process results from each model process are summarized and compared to insure results are consistent. Where differences occur, they should be reconciled or explained. By starting with a hard conversion, any flaws in the model's current logic can be documented for later removal during soft conversion.



Soft conversion focuses on making the model's performance as "correct" as possible in the new platform. Soft conversion corrects any mistakes or miscoding in the current model that are unintentional as well as takes advantage of the newer platform's capability. For example, some integer limitations of older platforms may be ignored and results calculated in full floating point. Because of this results may vary from the previous model but they should be more accurate than was able to be accomplished on some older systems.

The strengths of the SJTPO approach to the model migration from TP+/MINUTP to the CUBE/Voyager platform is that much of the logic is directly portable and that it should be quick to accomplish leaving much more time for model enhancements and updates. In fact, some TP+ modules, such as TRNBUILD, are directly usable in the Cube Voyager environment.

Our team's approach to this task is to accomplish the hard conversion within just a few weeks of notice-to-proceed. That way the SJTPO can be assured that the Cube Voyager platform can be used almost immediately. The soft conversion will start immediately following the hard conversion model and explore opportunities to enhance the processing of the model, take advantage of newer Cube Voyager features such as GIS/Geodatabase processing and build in the "hooks" for subsequent model enhancements expected to be recommended during subsequent stages of the project. By finishing the model conversion very early in the project more time is available to include and test enhancements that result from data collection and other analysis findings.

Task I.A.1 MODEL MIGRATION

The following is our understanding of the various components of the SJTDM as they operate currently along with identification of the various modules that would be migrated to the CUBE/Voyager platform after discussions with SJTPO staff.

Networks

The highway network in the SJTDM is maintained in MINUTP format. The model chain includes TP+ scripts that convert this to TP+ format for use in highway and transit assignments. The transit network is maintained as MINUTP card files. Both the highway and transit networks would be converted to the CUBE/Voyager platform.

Socioeconomic Data

The socioeconomic data in the model is maintained in database format, which is compatible with most travel modeling software. A custom CLIPPER program is used to reformat and prepare these files for the trip generation step. This program would be converted to the new modeling platform. Moreover, this process could be made geo-database compliant along with TAZ layer which will work with SJTPO's GIS platform. The latest version of CUBE/Voyager has extensive GIS functionality and is fully integrated with ESRI's ArcGIS platform.

Trip Generation

The trip generation step in the SJTDM is performed separately for recreational and non-recreational trips. Recreational trip generation (that accounts for casino and shore trips) is performed by a DOS-based CLIPPER program, whereas non-recreational trip generation (that accounts for work, shopping, school, truck and commercial trips) is performed by a FORTRAN program. Both of these programs would be scripted and migrated to the CUBE/Voyager platform.



Trip Distribution

This step is performed by a MINUTP routine and conducts 28 gravity model distribution runs. The internal-internal (I-I) and internal-external/external-internal (I-E/E-I) trips are distributed using composite skims comprised of highway and transit times. The trip distribution routine would be scripted and converted to the CUBE/Voyager platform.

Regional Trip Integration

The SJTDM includes the region covered by the Delaware Valley Regional Planning Commission (DVRPC) model due to its considerable interaction with the SJTPO region owing to its close proximity to the Philadelphia area. Since the trip generation and distribution steps in the DVRPC model is different from that in the SJTDM, the trip tables from the DVRPC model are combined with the SJTDM trips after reorganizing the trip purposes in a process known as 'weaving'. Currently this step is performed using a FORTRAN program and only for the non-recreational trip purposes. We will review the feasibility of moving this process to the new software platform. However, during the model enhancement phase, if the geographic coverage of the SJTPO Model is open to review and alteration (as discussed later), we recommend to not spend any resources to convert the existing FORTRAN program during the migration phase.

Mode Choice

Mode choice is performed in the SJTDM using a FORTRAN program, although the sub-process of adjusting the transit level-of-service matrices in preparation for the mode choice process is performed using TP+. The mode choice model follows a nested-logit formulation. Since the conversion of the mode choice model from FORTRAN to another software platform is a larger undertaking, we recommend that the conversion of this step to a new platform should be considered during the model enhancement phase which may recommend a new structure for the mode choice model. The process of adjusting the transit level-of service matrices will be converted from TP+ to CUBE/Voyager.

Temporal Model

The SJTDM has the capability to model a 'full-activity' day (hypothetical day producing the maximum number of trips) as well as any of the 48 user-defined 'analysis days' (comprising of either weekday, Friday, Saturday or Sunday for every month) to account for seasonal and weekday vs. weekend variations in trip making activity. The process to factor the trips from a full-activity day to an analysis day is performed in the SJTDM through the Temporal Model, currently implemented using a CLIPPER program and MINUTP routines. This model also splits the daily trips into four peak periods (AM peak: 6–9 AM, midday: 9 AM–4 PM, PM peak: 4–7 PM and night: 7 PM–6 AM) using a FORTRAN program. The Temporal Model would also be migrated to the new platform.

Toll Model

The SJTDM model incorporates a toll model that partitions trips into toll and non-toll trips to enable model sensitivity to toll policies on the toll roads in the region such as the Atlantic City Expressway, New Jersey Turnpike and Garden State Parkway. The process is implemented first using a MINUTP routine that skims the highway network for toll and non-toll paths and then using a FORTRAN program to split the trips separately for HOV and SOV between toll and non-toll trips using a binomial logit model that incorporates



toll path cost and time savings between toll and non-toll paths. This process would be converted to the CUBE/Voyager software platform.

Peak Hour Model

This sub-model converts the peak period highway trip tables to AM (7–8 AM) and PM (5–6 PM) peak hour trips for the work, non-work, trucks and recreational purpose groups. Peak hour trips are used to perform peak hour traffic assignment for air quality analysis purposes. This process is performed using a FORTRAN program and would be converted to CUBE/Voyager as part of this undertaking.

Highway Assignment

The highway assignment step has been fully converted to TP+ from MINUTP and performs equilibrium trip assignment for each of the four time periods or at an hourly basis. Conical volume-delay functions by facility type are used in this step in the SJTDM. The highway assignment step would also be migrated to the CUBE/Voyager platform.

Transit Assignment

The SJTDM has the capability to perform transit assignment (including transit skimming) using both MINUTP and TP+. This step is performed at the daily level for any of the analysis days. The transit skimming and assignment step would be migrated to the new CUBE/Voyager modeling platform.

Post-processors

The SJTDM incorporates several post-processors to facilitate additional analysis and reporting:

- a. Post Processor for Air Quality (PPAQ) analysis
- b. Post Processor for Congestion Management Systems (PPCMS)
- c. Performance Queries for Surface Transportation (PEQUEST)
- d. PEQUEST Performance reporting
- e. Mobile Source Emissions Modeling (MOBILE)

These postprocessor programs or newer versions of them would remain the same; however, they would be linked to run under the CUBE/Voyager modeling environment.

User Interface

Currently, CENTRAL is used to organize and apply the model chain. Although this program is very user-friendly and menu-driven, it is a separate application that needs to be installed and maintained separately. To take advantage of recent advances in modeling software capabilities, Cube/Voyager's 'flowchart-style' environment for the user-interface could be utilized (or can be scripted). This facilitates tighter integration of the modeling 'engine' with the user-interface and avoids the need for separate installation and maintenance. Examples of such interfaces developed by URS are the flowchart-style CUBE interface for NJRTM-E. However, if SJTPO staff would like to maintain the CENTRAL environment, URS will integrate the components developed in CUBE/Voyager with CENTRAL.

Model Migration Summary



As discussed above, several components of the SJTDM would be converted to CUBE/Voyager. We would discuss with the SJTPO Project Manager and Peer Reviewer the need for converting these programs and the priority for implementing the migrations. We understand that certainly all MINUTP and TP+ routines will be migrated to the CUBE/Voyager platform. We recommend that the CLIPPER programs be converted first as a top priority as CLIPPER is a very old database program and may pose challenges, especially with new operating systems such as Windows 7 and 64-bit systems. Next in priority would be the FORTRAN programs; although FORTRAN still continues to be widely used, the components that are easy to migrate would be converted to the new modeling platform for closer integration with the rest of the model components. We recommend keeping the FORTRAN programs that require considerable effort to migrate and suggest converting them during the model enhancement phase, such as the mode choice model. The table below summarizes our recommended priority for converting various programs.

Processes/Programs	Migration Priority
TP+/MINUTP	Definitely
CLIPPER	High
CENTRAL	Medium
FORTRAN (other than mode-choice)	Medium to Low
FORTRAN (Mode Choice)	Low

TASK I.A.2 MODEL RESULTS CONSISTENCY RUNS

During the migration process, each model component will go through a rigorous process to check the consistency of results between the old and the new platform. Once the model components have been migrated to the new platform, a series of test runs will be performed to ensure smooth operation of the model chain (including the feedback loop) and ensure that the model produces similar results as the existing model. However, it should be noted that newer algorithms in CUBE/Voyager may not produce identical results due to process improvements or error correction from previous versions. We will highlight any significant differences between the old and the new results to the SJTPO Project Manager and Peer Reviewer and work cooperatively to resolve any issues.

The primary focus of this task is to ensure that the SJTDM's functionality under the new platform is reasonable and similar to the current platform. Following the recommendations from the FHWA Manual – which is a standard practice in most of our modeling assignments – the URS Team will develop a list of network and model validation checks in consultation with the SJTPO Project Manager and Peer Reviewer. These checks will ensure SJTDM's ability to continue to assist SJTPO in regional modeling tasks including air quality analysis.

It is expected that since the focus of the Phase I effort is to migrate to a new platform and making sure the model produces similar results as before, the model validation checks would be reasonable and comparable to the previous model validation statistics. However, the review and checks performed during this new effort will be used to identify model enhancements and improvements that will be performed under Phase II.



TASK I.A.3 INSTALLATION, TRAINING & DOCUMENTATION

At the conclusion of the migration of the SJTDM to CUBE/Voyager, URS staff will install the new model on SJPTO computers (repetition of first sentence in previous paragraph: one of them should be deleted) and will provide training in two steps as requested in the RFP. Also, if desired, at the beginning of the project, URS can coordinate with Citilabs and SJTPO on purchase and installation of the software, although it is our understanding that the cost of purchasing the software will not be included in this proposal.

The first day of training will be devoted to general overview of the migrated model and its operation under CUBE/Voyager. Prior to this training day, URS will develop a User's Guide that will document the step-by-step process of running the new model under CUBE/Voyager. After SJPTO staff and others had a chance to practice the operation of the new model, a second day of training will be held at SJTPO offices. At this training the URS Team staff will provide additional details on model functions and address any questions from SJTPO staff and other agency staff. However, it should be noted that URS prides in our ability to involve client staff during the entire project duration. We believe that hands-on training is the best approach to ensure that SJTPO staff can run the migrated SJTDM and can interpret results without outside assistance. Hence, we would welcome constant communication with SJTPO throughout the project duration.

During the model migration task, URS will develop a series of draft memoranda documenting the migration process along with the results of each model component. This documentation will be provided to SJTPO in draft format for review. At the end of this task, a comprehensive report will be prepared by combining all technical memorandums.

Task Deliverables:

1. SJTDM migrated to the CUBE/Voyager Platform
2. Draft Technical Memoranda and Report
3. Installation of new model/software and Training of SJTPO staff in SJTDM under CUBE/Voyager

TASK I.B TRAFFIC DATA COLLECTION

Our subconsultant TechniQuest, a certified DBE firm, will perform the data collection. Having performed numerous data collection efforts throughout New Jersey, TechQuest staff is well qualified for the expected data collection on this assignment. Currently, TechniQuest has a contract with NJDOT for traffic data collection in South Jersey Region. As a part of that contract, NJDOT recently asked TechniQuest to performed traffic counts at many locations over next six months. This effort will provide enormous synergy between new data collection for SJTPO.

It is anticipated that after reviewing the existing traffic counts available from the various sources, SJTPO staff will identify locations where new traffic counts data will be collected. SJTPO Staff will provide a list of 70 locations of which 50 would be automatic traffic recorder (ATR) counts while remaining 20 locations would require Turning Movement Count locations. For non-summer ATR counts, a 24-hour period between Tuesday to Thursday would be included and for summer counts a period from Friday to Sunday would be covered. Some of the ATR counters would also collect classification counts in the standard FHWA 13-class system. All TMC counts would be conducted for to cover 13-hour period between 6AM and 7 PM. Both ATR and TMC would be reported in 15 minute periods.



These counts would be spread over both summer and non-summer seasons. It is anticipated that that some of the locations with heavy traffic counts and on major roads will require two or more ATR per locations. For our cost proposal, we assumed 75 counters would be required for 50 locations and these would be spread over both summer and non-summer months.

Although it is not requested in the RFP, we believe collecting new speed data on important roadway would be very helpful during the traffic assignment validation. Due to advances in data collection using the GPS technology, TechniQuest will also collect new speed and delay information on all major roads in summer and non-summer periods. Our cost proposal includes this data collection effort.

Task Deliverables:

1. A summary report on the data collection effort
2. A DVD with electronic files of all raw traffic data

PHASE II – Modal Enhancements & Improvements, Model Validation and Training

Under this phase, URS Team will three distinct tasks: A. Model enhancements and improvements to specific modules as directed by SJTPO, B. Model calibration and validation for each individual modules and entire model chain, and C. Training of SJTPO Staff in new enhancements to the SJTDM.

URS has assembled a well qualified team of individuals with directly suitable experience to provide efficient services to SJTPO. URS will lead the overall model improvement efforts while Whitehouse Group will play important advisory role in addition to support URS for specific module such as trip distribution and trip assignment validation. RSG will be primarily responsible for the development of the mode choice models. In order for the model enhancements work to proceed smoothly it is paramount to work closely with all members of the URS team involved in other aspects of the project. For example, the reasonableness of the trip distribution model output has a direct bearing on our ability to validate trip patterns by mode. Similarly, the output from the mode choice model has a direct bearing on the traffic and transit assignment output. Additionally, there are numerous details related to network coding, for example, and to CUBE/Voyager script development that require close coordination for this to be a seamless model development effort. All by way of saying, RSG staff will work closely with URS and the Whitehouse Group on all aspects of the model development effort to ensure the various efforts dovetail together. URS has a long-standing and collaborative working relationship with RSG, and has known Wade White and Haseeb Ahson for years, so this coordination will come very easily.

We also recognize the importance of working closely with SJTPO staff and other interested stakeholders to gain acceptance of the model enhancement work at key steps in the study. This collaboration with the agencies will be facilitated with frequent communication and deliverables at key milestones to spur a constructive discussion. Each key enhancement will have a deliverable and a point at which the client team would be engaged to discuss technical details of the recent work and next steps. The end product of this body of work will be a series of technical memos that folds nicely into an overall model documentation and validation report.

TASK II.A MODEL ENHANCEMENTS & IMPROVEMENTS



It is expected that SJTPO working with a peer reviewer and consultant selected for this project will develop a list of specific improvements. These improvements will be based on the recommendations from previous model reviews included in the SJTPO Model Update Report prepared in July 2006 and the results of reviewing the current model validation statistics against the standard model validation criteria published by FHWA. The URS Team will work with SJTPO staff and the peer reviewer to finalize the improvement list based on insights gained during the validation checks under the model migration phase.

As indicated in the RFP (and supported by our understanding of SJTDM results), the model improvements will focus on both transportation networks and specific modules of the four step process. There will be several data collection efforts going on in parallel to the model migration to CUBE/Voyager. In addition to new traffic counts collected for this project SJTPO will undertake a new household survey between July 2010 and March 2011. The new survey along with the existing database of household characteristics will provide sufficient observations for performing improvements to several specific modules such as trip generation, trip distribution, and mode choice. Although the Bureau of Census is in the process of collecting 2010 census data, it is unlikely that a complete Transportation Planning Package (CTPP) will be available by the beginning of the Phase II work. However, the URS Team will utilize any preliminary CTPP data or the latest American Community Survey (ACS) data during the model improvement or model calibration/validation steps.

Transportation Network Improvements

The previous model review had identified several issues related to networks including - model may have too many lower functional classification roadways, too much network/detail in the Atlantic City area, centroid connectors crossing major roadway facilities – among others. Some of these observations have been incorporated while others were left for future enhancements. The URS Team will thoroughly review both highway and transit networks along with the traffic analysis zone system. The representation of the base year highway and transit network is one of the most critical inputs to the travel demand models. CUBE/Voyager has very good graphical tools to perform network checks which make it very efficient to identify and correct errors in network coding.

Highway Network

The coded highway network represents the majority of primary roads in the SJTPO area. URS will review the network representation for consistency throughout the region and suggest changes for adding required details in certain areas, especially when a local street used by a bus route is not represented in the model. A summary of center-lane miles and lane miles by facility type and by county will be prepared for this task in addition to visual inspections. URS will also prepare a summary table of average speed by functional class and area type by county. In addition to visual network checks using color-coded graphic displays, maps will be created using large scale plotter for important network attributes that has significant impact on the model-chain, such as facility type, area type, number of lanes, free-flow speeds, etc. **CUBE/Voyager has significantly better network modeling capabilities such as junction coding that can enhance the network representation and thus improve the highway assignment results.**

On the more detail level, the network will be checked for node connectivity, intersection control type, one-way coding, proper turn prohibitions and toll plaza coding among others. Centroid connections to the surrounding links will be reviewed by overlaying the TAZ layer over the highway network along with other GIS layers showing streets, waterways and railways to verify that centroids are located and connected properly. The shortest path calculation in



the network editor will be used extensively to visually check the network connectivity and travel time (distance and speeds).

All of the checks listed will lead to corrections and improvements to the highway network including some of the issues identified by the previous peer review.

Transit Network

The URS team will review the base year transit network representations against the current transit routes to verify the inclusion of all public transit system routes in the model. The critical transit system attributes such as transit mode, access links, transfer points, stop locations, station connectivity, parking lots, and fare coding will be verified and adjusted as necessary.

Other important check for transit network relates to the estimated total route time vs. actual time in the route schedule. Transit running on separate physical right-of-way, such as NJ Transit's rail to Atlantic City would produce the same estimate as coded, however, the speeds on bus and jitneys running on streets may have big variation due to congestion. URS will prepare a summary table showing model estimated route time vs. schedule time to identify changes required in link attributes or factors that relate highway speed to transit speed. Transit path building will be used to verify and make improvements to the transit network.

As a part of the FY09 Conformity project for NJTPA, URS staff updated transit network in the model to reflect all NJ Transit bus routes and fixed guideway transit system routes (Commuter Rail, Light Rail, Newark Subway) as of early 2008.

Enhancement to Specific Modules

Using the information from the new household survey, the recently completed transit on-board survey and other data collection efforts and its comparison with the existing model results, SJTPO staff and the peer reviewer will develop specific improvements for each module of the SJTDM. Some of the known improvements needed based on previous reviews include:

Trip Generation – It was identified that traffic assignments for the PM peak on summer Friday was significant lower than observed traffic counts. This may be related to recreation (casino and beach related) traffic generation rates. Also, it was noted that the trip generation for the home-based school and non-home-based purposes may be high. The URS Team will compare the trip generation rates in the model with the new household survey results by trip purpose by various segmentations (income, household size) and make necessary adjustments. It may be necessary to recalibrate the trip production and attraction equations.

Trip Distribution - The friction factors for certain trip purposes such as Home-Based-Work produces some very short distance and some very long trips in the current model. Overall VMT produced by the model is also high, further indicating that the trip distribution module should be updated with information from the new HH Survey as well as preliminary information from Census 2010 on journey to work (JTW) data.

Temporal Model – This component of the model would be enhanced using the information from the new HH survey as well as traffic counts by time-periods. Special attention will be paid to the temporal model for the recreational traffic to improve representation of traffic related to casino and beach trips in the PM peak on summer Fridays.

Mode Choice Model Enhancement



URS anticipates that based on new Households Survey and existing databases, a new mode-choice model will be developed to improve the current process. The development of this new mode-choice routine and its implementation requires a significant effort and hence more detail is provided below for various steps of the mode choice module.

M1. Review Existing Data Sources and Surveys

Our first step in the development of the mode choice model will be to reach out to transportation agencies in and around the SJTPO region to identify a comprehensive list of data sources and to gain access to the data for the purposes of understanding SJTPO travel patterns by mode. We will review the available data sources for their usefulness in calibrating and validating the regional mode choice models. The RFP outlines a few of these data sources and the NJTPO model documentation mentions a couple others, and here is a reasonably comprehensive list that we would assemble, analyze and understand:

- Census and ACS data describing work trip patterns and mode choice
- 2001 and upcoming regional household trip diary survey
- Traffic counts and VMT estimates
- Transit boarding counts
- Beach Access Travel Survey (1996)
- Atlantic City Casino Expansion & Transportation Study
- NJ Transit system-wide on-board survey data

M1 Deliverable: a DVD with each of these surveys and metadata

M2. Develop Calibration Target Values

Once the available data have been assembled and reviewed for usability, the second step in the development of the mode choice model will be to create a set of mode choice model “calibration target values” that will be the primary indicators guiding the model calibration process. Calibration target values are shares of trips by mode, for each trip purpose and socioeconomic market segment (e.g. income or auto ownership) in the model. The goal of this task is to quantify the observed mode shares so that we can ensure the model replicates observed behavior at a regional scale.

Additionally, it is critical to understand mode shares related to externally oriented trips, which is understandably an important aspect of this model. For this reason we will look for travel data sets that span multiple planning boundaries and/or are outside but adjacent to the SJTPO region. We need to ensure that the model does a good job replicating the behavior of those travelers in the region who cross the model boundary since the SJTPO region experiences a large amount of travel across its planning boundary.

Finally, while tabulating the survey data we will look for a refined understanding of mode choice patterns by geography. The primary scope of the calibration target values is regional, but certain data sources do present the opportunity to refine our understanding of trip-making by mode at a sub-regional geography such as the town level or a perhaps a slightly more refined district geography. Sub-regional calibration



targets can also be used to refine the model during an iterative validation and model adjustment phase whereby we increasingly work to improve the model's ability to replicate more detailed behavior by geography, mode and market segment.

M2 Deliverable: Memo with recommended survey findings for use in model calibration and validation

M3. Estimate Mode Choice Models

The URS team has reviewed the current mode choice model and there is clearly a lot of work to be done to make the model reasonable compared to good practice and in any case it is not clear at all how the model is performing relative to observed data since very little evidence of reasonableness has been provided. Without the benefit of having seen a credible summary of the performance of the model, there are several aspects we would recommend revising:

- **Travel Modes** – We recommend that consideration be given to explicitly including toll roads in the mode choice model and creating an auto nest that distinguishes auto travel via general purpose lanes, HOV lanes and toll facilities. In our experience mode choice models have become quite detailed regarding transit, but for some reason lack detail regarding managed lanes, which tend to carry large numbers of people and are integral parts of the transportation system. By including toll explicitly in the mode choice model it is easier to validate the model's response to pricing and calibrate the toll market based on trip length and trip purpose.
- **Market Segmentation** – the model contains 22 trip purposes and there is a separate model for each purpose which implies that sufficient data exists to calibrate the model for each purpose. Additionally, four income segments are used for the home-based trip purpose, which further divides the market. It seems to us at first glance that there are too many trip purposes in the current SJTPO model because there is really no way sufficient data exists to support calibration and validation of all those separate models. Several of the models are quite similar and consideration should be given to the thought of combining them to facilitate calibration and reasonableness checking, unless other reasons exist downstream in the model for keeping the purposes distinct (such as time of day patterns and traffic assignment rules).
- **Model Coefficients** – Several of the model coefficients are in a reasonable range, but there are many exceptions based on our experience working with FTA and across the country on mode choice modeling. First, the scale of the travel time coefficients is much lower than typical. For example, in-vehicle time coefficients tend to be between -.02 and -.03 in models across the U.S., but the SJTPO model coefficients are much closer to zero which means that travel time and other level of service parameters have little effect on mode choice. Additionally, some of the key model ratios are outside the range of reasonableness, including many of the ratios between in-vehicle and out-of-vehicle travel time. Typically in the U.S. the coefficients for OVT are 2-3 times the magnitude of IVT, whereas in the SJTPO model the ratio is often 5-10. There are other problems, including the scale of the transfer coefficients, the size of CBD constants and the size of the alternative-specific constants (which tend to dominate the models in an atypical manner).



- **Transit Networks** – As an example of the type of value we can add, we would like to create new utilities in CUBE to facilitate network coding details such as walk access links, transfer links and drive access links. Access links are typically either (1) hand coded, which can be a very cumbersome and somewhat arbitrary process, or (2) are automatically created as the model is executed using simple maximum distance rules and tracing the network to find potential linkages between zones and transit stops, which can be problematic in terms of identifying reasonable access/egress walk distances and even in building realistic walk access/egress links among other problems. In contrast, RSG has developed an effective CUBE-based approach to automatically scan the networks and find all unique transit routes within a specified distance of each zone and build a specified number of links (e.g. no more than 2) to the closest stops for each unique transit route. This approach is effective for walk and drive access and has the advantage of facilitating consistent coding decisions by different analysts and ensuring reasonable transit access. Hand coded links can be used to supplement this automated process.
- **Road Networks** - It is good to see that care has been taking in such details as park-and-ride access coding. We will work with URS to ensure that toll and HOV facilities are carefully represented and distinguished from general purpose lanes and facilities. Additionally, consideration will be given to the traffic zone detail to facilitate appropriate access to existing and potential major transit projects.
- **Automated Reports** – RSG takes pride in developing custom automated reports to summarize key model outputs by geography, market segment and mode so that the outcome of a scenario can be efficiently reviewed and compared to another scenario or against observed data. These reports are either produced directly from the CUBE scripts or indirectly by linking CUBE outputs with Excel or ArcGIS templates and macros. We would work closely with the NJTPO to make sure the model is efficiently usable and informative in this regard.

RSG has extensive experience estimating and implementing mode choice models. In our professional opinion, given the available data sources, the most practical approach to developing a new choice model for the SJTPO is to *assert* a mode choice model structure and a set of mode choice model coefficients that is in fact consistent with good practice. The alternative approach would be to use statistical methods to *estimate* model coefficients. The current model documentation mentions that the intent of the previous model development effort was to assert a defensible mode choice model, but honestly the current model needs a fair amount of work to be defensible. We have the experience and credibility to do this work correctly. Our efforts would be best spent ensuring that the transition to CUBE is smooth, assembling and analyzing data useful in reviewing output from the models, demonstrating the validity of the models, and building user-friendly applications to facilities model input and output review.

M3 deliverable: Memo with recommended model design and parameters

M4. Implement mode choice models in CUBE

RSG brings to this project extensive CUBE/Voyager experience to complement the extensive experience of URS staff and Wade White. Namely, John Lobb and Brian Grady each have nearly 10 years experience using CUBE (and its predecessor software) and John Lobb in particular brings to this project the perspective of having managed a modeling program at an MPO and the requisite Voyager programming experience and choice modeling expertise.



The mode choice model implementation is listed as the fourth mode choice task, but this exercise really begins immediately in Phase 2 as the entire modeling process is designed to ensure a coherent and consistent application. RSG will work with others on the URS team and the SJTPO to design an overall model system and architecture that is well organized, efficient and which lends itself to the needs of the user.

One example of the need for close coordination is that it is important that travel modeling systems be consistent across model steps in terms of traveler sensitivities to time, distance, cost and other service features. For example, it is important that the implied traveler sensitivities to time and cost are consistent between the mode choice model and the path-finding and assignment models so that the rules governing path-finding are the rules governing choice of mode (e.g. the importance of time vs. cost). This also applies to trip distribution, where it is helpful if the impedance used in trip distribution modeling can be consistent with mode choice and trip assignment.

To facilitate usability of the model, RSG will provide two innovative features to the model, including an automated calibration routine that can be run by an experienced analyst to calibrate mode choice model constants, and a model output report that prints EVERY computation and data element for one example zone pair. This computation tracing report is critical to ensuring that the millions of calculations are being done correctly. Once the model is operating as anticipated, the calibration routine will be employed in a step-wise manner to incrementally adjust model constants until the model sufficiently matches observed data by mode, market and geography. Care will be taken not to “force” the model to match the data when it is having a hard time doing so – in such cases the calibration data will be reconsidered along with whatever aspect of the model might be making the calibration difficult to achieve.

Finally, once the mode choice model has been implemented, extensive testing of the software will be completed to ensure the model is working as anticipated. The custom reporting and computation checking features will be invaluable in this process.

M4 deliverable: CUBE/Voyager application that identifies the multi-modal skims, applies the mode choice models, assigns the transit demand, and reports key outputs from the mode choice model

Task Deliverables:

1. Separate technical memorandum for each model step enhancements
2. Draft Technical Report on Model Enhancements and Improvements

 **TASK II.B. BASE YEAR MODEL CALIBRATION AND VALIDATION**

During the model improvement process for specific modules, the URS Team will conduct detailed model validation checks to ensure the accuracy of the modeling process and reasonableness of results. URS will perform comprehensive model validation checks recommended by FHWA and included in “Model Validation and Reasonableness and Checking Manual, 1997”.

Following is a preliminary list of primary checks on network and other model components that we expect to perform. Please note that this list will be finalized with the SJTPO Project Manager and Peer Reviewer after reviewing the availability of existing base line data either from local sources or regional and national reports.

Transportation Network Checks

For the base year highway network, a summary of center-lane miles and lane miles by facility type and by county will be prepared for this task in addition to visual inspections. URS will also prepare a summary table of average



speed by functional class and area type by county and check for reasonableness (i.e. speed by facility type and area type are progressing in the proper direction). URS will also compare the average speed by functional class with available field observations.

For transit network, URS will prepare a summary table showing model estimated route time vs. schedule time and make necessary adjustments to validate the transit network.

Trip Generation Checks

The following checks would be performed as part of the validation of the trip generation model:

Input Data (Socioeconomic) Checks

The first aggregate check of model input data will involve summarizing data at the county level and comparing with control totals. Comparisons to measures from the previous model summaries will be performed. Tabular and graphical summaries of existing and future socioeconomic data will be prepared to review the accuracy of the data.

Tabular summaries will include cross-tabulation or summary of various indicators such as:

- Persons per household
- Vehicles per household
- Workers per household
- Vehicles per worker
- Employment to population ratio

GIS is an excellent tool for presenting the results of disaggregated data checks. The URS Team will prepare various maps of population and employment characteristics either in density terms (i.e. per acre) or in absolute terms. A comparison showing increase or decrease in important variables between various years will also be displayed to perform reasonableness checks.

Output Checks

Total Person Trips per Household or per capita

The total person trips per household or per capita estimated by the trip generation model will be compared with the values from the most recent household survey and can also be compared to those in the NCHRP 365 'Travel Estimation Techniques for Urban Areas' which contains these values for various regions. This measure can also be estimated by purpose and compared with those of other similar sized areas.

Percentage Trips by Purpose

The percentage of person trips by purpose estimated by the model would be compared with the most recent local rates and those of other regions for reasonableness.

Estimated vs. Observed Trips

The trips estimated by the model would be compared with the observed trips obtained from the weighted trip records from available household travel survey. This would be done at the regional level (or any geographic area), by purpose, income level, auto ownership.



Trip Attraction Checks

The following checks would be performed to evaluate the reasonableness of the trip attraction model:

- Home-based work person trip attractions per total employment
- Home-based school trips per school enrollment
- Home-based shop trips per retail employment

Trip Distribution Checks

The following checks would be performed as part of the validation of the trip distribution model along with comparisons with validation summaries from the previous:

Trip Length

The estimated trip lengths (distance and time) would be compared with the observed trip lengths by purpose and income group to ensure a reasonable match. The trip lengths for trips produced versus trips attracted by purpose and by area type could also be mapped in GIS and examined for reasonableness. The overall average trip lengths would be compared with other regions

Trip Length Frequency Distribution

The estimated vs. observed trip length frequency distribution by purpose would be examined visually.

Intrazonal Trips by Purpose

The percent of intrazonal trips by purpose would be estimated by zone size ranges and checked for unusually large percentages.

District-District and Major Trips

The estimated trips would be compared with the observed trips grouped at a district level. Trips to the major attractions (i.e. Casino) would also be reviewed.

Model validation and documentation

The mode choice model is one area of the SJTPO model that has not been validated well in the past. Below is a list of model validation tests we will run and document for the SJTPO mode choice model:

- **Trip distribution summaries** – As alluded to earlier, the success of the mode choice model calibration effort hinges to a large degree on the quality of the trip distribution model output by market segment. Care must be taken to ensure that the trip patterns are believable prior to trying to estimate trips by mode.
- **Transit path-finding** – We will take the onboard transit survey and “assign” it to the SJTPO transit network. This task helps to evaluate the reasonableness of the transit path-finding rules (i.e. we will check to see if the model finds the same transit option reported in the survey), and helps identify survey records that should be discarded because they make no sense.



- **Trips by mode, segment and geography** – The model choice model will be calibrated to reasonably closely reflect observed trip patterns found in survey data. It makes sense to document this check and discuss cases where the calibration process worked particularly well vs. cases where it didn't necessarily. This comparison includes comparisons for motorized and non-motorized modes (data permitting).
- **Comparison to observed counts** – Transit boardings by route and managed lane or toll road volumes from the model will be compared to observed data as an indicator of mode choice model performance.

Highway Assignment Checks

The validation tests for highway assignment comprise of systemwide, corridor and link-specific checks. The validation statistics would be compared with the targets specified in FHWA's 'Model Validation and Reasonableness Checking Manual – 1997'. The following checks would be performed as part of the validation of the highway assignment model; comparisons with validation summaries from the previous model would also be performed.

Link Volumes by Volume Groups

The model-estimated link volumes would be compared against the observed traffic counts by volume groups. Estimated to observe ratios would be computed for each of these volume groups.

Link Volumes by Facility Type and Area Type

The model-estimated link volumes would be compared against the observed traffic counts by facility type and by area type cross-tabulations. Estimated to observed ratios would be computed for each of these volume groups.

Link Volumes by Screenlines and Cutlines

The estimated link volumes would be compared against the observed traffic counts by screenline. The maximum desirable deviation in total screenline volumes cited in FHWA's 'Calibration and Adjustment of System Planning Models' would be referenced for this validation check.

Link Volumes – R-squared and Percent RMSE

The link volumes would also be compared against the counts using statistics such as the coefficient of determination (R-squared) and the percent root-mean-squared error. A scatter plot of the volumes vs. the counts would also be developed for visual examination.

Vehicle Miles Traveled (VMT) by Facility Type and Area Type

The estimated VMT would be compared with the observed VMT obtained from Highway Performance Monitoring System (HPMS) data if available. This check would be performed by facility type and area type. Estimated to observed ratios and root-mean-squared errors would be computed for each of these categories.

Speed by Segment and by Facility Type/Area Type



If observed speeds are available from travel time field runs, the model-estimated speeds by segment can be compared with observed values. The speed comparisons can also be done by facility type and area type for which minimum, maximum and average speeds can be estimated.

Transit Assignment Checks

Several validation checks can be performed for the transit assignment step based on availability of data from on-board surveys and data from transit operators. The following checks would be performed for this step; comparisons with validation summaries from the previous model would also be performed.

Ridership Comparisons

The estimated vs. observed ridership would be compared by route, mode, company and region.

Boardings/Alightings

The estimated vs. observed boarding's and alighting would be compared by station for major stations, based on availability of data.

Runtime Comparisons

The model estimated route time vs. runtime from official schedule would be compared by route.

Transfers per Trip

The estimated vs. observed transfers per trip would be compared at the system level.

Feedback Loop Checks & Overall Model Validation

The model-estimated speeds at the end of the highway assignment step in the last feedback loop would be compared with the speeds input to the trip distribution step and checked for a close match. URS will perform a detail validation check for the entire model chain and confirm that model outputs are within acceptable errors in accordance with the standards for regional transportation models. URS will summarize the results of model validation for SJTDM along with the acceptable standards and where possible also include validation statistics from other regional models in the nearby MPOs (DVRPC & NJTPA).

Task Deliverables:

1. Draft and Final Model Validation Reports

TASK II.C MODEL TRAINING

During the model improvements and enhancements work, URS Team will develop a series of technical documentation and provide to SJTPO for review and comments. It is also anticipated that SJTPO staff will be provided with detailed descriptions important model specifications and process for review and approval prior to implementation. The entire process will be collaboration between URS Team and SJTPO staff and peer reviewer. This will ensure that SJTPO staff understands the very essence of every enhancements to the SJTDM processes. URS staff will meet SJTPO staff on regular basis especially after submission of technical memorandum of each major model enhancements and present the process and new results.



However, at the conclusion of major enhancements to model, URS Team will conduct training of SJTPO and subregion staff on model improvements, functionality and its application to typical uses of the model by SJTPO staff. We recommend that the final training sessions be a two-day event. The morning of the first would be devoted to high-level review of model enhancements and improvements and its working under CUBE/Voyager and may be suited for non-technical and technical audience. The second half of the first day would provide detail technical information on the new functionality of the model and compare the results with previous version of the model. This session would be targeted to planners familiar with existing SJTDM. The second day will provide hands-on training on typical application such as implementation of alternative set of demographic projects such as center-based growth scenario, and addition of new infrastructure improvements such as Rt. 55 extension to shore or widening of the Garden State Parkway. The two-day training would also allow ample time allotted for questions and answer which is critical for adopting new model.

A new expanded User's Guide will be provided so that SJTPO and subregional planners can run the new model and interpret the model results without consultant's assistance. This would be important during the development of the next regional transportation plan.

Task Deliverables:

1. Model User's Guide
2. Two-day training and presentation materials.

* indicates work to be deferred until Fall 2010
contract modification

**FY 2011-2012 SJTDM Improvements
Cost Estimate - Summary by Task by Firm**

Task Description	URS	WGI	RSG	TQ	TOTAL
Task I.A: Model Migration, Installation and Training	\$ 33,649	\$ 36,980	\$ 2,480	\$ -	\$ 73,089
Task I.B: Traffic Data Collection *	\$ 2,724	\$ -	\$ -	\$ 32,534	\$ 35,259
Task II.A: Model Enhancements and Improvements	\$ 133,559	\$ 35,256	\$ 85,440	\$ 20,231	\$ 274,486
Task II.B: Base Year Model Calibration and Validation	\$ 41,397	\$ 42,627	\$ 8,672	\$ 15,240	\$ 66,536
Task II.C: Model Training and Documentation	\$ 17,150	\$ 5,544	\$ 2,160	\$ -	\$ 24,854
Project Management and Quality Assurance	\$ 15,347	\$ 3,520	\$ 3,680	\$ -	\$ 22,547
TOTAL LABOR COST	\$ 245,856	\$ 89,952	\$ 109,000	\$ 52,766	\$ 497,574
EXPENSES	\$ 2,400	\$ 750	\$ 2,200	\$ 38,225	\$ 43,575
URS Team Total	\$ 247,456	\$ 90,702	\$ 111,200	\$ 90,991	\$ 540,349
	229,076	85,158	109,040		514,265
Percent of Fee by Firm	45.8%	16.8%	20.8%	16.8%	100.0%

* For ATR costs is included as expense, for a detailed breakdown by Item, please refer to TechniQuest cost estimate.