Cochise County and Sierra Vista
QRS-II Model Update
ADOT MPD Task Assignment 12-09

PROJECT WORK PLAN

Background Information

Model Dataset

The model dataset to be developed will be easy to update and will contain the key parameters and data used for current and future travel demand modeling and environmental justice analysis. The model dataset will consist of two components.

The first component would primarily consist of traffic analysis zone (TAZ) level data such as population, dwelling units, retail or non-retail employment plus data related to special generators. Sources for this dataset include local data, the US Census, the Arizona statewide model, the existing Sierra Vista QRS-II model, and national databases such as the freight analysis framework, Transearch plus Woods and Poole.

The second component of the model dataset is a network file that contains detailed information on all the model highways and streets. Typical data included in that file include roadway identification information, travel speed, average daily traffic count data, functional classification of the link, and many other pertinent items.

Model Structure

The old Sierra Vista travel demand model was developed as a typical small urban area model. However, it would not be prudent to develop the new Cochise County-Sierra Vista (CCSV) QRS-II travel demand model as a typical urban area model. Because it is countywide, the new model will include a number of smaller urbanized areas (Benson, Bisbee, Douglas, Huachuca City, Tombstone and Wilcox), as well as significant rural population. Furthermore, a significant amount of auto and truck travel on highways within Cochise County begins and/or ends outside of Cochise County -- in an adjoining county, state or in Mexico.

Traditional urban trip generation, distribution and assignment procedures can certainly be used for the Sierra Vista area, but specialized data and modeling procedures will be needed to adequately address the unique trip purposes, generation, distribution, and traffic assignment characteristics associated with rural, intercity, intercounty, interstate plus international auto and truck travel.

For example, special purposes, trip generation and distribution procedures are required for:

- Long distance work commute trips within Cochise County and between surrounding counties
- For tourist travel into and within Cochise County
- For international auto and truck travel

WSA will take into account the data sources that are needed to model these unique trip purposes. For example:

- PAG's recently completed external travel survey could provide very useful information on the magnitude of travel between Cochise and Pima Counties
- Census journey-to-work data, while somewhat dated, can be used to quantify intercounty and interstate work commute patterns
- The American Community Survey and National Household Travel Survey data can be used to estimate longer distance tourist, business and other travel
- Transearch and Freight Analysis Framework (FAF) data can be used to estimate existing and future interstate, as well as inter- and intra-county freight movements
- Data from WSA's Statewide Multimodal Freight Study recently completed for ADOT can be used to estimate goods and freight movements through the county
- GSA's Border Wizard data can be used to quantify international travel through the US-Mexico Ports of Entry

Environmental Justice (EJ)

To enhance the ability of the QRS-II model to provide Title VI and EJ analysis capabilities for Cochise County and Sierra Vista (i.e., the study area), the approach to creating the model can enhance the ability to assess whether EJ communities are disproportionately impacted by planned or future transportation projects in the study area. When identifying the spatial distribution and concentration levels of potentially impacted population groups within the study area, care must be taken so that the course scale of TAZ's do not overlook EJ population groups that live within smaller geographic areas. A more complete spatial distribution of the EJ communities can be obtained at the block group and block levels, thus these scales are considered more appropriate to properly assess EJ concerns. This is important when it is anticipated that project impacts are not uniformly distributed over the study area.

To identify concentrations of EJ populations, this study will use US census data, spatial autocorrelation measures, and Geographic Information System (GIS) modeling to both categorize EJ populations by concentration levels and to define zones as a function of EJ concentration levels. Zones with no/low, medium, high, and extremely high concentrations of EJ populations can thus be defined within the study area. Finally, the outcome map showing the spatial concentration of EJ communities within the study area of Cochise County can be used by ADOT and the local governments to focus their community outreach efforts.

Administration

A technical advisory committee (TAC) has been established that includes the following agencies:

- City of Sierra Vista
- Cochise County
- Southeastern Arizona Association of Governments
- Arizona DOT – Multimodal Planning Division, Safford District and Tucson District Traffic Engineering
- Cochise College
- Cochise County jurisdictions (likely Benson, Bisbee and Douglas)

WSA will establish and maintain a close working relationship with the TAC since the expectation is for the county to take ownership of the model and model dataset at the end of the project. Working papers will be generated at each step to document the project work effort, findings and recommendations. Meetings with the TAC will be held near the end of each primary project phase to review and discuss the draft working paper and to get input on finalizing the working paper to ensure that the modeling products reflect what is expected from the consultant. Monthly meetings will be held as necessary with ADOT's project manager and representatives from Cochise County and the City of Sierra Vista.

Because the CCSV travel demand model will not be a traditional urban area model, using a design-build approach will provide the best result. Task 1 focuses on *designing* the new CCSV Model, while Tasks 2 through 7 focus on *building* the new CCSV model.

Task 1: Refine the Work Plan

When developing a model for a region as diverse and complex as Cochise County, it is crucial to spend time at the outset designing the model. Based on the review of available local, state, national, and commercial data, a technical memorandum is to be developed that will outline the model architecture for the Cochise County-Sierra Vista travel demand model and a work plan and schedule for implementing and applying the model. The work plan will address each model component including trip generation, trip distribution, external and truck models, integration with international and national freight, and traffic assignment procedures. In addition, a validation plan will be presented and will include proposed criteria for each model step based on the TMIP Model Reasonableness Guidelines.

The actual model structure will be developed as part of this task. However, some of the key model components that will be considered, and various issues that will need to be decided upon, in consultation with TAC, include the following:

- Trip Purpose Taxonomy – The trip purposes included in the model will include the traditional types: home based work, home based other, and non-home based. Other purposes that should be considered include longer distance intercity commuter, tourist, business, and non-business trips
- Household Disaggregation – The household data at the zonal level can be disaggregated into distributions of size (household size, workers per household, etc.) and wealth (income or vehicle ownership)
- Trip Distribution Models – Traditional gravity models will be used for trip distribution; however, special treatment may be required when gravity models are used in areas having multiple urban centers like Cochise County
- Truck Modes – The treatment of commercial vehicles in Cochise County is quite important and must be considered
- Environmental Justice – Data and procedures are to be determined for Title VI Environmental Justice impact analysis

Deliverable

- *Technical Memorandum 1: Cochise County Travel Demand Model Work Plan.* This document will include a description of the model structure including folder structures, input and output files, flow chart, review of available data, additional data needs, a detailed work program, and a schedule for model completion and application

Task 2: Update Existing QRS-II Model and Build Model Capacity

WSA has purchased and provided three licenses for the 500 zone versions of QRS-II and Advanced GNE. The number and size of the licenses may change as the result of the Task 1 model design and work plan refinement.

QRS-II is a toolbox that contains specialized software tools that an experienced modeler can use to create a travel demand model for an area like Cochise County. Once created, less experienced staff can be trained to run the model and effectively interpret the results. To be effective, the staff using the model will require a good understanding of:

- The theory behind travel demand modeling
- How to use QRS-II and Advanced GNE software tools
- The CCSV travel demand model inputs and process
- How to check and interpret model results

The objective of Task 2 is to provide stakeholder staff with the knowledge required to maintain and run the model and interpret and use the results. The most effective way to accomplish the training is to break it into 2 phases:

Phase 1: Dr. Alan Horowitz, the developer of the QRS-II software, will conduct a three day session covering the theory behind travel demand modeling and how to use the QRS-II and GNE software to do travel demand modeling. Phase 1 would be conducted using datasets and models specifically developed by Dr. Horowitz for training purposes. Following the Phase 1 training session, attendees would be given four to six weeks to practice and assimilate the lessons before beginning the Phase 2 training.

Phase 2: Tom Cooney, the architect of the new CCSV travel demand model, will conduct a two to three day advanced training session covering the CCSV travel demand model inputs and processes and also how to check and interpret the model results. The Phase 2 training would be conducted near the end of the project.

There are a number of ways the training could be structured, and these will be discussed during the course of Task 1. However, the approach proposed by WSA has worked well on previous projects.

Deliverables

- QRS-II software and documentation
- QRS-II training materials
- CCSV travel demand model users guide

Task 3: Develop and Update Modeling Datasets

This task will include the development of the model datasets required for the model including zones, network and socioeconomic inputs. The second component of this task is the collection of available data to support the model development.

WSA will obtain all of the necessary data and any previous studies for the model development including:

- Existing Sierra Vista QRS-II mode
- Arizona statewide model
- Planning studies
- Mapping, especially GIS maps from the state, county and cities
- Aerial photographs
- Traffic counts including all available count data obtained from ADOT, Cochise County and the cities. If additional data is needed, a request will be made early in the project in order to give time for counts to be made
- Socio-economic data
- Network data
- External station data, especially at the border crossing
- Truck data
- Transit data

Traffic Analysis Zone (TAZ's) Geographic File

TAZ's are the basic building block of all travel demand models, and thus require special care when a new model is being developed. As a starting point, WSA will review the existing TAZ's that are in the Sierra Vista model. WSA will develop a recommended zonal system based on the following criteria:

- Maintaining consistency with the Sierra Vista zone structure
- Higher levels of detail in populated areas of the county
- Zonal boundaries are consistent with political jurisdictions
- Zonal boundaries are consistent with census geography including census blocks, block groups and tracts
- Zonal boundaries will conform to good practice with respect to network and geographic barriers
- Zonal boundaries that consider EJ factors

A new zonal structure will be created based on the criteria above and the changes will be documented. A useful feature of WSA's zone system is that the numbering system allows for quick reference to the location of the zone or association to a larger zone system. Example applications include the identification of political jurisdictions.

Traffic Analysis Zone (TAZ's) Socioeconomic Dataset

Once TAZ's have been developed and approved by the TAC, WSA will develop socioeconomic datasets for the base year and required forecast years. The final list of demographic variables will be determined in Task 1, but will almost certainly include:

- Occupied households
- Population in households
- Total employment
- Retail and non-retail employment

Base year estimates will be developed from 2000 census data and forecasted up to the new base year considering county level control totals for each variable. One means of developing future year forecasts of population and employment is to use a commercial database such as Woods and Poole, which is frequently used as a source for this type of data. Other means of forecasting socio-economic data will be reviewed and used if practical. WSA will solicit input from the TAC in identifying and using these data.

Model Network

Highway network development would begin by extracting the Cochise County highway networks from the ADOT statewide model, as well as available Cochise County and city GIS files. Street maps, aerial photographs and other databases would be referenced in order to add other existing roads and relevant roadway attributes. Additional information may be obtained from field surveys. This information would establish a baseline condition for the network. Roadway network density requirements will be based on an evaluation of roadway network topology to ensure realistic traffic loading patterns.

Possible network attributes will include functional classifications, capacity per lane, and free flow operating speeds. However, link-based adjustment attributes will be added to account for variations in speed, capacity and volume-delay functions. This will allow for adjustments based on lower speed limits, higher density of traffic signals, influence of stop controlled intersections, or other geometric constraints. Upon completion, the highway network will have fully populated attribute fields to conduct a capacity constrained traffic assignment.

After completion of the baseline network, a database of planned network improvements will be added. This database will identify a description of each project, and the expected year in which the project will be completed.

Deliverables

- *Technical Memorandum 2: Cochise County Travel Demand Model Dataset.* This document will document the development of the TDM data set
- GIS file containing traffic analysis zones without the socioeconomic data
- GIS file containing traffic analysis zones populated with socioeconomic data for the base year and the two forecast years
- GIS file containing the roadway network and attributes used to run the model
- WSA will present the results of the model dataset to the TAC

Task 4: Calibrate the QRS-II Model for County Wide Results

This task includes performing trip generation and trip distribution for the traditional internal home based work, home based other, and non-home based trips. It also includes implementation of model procedures for special generators (i.e. Fort Huachuca, the Mexican Ports-of-Entries, etc.), external travel, truck travel, and other special trip purposes such as longer distance tourist and business travel. Lastly, it includes the trip assignment processes for all trip purposes.

Internal Trip Generation

The attribute data for internal trip generation was developed in Task 3 under the TAZ's. The starting point for trip generation rates could come from the rate tables used for the statewide model. Incorporation of special generators would be the next enhancement step. As a minimum, recommended internal trip purposes will include home based work, home based other, and non-home based.

Internal Trip Distribution
Trip distribution model parameters are normally developed through the use of a travel survey. In lieu of a survey, imported parameters (from the National Highway Travel Survey, the Arizona Statewide Model, or other sources) can be used to produce a rational gravity model friction factor distribution for each trip purpose.

During the model development, the team will examine the difference of travel characteristics of trips made internal in the urbanized areas versus those made within the rural area or between the rural and urban areas. It may be necessary to further stratify the trip purposes by geography. Parameters that control the gravity model can then be used as one of the calibration parameters to help achieve base year vehicle miles of travel (VMT) estimates.

External Stations
In addition to relating external link growth to historical count information, the statewide model might also be used to provide estimates of external forecasts, and to provide external to external, internal to external, and external to internal trip tables. This ensures that urban area forecasts are sensitive to completion of statewide projects that could divert external trips to or from a route through the urban area. This also establishes consistency between external urban cordon volumes and statewide model forecasts.

Truck Model
Truck volumes are an important component of the external movements in the county as well as contributing to local movements within the county. The overall model design of the truck model will be to generate truck movements disaggregated by geography and truck type. This disaggregation scheme is based on the difference in attractive characteristics of different vehicle types and the distribution differences for trips of different purposes (local vs. long-haul). Truck movements will be classified into the following types by their geographical origin and destination:

- Through: Movement of trucks that cross through the county but are not consumed or generated
- Imports: Movements of goods consumed in the county or part of a transshipment that is repackaged in the region
- Exports: Movements of goods that are generated in the region
- Local Movements: Localized movements of trucks

Import and export movements of trucks will be generated with the aid of ADOT's Transearch database (and possibly the Arizona statewide model). A seed distribution of flows will be generated specific to Cochise County. The seed trip tables will then be factored to the external truck volumes. The internal end of the import and export trips will be generated using regression models based on zonal employment.

A common approach that will be used for local truck movements is to apply models from "Quick Response Freight Manual" (FHWA, September 1996). Methods in the QRFM are based on surveys conducted in the late 1990s. The parameters recommended provide a good starting point for adjustment based on local conditions.

Traffic Assignment
Since most small urban areas do not have significant congestion, the major issue associated with traffic assignment involves validation of paths and screen lines to ensure good validation against base year counts by resolving path flips. In some cases, preliminary traffic assignments reveal the need to adjust trip distribution friction factor assumptions. The speed and capacity adjustment factors proposed in Task 3 will be used to fine tune path assignment. Otherwise, an equilibrium capacity-constrained assignment is likely to suffice, and other experimental approaches may be considered if there are validation issues.

Deliverables

- *Technical Memorandum 3: Cochise County Calibration Report*
- WSA will present results to the TAC

Task 5: Run and Adjust QRS-II Model

The Model Validation Plan identified in Task 1 will be conducted as part of Task 5. As discussed in Task 1, validation will cover all steps in the model process including the comparison of estimated traffic to observed traffic counts. Comparison of assigned traffic volumes to actual traffic counts is the step that occupies most of the time in model validation. Several different sources of validation criteria exist and can be summarized as:

"There are several system-wide or aggregate validation checks of the auto assignment process. The checks are generally made on daily volumes, but it is prudent to make checks on volumes by time-of-day. System-wide checks include Vehicle Miles of Travel (VMT), Vehicle Hours of Travel (VHT), cordon volume summaries, and screen line summaries. In addition to checking summations of VMT, VHT and volumes, the average VMT and VHT per household and person should be checked (source: Validation Manual, TMIP, 1997, pg. 87)."

Acceptable error and specific measures will be defined in the validation plan. Examples of typical model criteria and standards are discussed in the following paragraphs.

VMT Error by Functional Class

Vehicle miles of travel can be cross classified by several network variables. Example target criteria for VMT by functional class include:

- Freeways: +/- 7%
- Arterials: +/- 10%
- Lower Class: +/- 15%
- Overall: +/- 3%

In practice, +/- 10% error for each area type is used in validation.

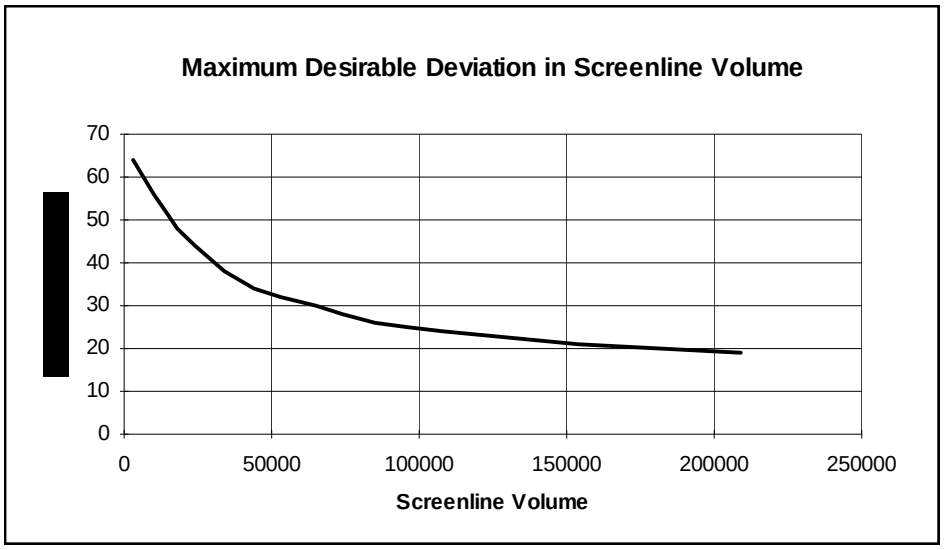
Percent Root Mean Square Error (%RMSE) by Volume Group

Percent Root Mean Square Error is the second evaluation criteria for the traffic assignment validation. Percent RMSE provides a measure of relative error of the assignment as compared to the ground counts, and provides a measure of accuracy. Practice is to calculate the percent RMSE by volume group rather than for all links overall. This rationale is based on the need for higher levels of accuracy for higher volume facilities where large volume errors can misrepresent capacity needs in the future.

Screen Line Allowable Error

The final assignment validation criteria used is an analysis of the screen line error and the maximum desirable error based on volume. Screen lines are made of three types:

- True screen line that crosses entire study area
- Cut line that includes several parallel facilities
- Cordon line that isolates all traffic movements in and out of specific area



The screen lines for the model will be based on a review of available traffic counts and observed traffic patterns in Cochise County. Prior to the validation process, the screen lines will be reviewed with the TAC. The allowable deviation on a screen line, regardless of type, is based on the total count of the screen line per the NCHRP 255 process for checking screen line validation.

Quality Control/Quality Assurance
WSA has a strong commitment to high quality services and professional products. WSA's national practice leader in modeling, Rob Bostrom, will perform this key task. Mr. Bostrom's independent team will make reviews at model dataset and validation stages of the project.

WSA follows FHWA guidelines for model validation and has written an internal manual for making model quality assurance checks.

Deliverables

- *Technical Memorandum 4: Validation Results*. Memorandum will document the results of the validation process including maps and tables were possible to show the model results
- WSA will present the results of the validation process to the TAC

Task 6: Provide Preliminary Assessment and Presentation of Results

This task consists of making model runs for the future year planning scenarios requested by the TAC. A typical scenario would be the recommended long-range transportation plan which would include changes to the existing highway network. These scenarios will be run for both the current year and the two specified future years. The other key component of this task will be to perform the EJ impact analysis as previously described.

Deliverables

- Model runs for any future year scenarios (such as the recommended long-range transportation plan projects) requested by the TAC. These results will be formally presented to the TAC.

Task 7: Finalize and Deliver Calibrated QRS-II Model with Data and Maps

This task concludes the modeling work. The calibrated QRS-II model, along with maps showing the results, will be delivered to ADOT, the county and the city. These maps will include the EJ analysis.

Deliverables

- The final QRS-II model along with GIS shape files for both the network and the traffic analysis zones. The network will contain the model run for the base year and the two future years (2020 and 2040) for the existing model network and any needed model scenarios.

*** End of Project Work Plan ***