SUPERSTITION VISTAS TRANSPORTATION PLANNING WHITE PAPER
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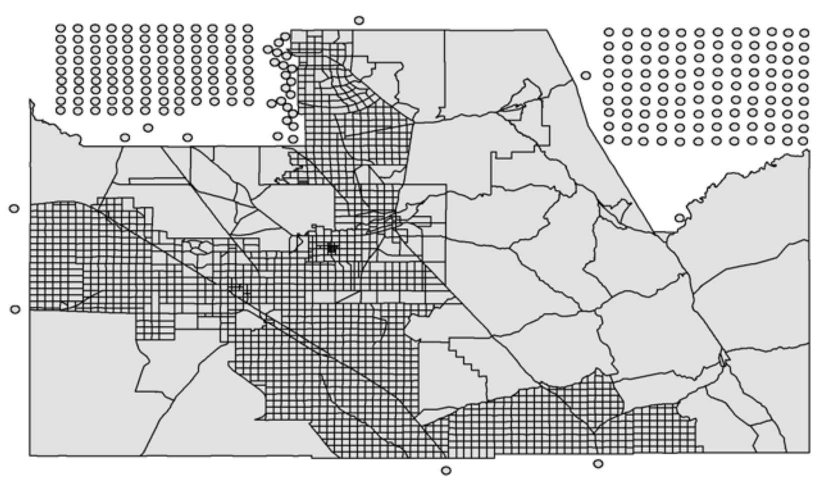
The Superstition Vistas planning team developed three alternative community growth and transportation options to evaluate different ways the Superstition Vistas area in Pinal County could accommodate future population and job growth. One key variable used to evaluate the options is the modeling of travel behavior. This technical white paper provides a general overview of the transportation modeling performed for the Superstition Vistas community growth and transportation options including an overview of transportation modeling, key model refinements, and results of the modeling process.

INTRODUCTION TO TRANSPORTATION MODELING

Engineers and planners employ the use of transportation models to help estimate the travel behavior of future residents. This includes how much traffic will be on their roadways, how many people will ride public transit, and how many people will walk or bike. Models come in many scales, from citywide models, County Models, Metropolitan Planning Organization (MPO) area models, to statewide models. Each model helps plan for the future transportation needs of residents. For Superstition Vistas area the Pinal County model was used. This model contains many planned transportation projects both funded and unfunded. The Pinal County model focuses on automobile travel connecting employment and housing center together throughout the county. However, this does not address to two major challenges: capturing localized non-auto trips and estimating regional public transportation travel.

The following map illustrates the original transportation analysis zones (TAZ) used within the Pinal County model. While comprehensive at the statewide scale, these zones do not provide the level of detail necessary to assess the localized impacts of different land uses. In addition, the Pinal County model does not provide the ability to model regional public transportation investments. This omission is understandable as there are no regional public transit investments in Pinal County.

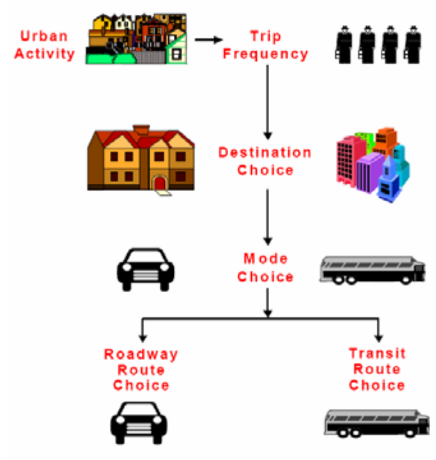


The Pinal County Model was modified to add sensitivity to non-automobile travel behavior. These refinements include:

- Addition of smaller transportation analysis zones (TAZ) within the Superstition Vistas area.
- Addition of a gridded roadway network into the Superstition Vistas area.
- Incorporating relationships between land use density and localized travel behavior.
- Integrating assumptions about regional public transportation capture.

These enhancements were added to the model incorporating local trip pattern and mode behavior and using national research to validate assumptions.

TRANSPORTATION MODELING METHODOLOGY



The methodology used for the modeling of Growth and Transportation Options makes use of the Pinal County Travel Demand Model. In the simplest terms, the model turns people and employees into trips, finds their origin and destination and assigns them a path to complete their trip. The model calculates all daily trips through three major trip types: Home Based Work, Home Based Other, and Non Home Based.

The modeling allows planners and engineers to estimate current and also future traffic demands. The refined model provides for the ability to compare how changes to land use and demographics will impact the local and regional transportation network and allows us to test transportation and land use ideas.

The transportation model produces a mathematical representation of an individual's decision-making process:

Why make a trip → When to make the trip → Where to make the trip → How to make the trip → What route to follow to complete the trip.

These individual choices combine so that aggregate impacts can be assessed. The aggregate impacts help determine what future transportation needs might be. The Superstition Vistas team used the transportation model to determine appropriate transportation networks for each community growth scenario. The planning team developed unique demographic, economic, alternative mode assumptions to estimate the future travel demand for each scenario.

The Pinal County transportation model includes a series of mathematical models that simulate travel on the transportation system. This macroscopic process encompasses the four primary steps taken to estimate travel demand from a given land use and transportation network. The four steps in this approach are as follows:

> *Trip Generation* – the estimation of the number of trip-ends for each zone.
>
> *Trip Distribution* – the estimation of the number of trips between each zone pair.
>
> *Modal Split* – the prediction of the number of trips made by each mode of transportation between each zone pair.
>
> *Traffic Assignment* – the amount of travel (or number of trips) that is loaded onto the transportation network through path-building and is used to determine network performance.

A Non Traditional Modeling Approach

Within the Superstition Vistas effort three growth scenarios types were generated, Land Use scenarios and a Transportation Scenario to accompany. All were generated with help from our steering committees. Specific evaluations and results of the scenario process will be given in the following paragraphs; however we would like to provide an overview of how the evaluations were completed.

Testing demographic and transportation scenarios

Within the context of the Superstition Vistas Vision various demographic scenarios were run through the transportation model to estimate future traffic demands. These scenarios contained population, households, and employment which was input directly into the models zones. Zones are geographic areas that contain houses and jobs. The model then converts houses and jobs into trips and then places the trips onto the transportation system connecting them together. Many indicators were developed to evaluate each scenario (which is described in the following section).

Transit Capability and Mode Choice

One of the areas of the Pinal County Model that were expanded on was person trip movement. It is important to note that this process was used as a scenario planning tool. Within the model, formulas were applied to simulate a multi-modal model. These formulas helped to predict the percentage of auto, transit trips, walk and internal trips within the study area. This process is known as the five D process. The five Ds, Density, Diversity, Design, Distance, and Destinations are based on over 50 national case studies completed by MPOs, COGs, and Federal agencies looking at the effect the five Ds have with person trip movement. Specifically, a majority of these case studies are being aggregated in the NCHRP Report 08-61 "Travel Demand Forecasting: Parameters and Techniques." In the five D mode choice, each factor affects ridership based on elasticity factors. These factors are then used in a skim or travel time matrix to determine an estimated ridership. The process was developed as an additional layer to the person to vehicle trip conversion factor that exists within the travel demand model. Vehicle occupancy rates were maintained. The five D process to determine transit potential relied on the following major factors:

Distance/Destinations

After each scenario was run through the model, predicted travel times were obtained and used to generate trip tables of travel times (often called skims). These skims were used as input into a mode choice routine and compared with transit travel times. These travel times were used to evaluate the likelihood that individuals will select transit over a vehicle based on the total travel time of the trip. The image below shows how the mode choice model script incorporates the elements of the TDM into the process. Notice that the model includes the TDM Network, TAZ information, transit stop locations, and person trip table inputs.

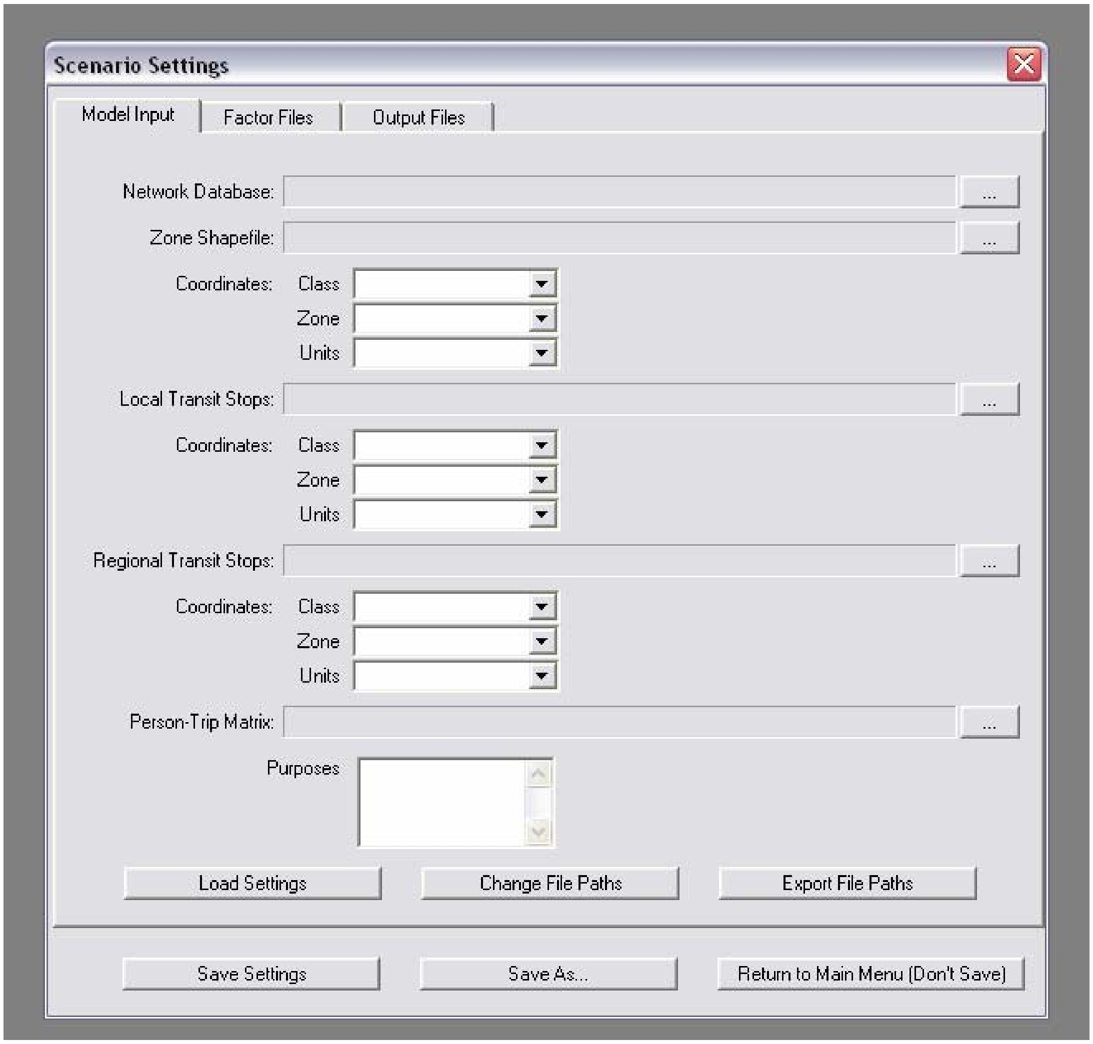
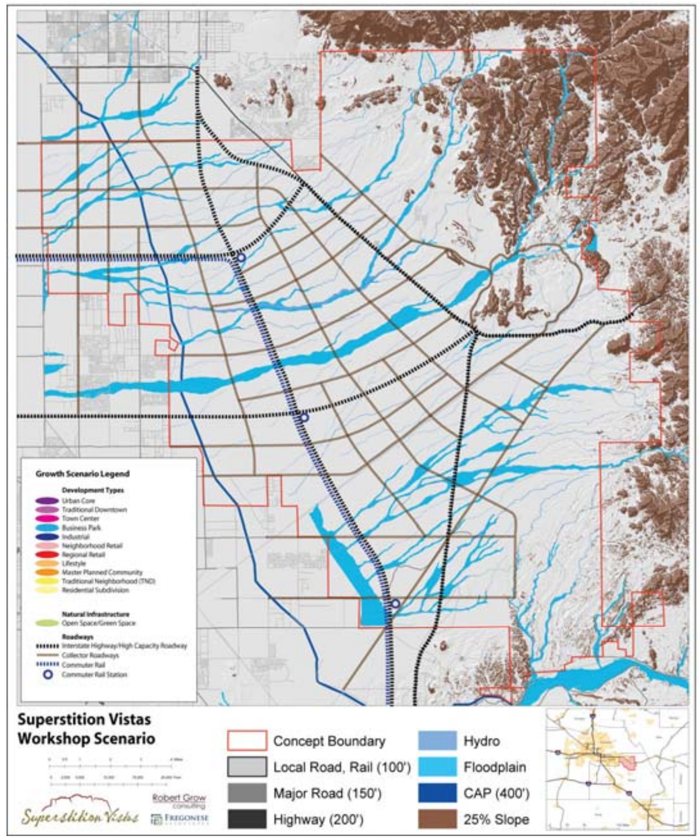


Figure 1: Mode Choice Macro

To develop transit travel times, several transit routes were developed throughout the process and again with internal working groups. These routes as defined, provided the framework for detailed model input, at which time, speeds, headways and costs were input into each route. Travel time tables were again developed for the transit system and used as input into compete against auto travel times.

Density

Each demographic scenario contains household and employment density which plays a major role in the time it takes to get to a transit station. Less dense developments often have fewer streets which translate into less accessible transit stations. The densities in the Superstition Vistas area varied within each scenario. The mode choice model evaluates each zone within the model to estimate the population and employment density. The zones with higher densities have a higher likelihood of capturing pedestrians to either walk or ride transit.



Diversity

The diversity factor looks at the balance of housing and jobs within the vicinity of the traveler. It also looks at demographic inputs such as age, median income, and number of available vehicles per household, to determine if the travelers are more likely to be dependent on transit.

Design

Developments that have a mix of uses within walking or biking distance from each other have the ability to reduce overall auto travel demand and often result in transit trips. On average, a single household generates ten auto trips per day. Of those ten trips only two to four are home to work trips. In walkable, mixed use developments, a percentage of the remaining trips are satisfied by walking or biking. These percentages vary anywhere between 12 to 40 percent. Within the mode choice development intensity/density and Walkable/mixed use developments affect the outputs via set factors based on national and localized data. The following image is a screen shot of the TDM macro that incorporates these factors.

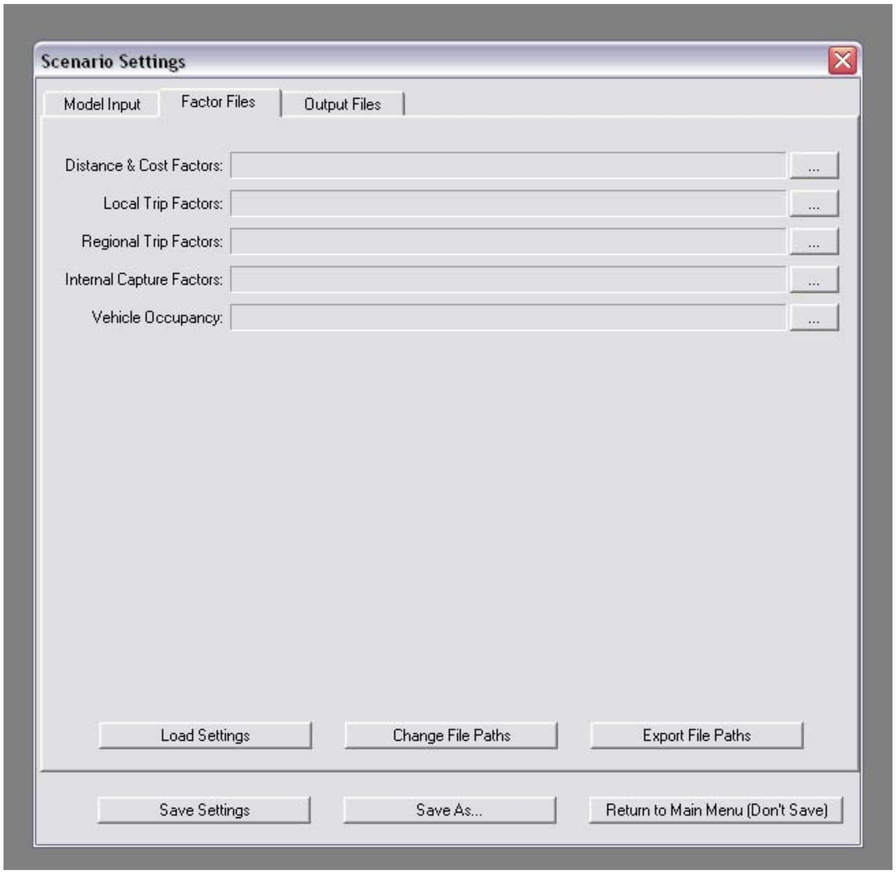
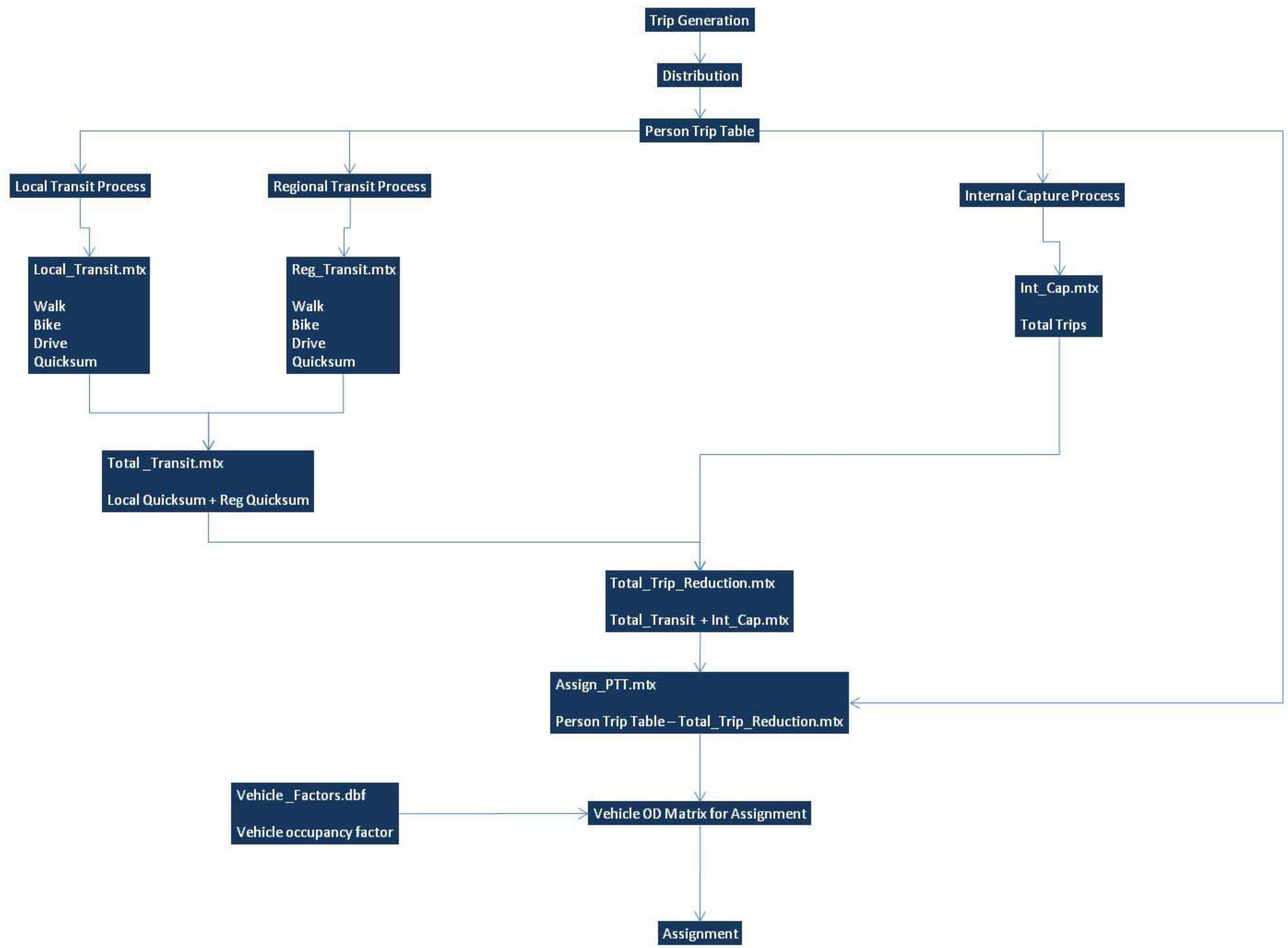


Figure 2: Mode Choice Factor Inputs

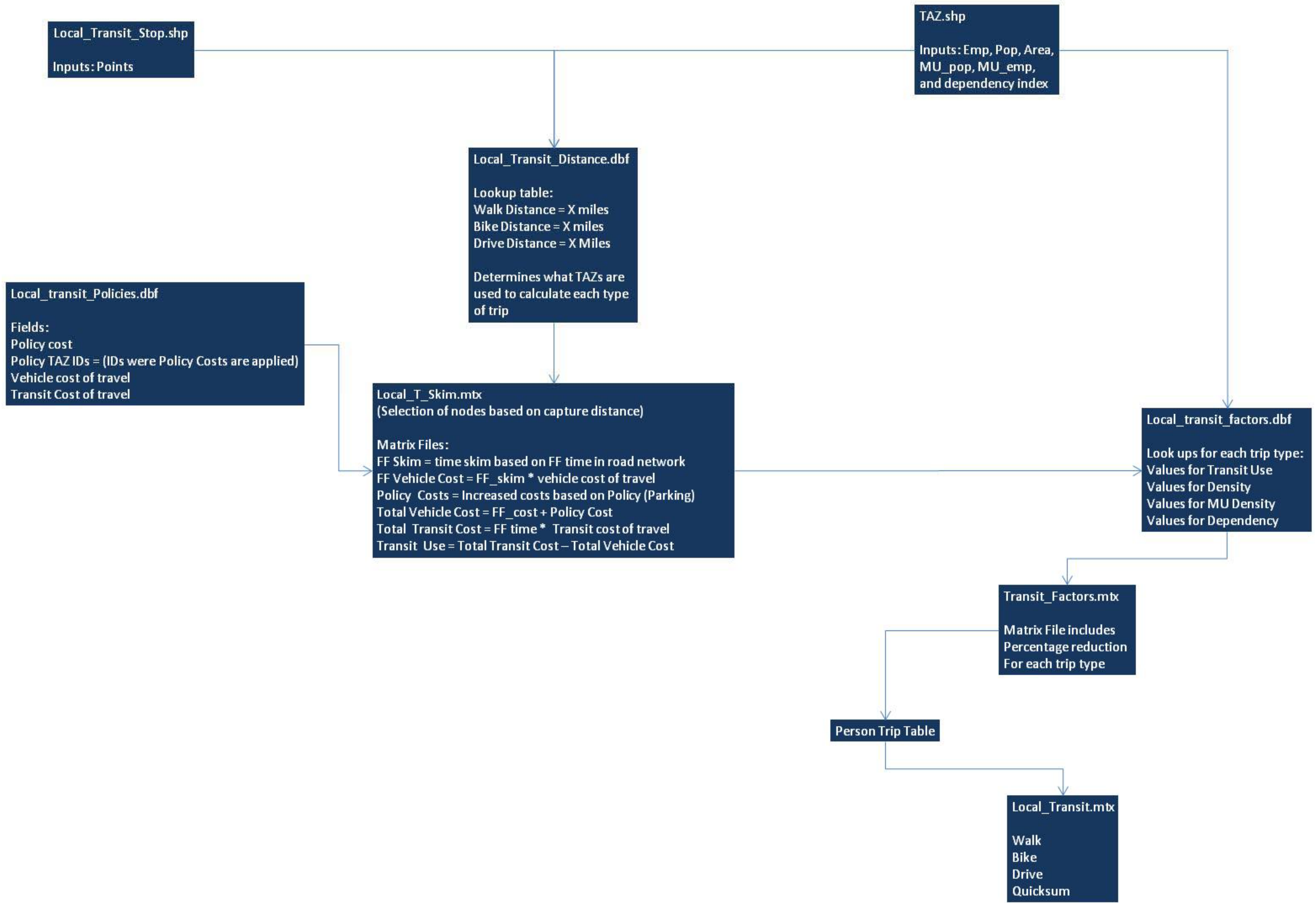
Five D Summary

In each situation, the team relied on ranges developed through national research that compares results observed in regions of similar size to the Phoenix Region. Based on regions of similar size, density, and transit ridership each component of the mode choice was refined to meet expected criteria. The following four pages show a flow chart of exactly how the additional factors are incorporated into the model process. The first page shows the overview of how the process is incorporated into the four step modeling process. While the remaining three pages reflect the how each specific element of the mode choice model works. Again it is important to note that this is a scenario planning tool and that final road projects were evaluated both with and without this mode choice tool. It is important to realize that this five D mode choice model is intended to predict transit, walk and bike trips within a specific land pattern scenario. This process has been used in many areas throughout the Country (Southern Louisiana, Dallas, Tulsa, Michigan, and others). The State of Florida uses a similar process called Aggregate Rail Ridership Program (ARRP) as a means to back check their traditional model choice models. In many cases, the ARRP process derives more realistic ridership numbers which are presented to the Federal Transit Authority (FTA) for agreement. The challenge of the traditional mode choice model within a visioning and scenario process lies in the fact that the current FTA process does not allow for land use to be considered for New Starts transit facilities. At the same time, the vision calls for the creation of mixed use walkable developments with a complementary transportation system.

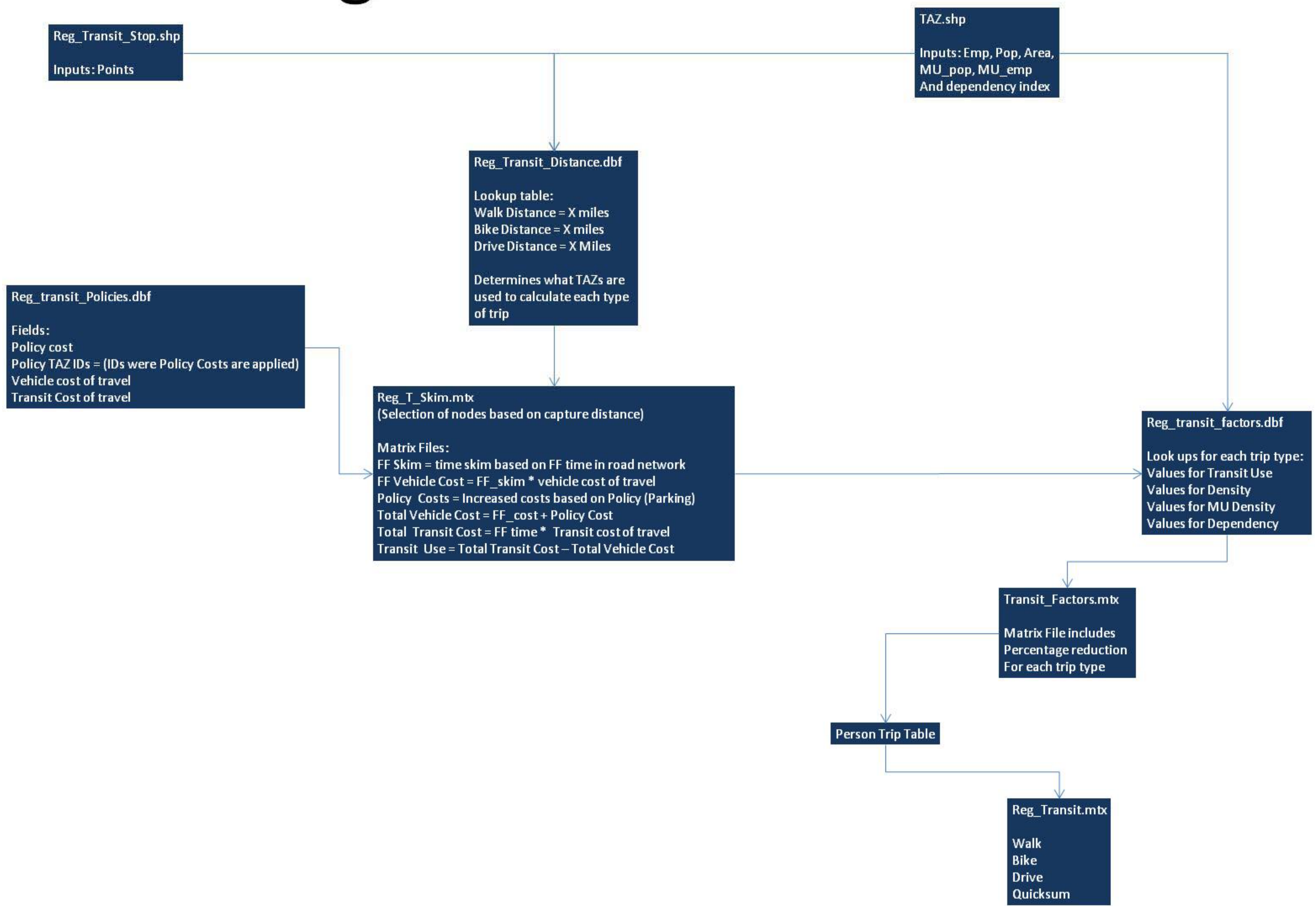
Mode Choice Overview



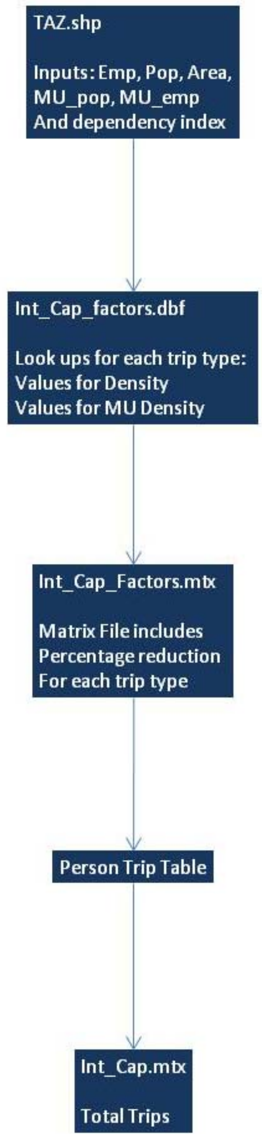
Local Transit Process



Regional Transit Process



Internal Capture Process



Scenario Modeling

Through the planning process four different land use scenarios were developed to measure the benefits derived from each scenario. In response to varying scenarios, the transportation element was developed to marry land use patterns with associated transportation scenarios.

The travel demand model takes the existing conditions and uses future demographic data to predict future scenarios based on the differing trends in land use. By using the Pinal County Travel Demand Model the team tested the consequences of each growth scenario. By using indicators such as vehicle miles traveled (VMT), vehicle hours traveled (VHT) and delay the team predicted future outcomes that may occur in each different scenario. Other indicators that are of particular importance for transportation planning purposes are Value of Time Lost and Gallons of Fuel Wasted Annually and Carbon emissions Produced. The graphs on the right show the changes between the different scenarios. Notice how as the scenarios move from A to D the Time Lost, Fuel Wasted and Additional Lane Miles Required decreases. This identifies that our land use and development patterns have a clear effect on the transportation systems, both their function and cost. These examples do not necessarily determine that scenario D is the best option for the Superstition Vistas Area, but they are merely indicators on different development choices and the resulting cost associated. The following table demonstrates the transportation indicators for each scenario.

Scenario			Scenario A	Scenario B	Scenario C	Scenario D
Model with D's Processing	VMT		16,500,000	11,800,000	11,700,000	9,100,000
	per capita (miles)		8	12	12	9
	VHT		960,000	420,000	340,000	250,000
	per capita (Hours)		0.5	0.4	0.3	0.3
	Delay		640,632	164,000	114,000	79,000
	per capita (Hours)		0.3	0.2	0.1	0.1
	Local Transit Ridership		32,175	197,340	213,070	217,360
		Walked to Transit	24,131	148,005	159,803	163,020
		Bike to Transit	1,609	19,734	21,307	21,736
		Drive to Transit	6,435	29,601	31,961	32,604
	Regional Transit Ridership		26,325	161,460	174,330	177,840
		Walked to Transit	11,846	72,657	78,449	80,028
		Bike to Transit	1,316	16,146	17,433	17,784
		Drive to	13,163	72,657	78,449	80,028
	Total Transit Ridership		58,500	358,800	387,400	395,200
	Walk/Bike Trips		970,000	1,620,000	1,770,000	1,830,000
	Vehicle Trips		8,170,000	7,730,000	7,620,000	7,580,000
	Value of Time Lost (per year)		$ 4,500,000,000	$ 1,200,000,000	$ 800,000,000	$ 600,000,000
	Gallons of Fuel Wasted Annually		140,000,000	36,000,000	25,000,000	17,000,000
	Air Quality (per year)					
		NoX(tons)	9,958	7,121	7,061	5,492
		CO2(tons)	2,409,000	1,722,800	1,708,200	1,328,600
		VOC(tons)	11,950	8,546	8,473	6,590