The following documentation is excerpted from *National Travel Time Analysis: Adjusting for Population Density and type of Road to Determine Time-based Service Networks for VHA Sites* (VHA Planning Systems Support Group, field unit for VHA Office of Policy and Planning, Sept. 2002). It is modified as appropriate to reflect methods used by the VSSC once travel time data were obtained from the VHA Planning Systems Support Group.

OBJECTIVE

To determine the numbers of actual and projected enrollees that are within defined travel time parameters for primary care, hospital care and tertiary care after adjusting for differences in population density and types of roads.

METHODOLOGY

FACTORS IMPACTING TRAVEL TIME

There are several factors that impact travel time most of which cannot be controlled for in a national analysis. Factors such as road conditions, number of lanes, seasonal changes are all factors that are not measurable or easily defined for use in this type of national analysis. Other factors that impact travel time are population density and types of roads. These factors can be derived to more appropriately adjust travel times.

DERIVING POPULATION DENSITY

To adjust the road network to reflect changes in population density, the 2002 Census total population by Census tract was used. Using a mixture of established standards and local knowledge, five separate ranges were established.

1) High Urban: 3,000 or more people per square mile
2) Urban[1]: 1,000 to 2,999 people per square mile
3) Transitional Urban: 100-999 people per square mile
4) Rural: 7-99 people per square mile
5) Frontier or High Rural[2]: 1-6 people per square mile.

[1] The U.S. Census Bureau classifies as urban all territory, population, and housing units located within urbanized areas (UAs) and urban clusters (UCs). It delineates UA and UC boundaries to encompass densely settled territory, which generally consists of a cluster of one or more block groups or census blocks each of which has a population density of at least 1,000 people per square mile at the time.

[2] "Rural Health in the United States", Ricketts, T. (ed); pp 8-9.

ADJUSTING AVERAGE ROAD SPEEDS BY LOCATIONS AND TYPES OF ROADS

In order to adjust each of the road types used in this analysis, more information was needed in regards to average speeds in different types of population densities and on different types of roads. In the *2002 Urban Mobility Report*[3], references to different size urban areas and average road speeds are provided (see).

Table 1: 2002 Urban Mobility Report Summaries

Urban Area	**Average MPH During Peak Hours**	**Year 2000**
Small Urban Areas	Max of Peak Period Fwy Speed	59
	Max of Peak Period Prin Arterial Speed	32
Medium Urban Areas	Max of Peak Period Fwy Speed	56
	Max of Peak Period Prin Arterial Speed	32
Large Urban Areas	Max of Peak Period Fwy Speed	51
	Max of Peak Period Prin Arterial Speed	31
Very Large Urban Areas	Max of Peak Period Fwy Speed	45
	Max of Peak Period Prin Arterial Speed	29
All 75 Urban Areas	Max of Peak Period Fwy Speed	49
	Max of Peak Period Prin Arterial Speed	30
Total Max of Peak Period Fwy Speed		59
Total Max of Peak Period Prin Arterial Speed		32

The four types of urban areas were translated into the three types of urban areas used in this analysis. For the purpose of this report, small urban equals transitional urban; medium and large urban areas equal urban and very large urban equals high urban. Frontier and rural areas in this analysis were assigned the maximum average speed allowed.

[3] Texas Transportation Institute, “2002 Urban Mobility Report”, Texas A&M University, 2002

Using a national average (individual areas could be assigned specific values but time did not allow for this type of analytical specificity), the following assignments were made:

Table 2: Speed Adjustment Factors for Types of Roads in Different Populated Areas

Speed Adjustment Factors for Types of Roads in Different Populated Areas			
		Max MPH	Adj. Factors
Frontier	Primary	65	1.00
	Secondary	55	1.00
	Connecting	45	1.00
Rural	Primary	65	1.00
	Secondary	55	1.00
	Connecting	45	1.00
Transitional Urban	Primary	59	0.91
	Secondary	32	0.58
	Connecting	29	0.64
Urban	Primary	53	0.82
	Secondary	31	0.56
	Connecting	26	0.58
High Urban	Primary	45	0.69
	Secondary	29	0.53
	Connecting	20	0.44

For all ferry crossings, average speed was assigned 10 mph.

DATA SOURCES

The following data sources were used in this analysis:

1) Extract of VA Site Tracking (VAST) data as of August 1st, 2002 (VAST07262002 provided by VHA Planning Systems Support Group). This extract included the multiple provider sites geocoded to the ZIP code level.
2) Census 2000 total population at the tract level.
3) Census 2000 tract polygon files used to derive population per square mile.
4) Major roads network as provided to ESRI by GDT. This data set was provided free and includes all interstates, freeways, primary, secondary, and connecting roads as well as all ferry routes (see Appendix A on page A-1 for types of roads included by Census Feature Class Codes). Transportation network for Puerto Rico data were not available for this analysis but substitute data for Puerto Rico is forth coming.
5) Geocoded Veteran enrollee data as provided to CONDOR/Milliman, USA for actuarial projections aggregated to the ZIP code level. 39,141 ZIP codes representing 6,534,309 enrollees in the continental United States, Alaska, Hawaii and Puerto Rico were included in this analysis.
6) ZIP code database (ZIP042002 provide by VHA Planning Systems Support Group) that includes current and historical ZIP code population weighted centroids based upon residential postal deliveries.
7) ZIPInfo ZIP code-county FIPS code database
8) ZIPInfo ZIP code lookup for latitude and longitude (for rare occasions when latitude and longitude were incorrect or missing in other data sets for a particular ZIP code)
9) USPS ZIP code-city lookups (for occasions when a ZIP code for a given facility was suspect)
10) MapPoint 2000 (Microsoft) transportation network, for QA purposes.

SOFTWARE USED

The majority of this analysis was involved with creating the initial data sets formatted for use in a GIS environment. Once these geographic entities are created, much of the analysis will not take a significant amount of time nor need all of the software listed here. The following software packages were used in this analysis:

1) ESRI ArcView 3.2, for geographic information presentation/analysis
2) ESRI Spatial Analyst, for geographic information presentation/analysis
3) ESRI Network Analyst, for determining transportation network
4) ESRI ArcGIS 8.2, for geographic information presentation/analysis
5) ESRI ArcInfo, for geographic information presentation/analysis
6) Microsoft MapPoint 2000 (for QA of travel-time polygons)
7) SAS, for data analysis and summarization
8) Microsoft Excel, for presentation
9) Crystal Decisions Crystal Reports, for presentation

ANALYTICAL PROCESS

Briefly outlined, the following process was used:

1) Using GIS analytical tools, smooth the population density data at the Census tract. This is achieved by using a 0.25 mile grid over laid onto the Census 2000 population. Each cell is assigned the value of the underlying population density. Each cell is then compared to the mean value of all neighboring cells within a five-mile radius and assigned the mean value that is closest to its own value.
2) Derive contours based upon population densities as defined for high rural, rural, transitional urban, urban and high urban.
3) Assign to each road segment within each population density the appropriate travel cost factor according to the type and location of road.
4) Derive travel time service networks for all VHA sites for 30, 60, 90, 120 and 240 minutes travel time[4].
5) Create polygons based upon each of the defined travel time parameters.
6) For each travel time parameter, extract the ZIP codes contained in the associated polygons
7) Match the ZIP codes to the number of enrollees by ZIP code (or ZIP-by-county combination where ZIP codes crossed county lines).
8) Aggregate total number of enrollees within the travel time parameters at the county, market, and VISN levels.
9) For each of the primary care, acute hospital care, and tertiary care standards, compute the percentage of enrollees within the standard at each level of aggregation. For example, the percentage achieving the primary care standard in a certain market would be the number of enrollees living in ZIP codes within the 30 or 60-minute travel-time polygon, divided by the total number of enrollees in that market.

FUTURE IMPROVEMENTS UPON THE PROCESS

The transportation network used in this analysis may not have accurate impedances or connections. More robust data sets are available but time and costs prohibited their use in this analysis. Also, there are datasets available that show where fixed transit systems exist and would allow for the inclusion of subway systems into the analysis. This would be especially helpful for high urban areas. More in-depth analysis of the different types of roads to insure that the appropriate classification is applied according to available mobility studies. The inclusion of certain air travel routes for Alaska and Hawaii would also improve the results for those distinct geographical areas.

APPENDIX A: ROAD TYPE CLASSIFICATIONS

This is a listing of the entire Census Feature Class Codes (FCC) for roads existing nationwide. Some of these were not used due to availability or appropriateness of use in this analysis. Since the Veteran enrollee data was aggregated and represented at the ZIP code level, it seemed irrelevant to use local neighborhood streets for derivi ng service area boundaries. It also increased the amount of computation time for what seemed to be very little benefit. In reviewing the data, the majority of the veterans are well within acceptable ranges of the major roads used in this analysis. Specific numbers are forthcoming on exactly how many enrollees are greater than one mile from any of the roads used in this analysis.

There were 449,517 road segments provided in this data set. Please note that this data does not include non-US roads (e.g., between Alaska and Washington state or Puerto Rico). Other data sets may be available for Puerto Rico or major highways through Canada. Also, there are data sets that provide fixed transit information so that subways could also be included in future analyses.

A1 PRIMARY HIGHWAY WITH LIMITED ACCESS
A10 Primary road with limited access, major category
A11 Primary road with limited access or interstate hwy, unseparated
A12 Primary road with limited access or interstate hwy, unseparated in tunnel
A13 Primary road with limited access or interstate hwy, unseparated underpassing
A14 Primary road with limited access or interstate hwy, unseparated rail line in center
A15 Primary road with limited access or interstate hwy, separated
A16 Primary road with limited access or interstate hwy, separated in tunnel
A17 Primary road with limited access or interstate hwy, separated underpassing
A18 Primary road with limited access or interstate hwy, separated rail line in center
A19 *not used*

A2 PRIMARY ROAD WITHOUT LIMITED ACCESS
A20 Primary Highways without limited access, major category
A21 Primary Highways without limited access, unseparated
A22 Primary Highways without limited access, unseparated in tunnel
A23 Primary Highways without limited access, unseparated underpassing
A24 Primary Highways without limited access, unseparated rail line in center
A25 Primary Highways without limited access, separated
A26 Primary Highways without limited access, separated in tunnel
A27 Primary Highways without limited access, separated underpassing
A28 Primary Highways without limited access, separated rail line in center
A29 *not used*

A3 SECONDARY and CONNECTING ROAD
A0-30 Secondary state and county highways, major category
A31 Secondary state and county highways, unseparated
A32 Secondary state and county highways, unseparated in tunnel
A33 Secondary state and county highways, unseparated underpassing
A34 Secondary state and county highways, unseparated rail line in center
A35 Secondary state and county highways, separated
A36 Secondary state and county highways, separated in tunnel
A37 Secondary state and county highways, separated underpassing
A38 Secondary state and county highways, separated rail line in center
A39 *not used*

A4 LOCAL, NEIGHBORHOOD, and RURAL ROAD5
A40 Local, neighborhood, rural road, city street, major category
A41 Local, neighborhood, rural road, city street, unseparated

A42 Local, neighborhood, rural road, city street, unseparated in tunnel
A43 Local, neighborhood, rural road, city street, unseparated underpassing
A44 Local, neighborhood, rural road, city street, unseparated rail line in center
A45 Local, neighborhood, rural road, city street, separated
A46 Local, neighborhood, rural road, city street, separated in tunnel
A47 Local, neighborhood, rural road, city street, separated underpassing
A48 Local, neighborhood, rural road, city street, separated rail line in center
A49 *not used*

A5 VEHICULAR TRAIL
A50 Vehicular (4WD) Trail, major category
A51 Vehicular (4WD) Trail, unseparated
A52 Vehicular (4WD) Trail, unseparated in tunnel
A53 Vehicular (4WD) Trail, unseparated underpassing
A54-A59 *not used*

A6 ROADS with SPECIAL CHARACTERISTICS
A60 At-grade ramp or connecting road not associated with a limited access highway
A61 Cul-de-Sac, the closed end of a road that forms a loop or turn around
A62 Traffic Circle, the portion of a road or intersection of roads forming a roundabout
A63 Access Ramp, the portion of a road that forms a cloverleaf or limited access interchange
A64 Service Road, provides access to businesses and rest areas
A65 Ferry Crossing, Passenger, Seasonal
A66 Ferry Crossing, Passenger, Year-Round
A67 *not used*
A68 Ferry Crossing, Vehicular, Seasonal
A69 Ferry Crossing, Vehicular, Year-Round
5 Road types that are in grey color were not used in the analysis.

SOURCE:
NATIONAL TRAVEL TIME ANALYSIS: ADJUSTING FOR POPULATION DENSITY AND TYPE OF ROAD TO DETERMINE TIMEBASED SERVICE NETWORKS FOR VHA SITES. VHA PLANNING SYSTEMS SUPPORT GROUP, FIELD UNIT FOR VHA OFFICE OF POLICY & PLANNING.