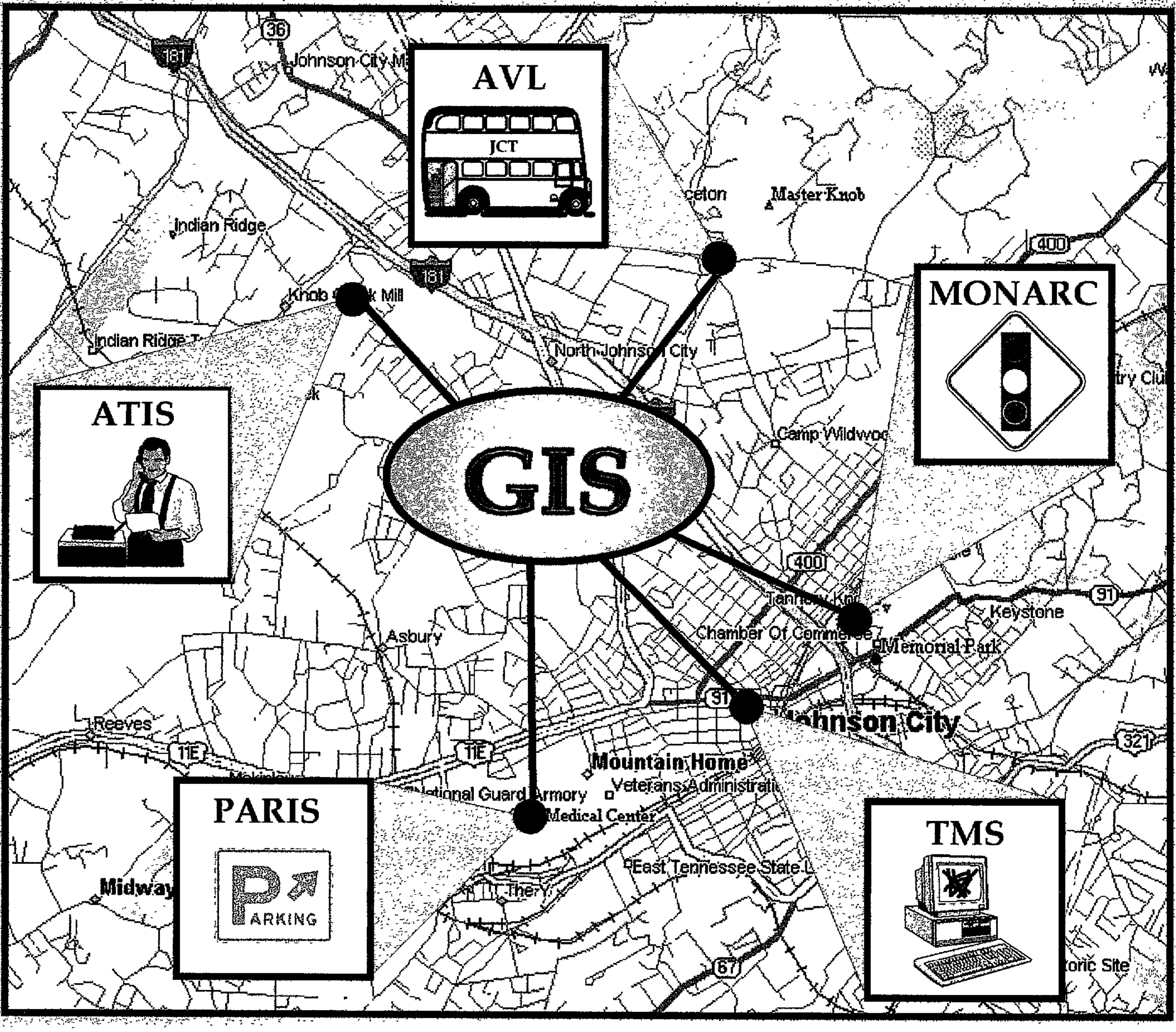
JOHNSON CITY MED-TECH CORRIDOR
ITS PROJECT

GEOGRAPHIC INFORMATION SYSTEMS (GIS) PHASE I REVIEW and PHASE II PROSPECTUS



October 1996

Geo Decisions
A Division of Gannett Fleming, Inc.

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Introduction

Task 3.7 of the adopted scope of work for Geo Decisions for Phase I of the Johnson City Med-Tech Corridor ITS project is a requirements to “assess the feasibility of integrating certain multimedia elements into GIS such as on-line video imagery and voice annotations.” As the project has been developed over Phase I, the potential role of GIS in succeeding phases has become more focused on certain applications. Therefore, we have expanded the scope of this document to: 1) provide a brief review of GIS aspects of Phase I; and 2) offer ideas for GIS utilization in Phase II and beyond. While the original goals of Task 3.7 are discussed in this report, the document content should be more relevant and useful as related to continued project development.

Review of GIS Element of Phase I

Phase I of the Johnson City Med-Tech Corridor project involved development of a GIS-based interface to the Parking And Routing Information System (PARIS). Geo Decisions successfully implemented such an interface based upon the ArcView GIS software “engine.” As shown in Figure 1, the GIS display is launched the PARIS graphic user interface (GUI) through selection of a menu choice. The default ArcView window opens up to a map of Lots C and D. There are options to change the geographic view to Lot E, Lot L, or to the entire VA campus (Figure 2). For Lots C and D, when a button is clicked on the view is automatically refreshed

Figure 1
Base PARIS - GIS
Interface Display

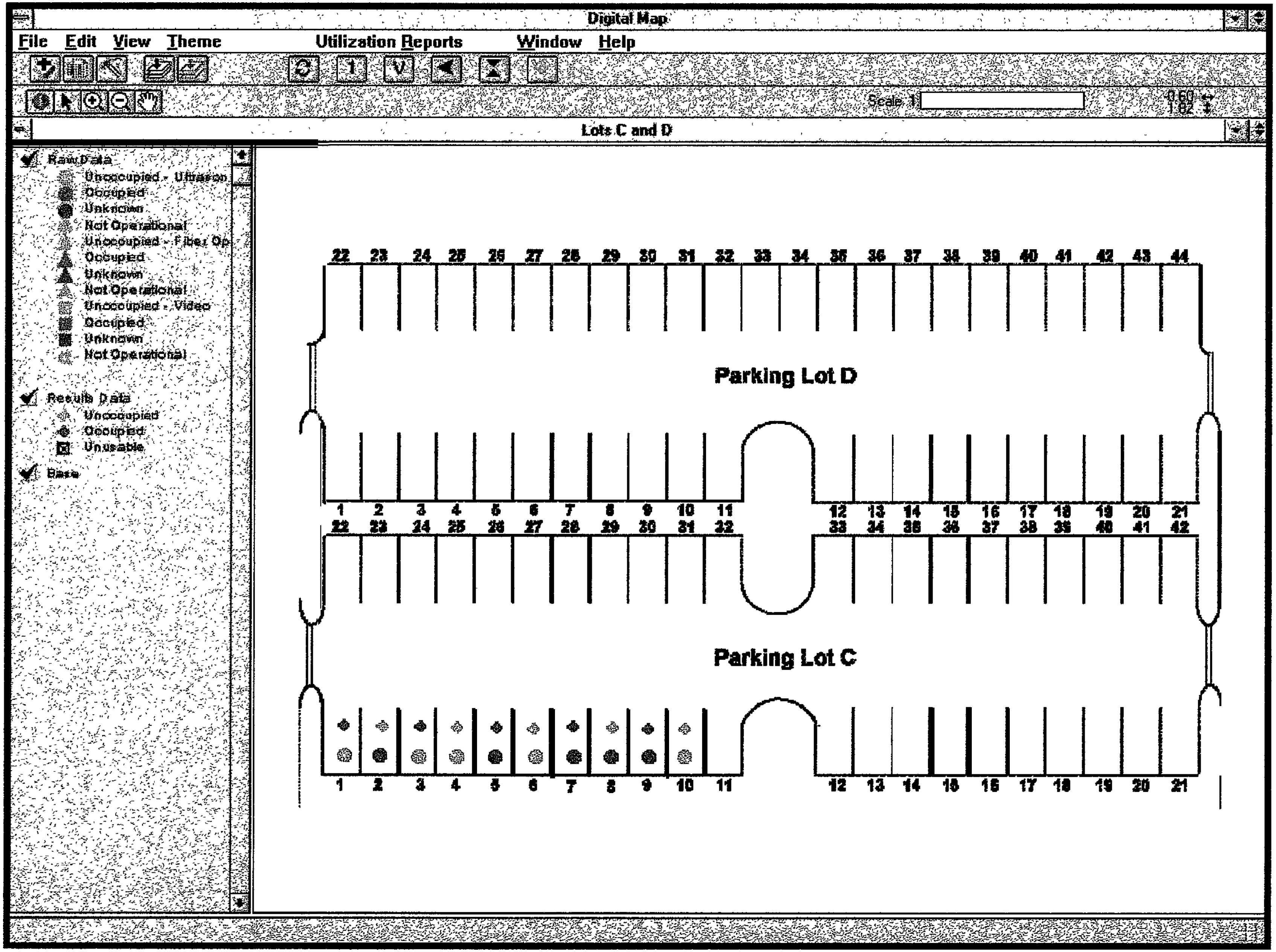
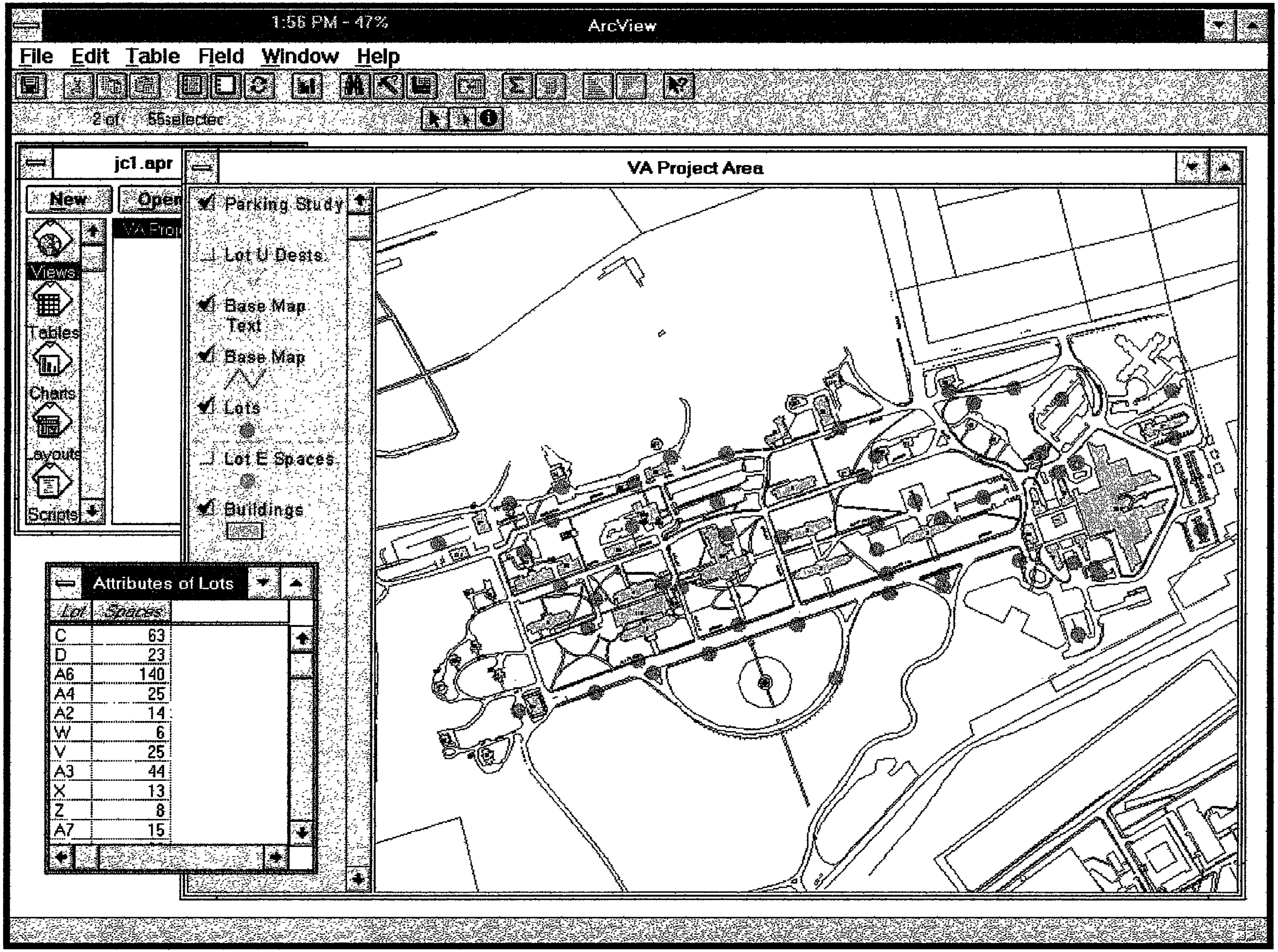


Figure 2
PARIS - GIS
VA Campus Interface Display



every 5 seconds from an on-line polling of the PARIS database to reflect the occupied/vacant status of each individual parking space. This status is shown in red symbols (occupied) and green symbols (vacant). There are three categories of space sensors-fiber optic, ultrasonic, and video-and unique varieties of symbol shapes display each type. Data tables can also be displayed for overall occupancy status as well as status by type of sensor. A second major element of the GIS interface to PARIS is a set of preprogrammed macro commands that generate reports and charts for parking summary data. This information is selectable by the user for time period, lot, sensor type, etc. The generated data and graphics are capable of being exported to other Windows-based analysis programs (Figure 3). For example, an ArcView data table showing average parking occupancy for Lot C for a month's time can be viewed and exported in a format suitable for use in a Microsoft Excel spreadsheet.

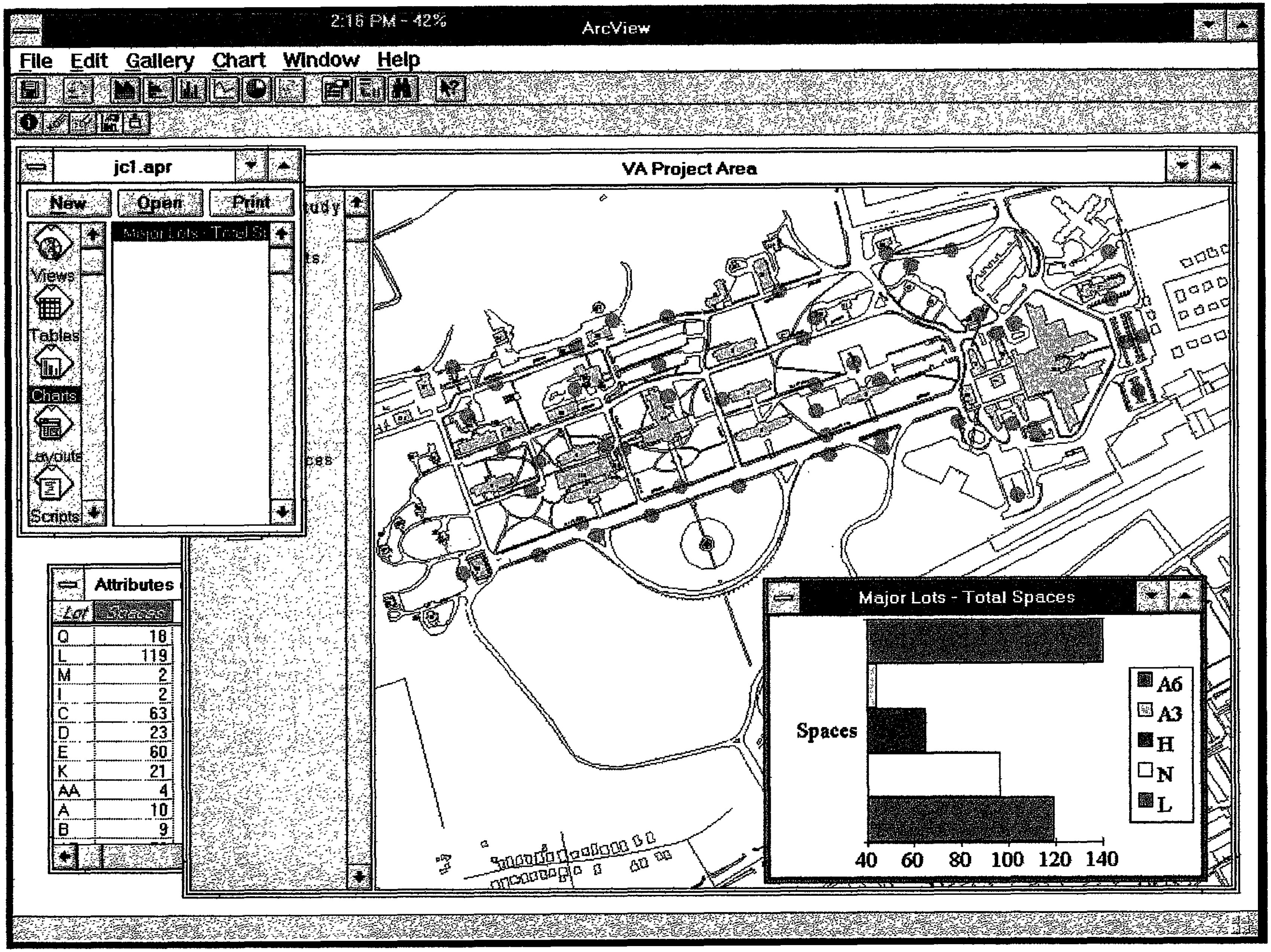
GIS Integration with Johnson Citv MTPO Transportation Management Svstems

Phase II requirements for the Med-Tech ITS project will include integration of GIS functions with the Johnson City MTPO's Transportation Management Systems (TMS) programs. Such programs involve the use of computerized management systems to improve performance of the MTPO region transportation infrastructure. TMS can have many components, and a major goal of Phase II will be to utilize GIS capabilities to integrate disparate TMS elements. The Johnson City MTPO TMS program has been under development for some time, and presently includes the following systems:

- Travel demand forecasting modeling (MinUTP)
- Desktop GIS (ArcView)
- Census demographic spreadsheets
- Transportation Improvement Program (TIP) spreadsheets

Future elements and those under development include:

Figure 3
PARIS - GIS
Parking Data Chart Interface Display



- GIS ArcView-based "TRAILBLAZER" transportation management system
- MONARC traffic signal management system
- Automated vehicle location (AVL) system for Johnson City Transit
- Advanced Traveler Information System (ATIS)
- Incident Management System (IMS)
- Access to MTPO information via interactive Internet capabilities

These program areas are in addition to the PARIS parking management system currently being developed for Phase I of the Med-Tech project, which has a significant GIS component, and is intended to be accessed on line from MTPO offices.

The balance of this report will provide an overview of how GIS is being integrated with existing, current, and future MTPO TMS projects, and how GIS can fit into Phase II of the Med-Tech ITS project.

GIS-Based "TRAILBLAZER" Transportation Management Svstem

During Summer, 1996, Geo Decisions began development of a GIS-based transportation management system called TRAILBLAZER. The project was sponsored by the MTPO and is being coordinated through the City of Elizabethton GIS Department. TRAILBLAZER is designed to serve as a prototype to be expanded throughout the MTPO jurisdictional region. ArcView is being customized to facilitate display and analysis capabilities in an easy to use interface. While much of the mapping and data are specific to Elizabethton, other information is MTPO-wide in scope. This data includes traffic volumes, functional classification of roadways, MTPO, city, and county boundaries, railroads, water features, bicycle routes, Census demographics, traffic signals, bridges, and fire stations. These databases and associated maps are accessed through a combination of customized pull-down menus and buttons. A prototype graphic menu has also been included for future expansion and accessing of the Med-Tech ITS systems, including PARIS, Johnson City Transit AVL, ATIS kiosks, MONARC signals, and incident management. TRAILBLAZER is of statewide significance in that it incorporates significant digital mapping and data resources obtained from TDOT. This has not been accomplished through GIS by any other MPO in the state. Figures 4 through 11 provide examples of ArcView functionality and data presentation that have been developed for TRAILBLAZER.

MONARC - GIS Linkage

Beginning in March, 1995, staff of Geo Decisions, the Johnson City MTPO, and the Johnson City Engineering Department met to determine the suitability of linking MONARC (Master Office Network Adaptive Real-Time Control) computerized traffic signal control systems with the MTPO's and City's ARC/INFO and ArcView GIS software. Further, we contacted Automatic Signal/Eagle Signal, makers of MONARC, to ask pertinent technical questions and seek clarifications regarding certain functions of the software. The results were included ***in*** the report ***GIS and Transportation Management Systems at the Johnson City MTPO,*** completed later that year. The following summary of our work is abstracted from this report:

> We first analyzed graphics display capabilities of MONARC. The system can support various levels of City-wide street and intersection maps. There are two types of files supported, both in Windows format: bitmaps and metafiles. As both are binary (raster) in structure, this means that MONARC has no standard vector graphics capabilities. The Montgomery County ATMS will be using vector-based street maps, but it must be assumed that this will be made possible through a custom-designed interface. In Johnson City's case, a DXF vector file of streets was converted into metafile format for display. Intersection graphics are also to be added and will be actual intersection diagrams showing individual lanes. These will also have to be rasterized. The MONARC program allows interactive entry of text labels (i.e., for street names) and signal head locations. This provides a real-time schematic display of signal phasing changes, detector readings, pedestrian phases, and other user-defined data that can be viewed by the operator. The coordinate system used by MONARC for display is an X-Y grid of screen units. These are not real-world GIS coordinates, but it is possible that the MONARC coordinates could be translated into GIS units.
>
> The MONARC data collection system is based upon IBM's DB2 database management software. Most database printouts are created in this format; however, others are generated in ASCII format. American/Eagle Signal has indicated that whichever is the case, all can be easily converted into ASCII tables. From this point, the tables could be converted into GIS format, whether in dBase

Figure 4
MTPO TRAILBLAZER GIS Project
ArcView Main Entry Screen

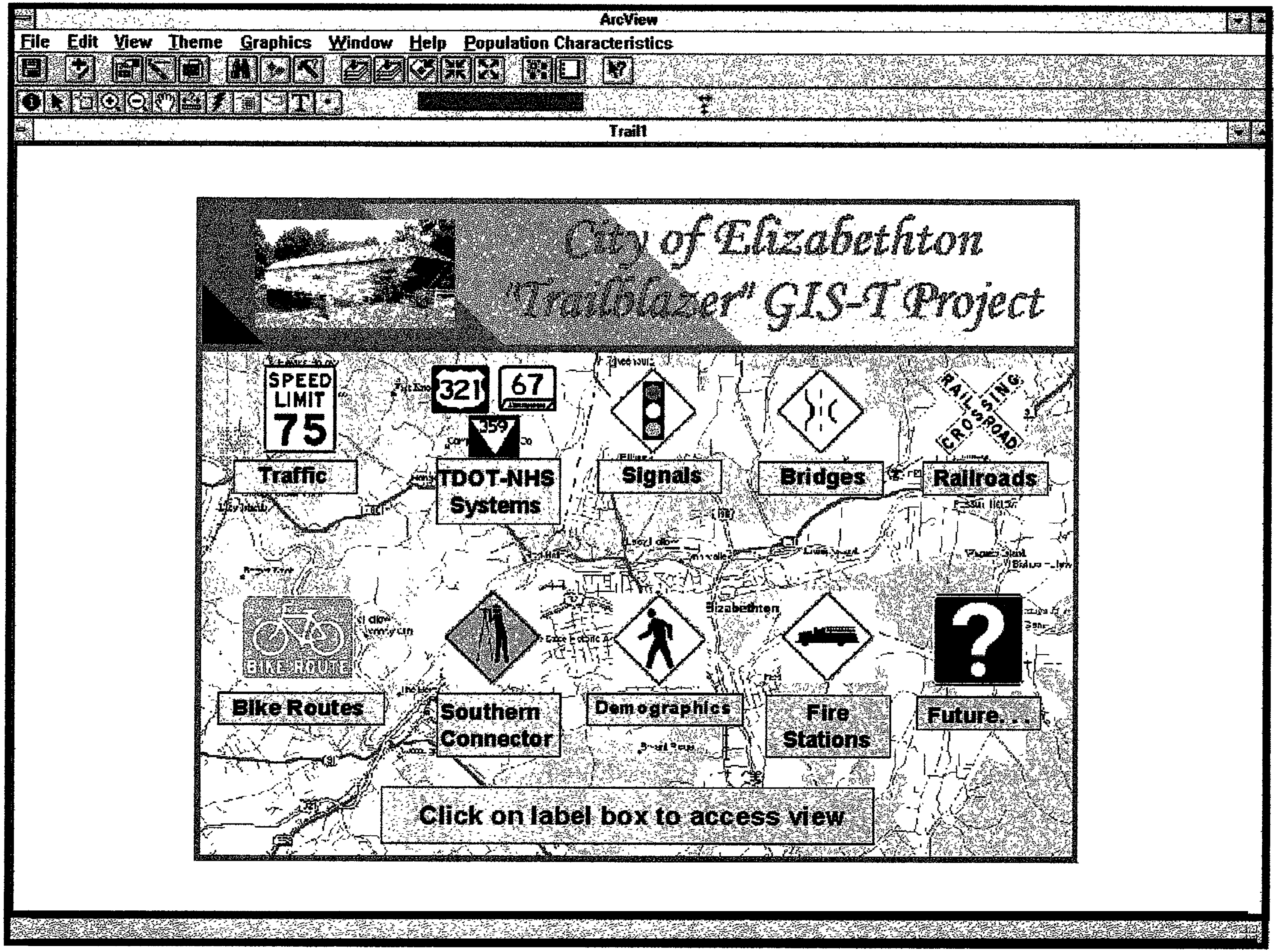


Figure 5
MTPO TRAILBLAZER GIS Project
ArcView Demographics Menu Screen

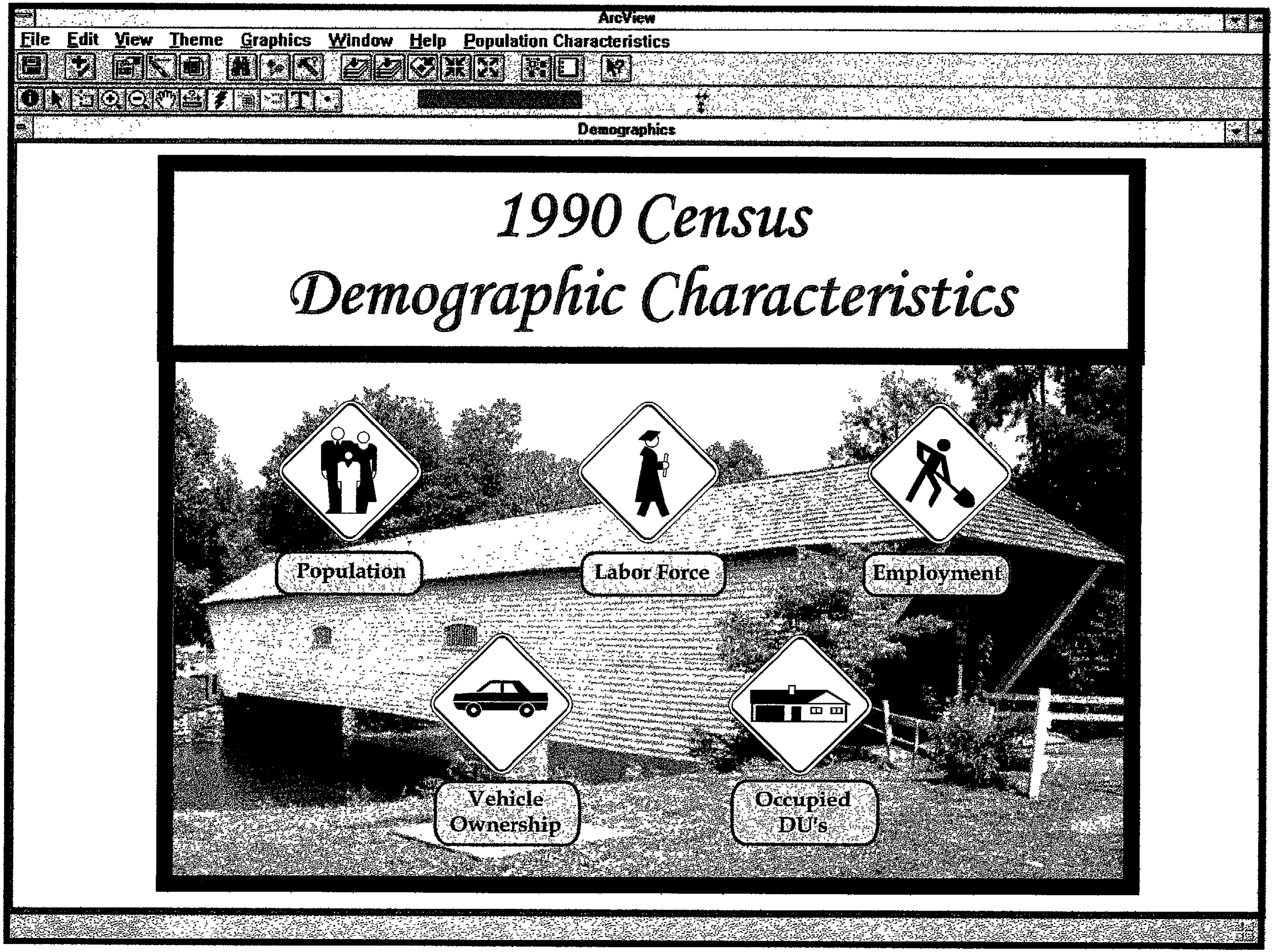


Figure 6
MTPO TRAILBLAZER GIS Project
ArcView Demographics View

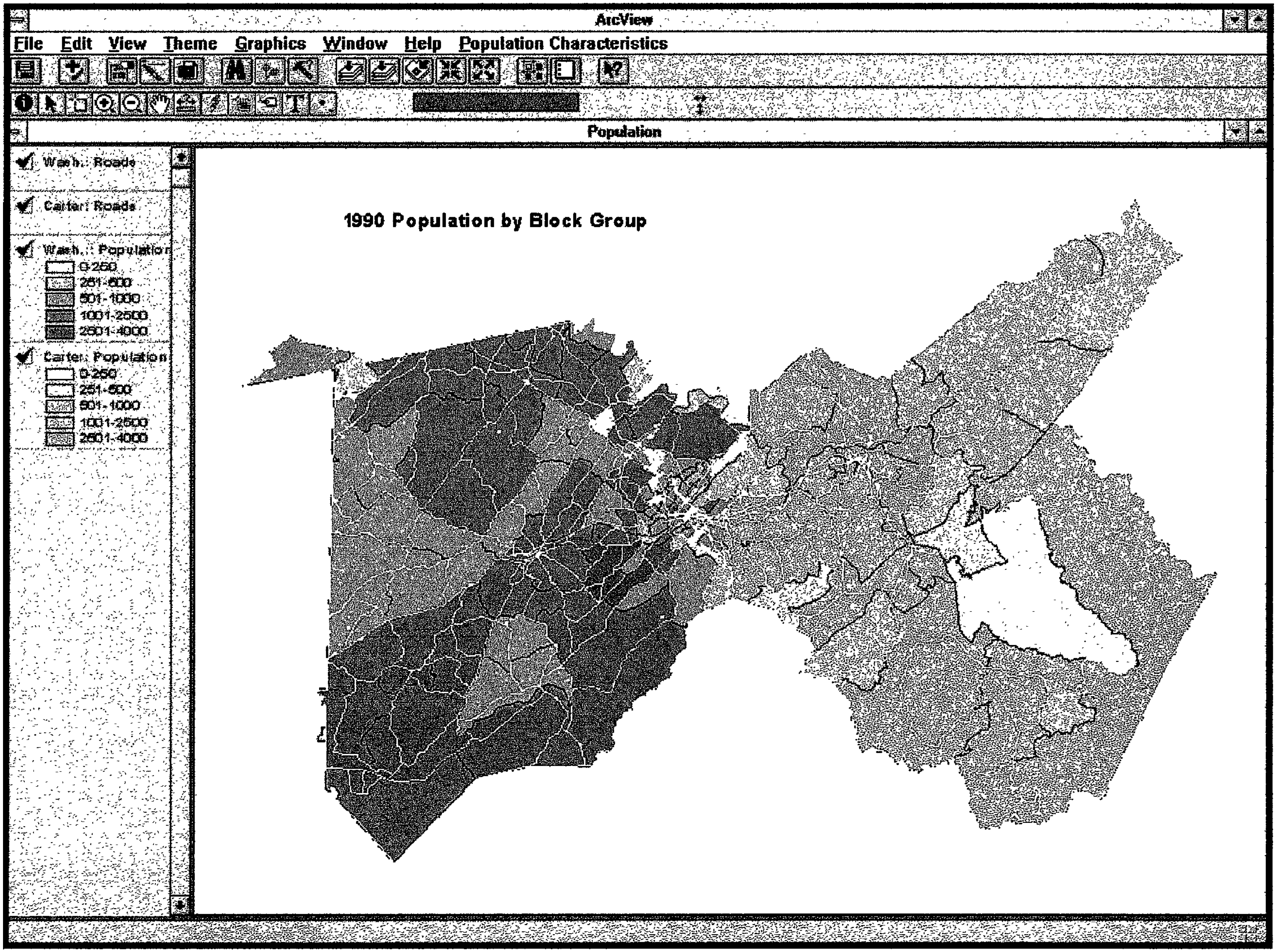


Figure 7
MTPO TRAILBLAZER GIS Project
ArcView ITS Menu Screen

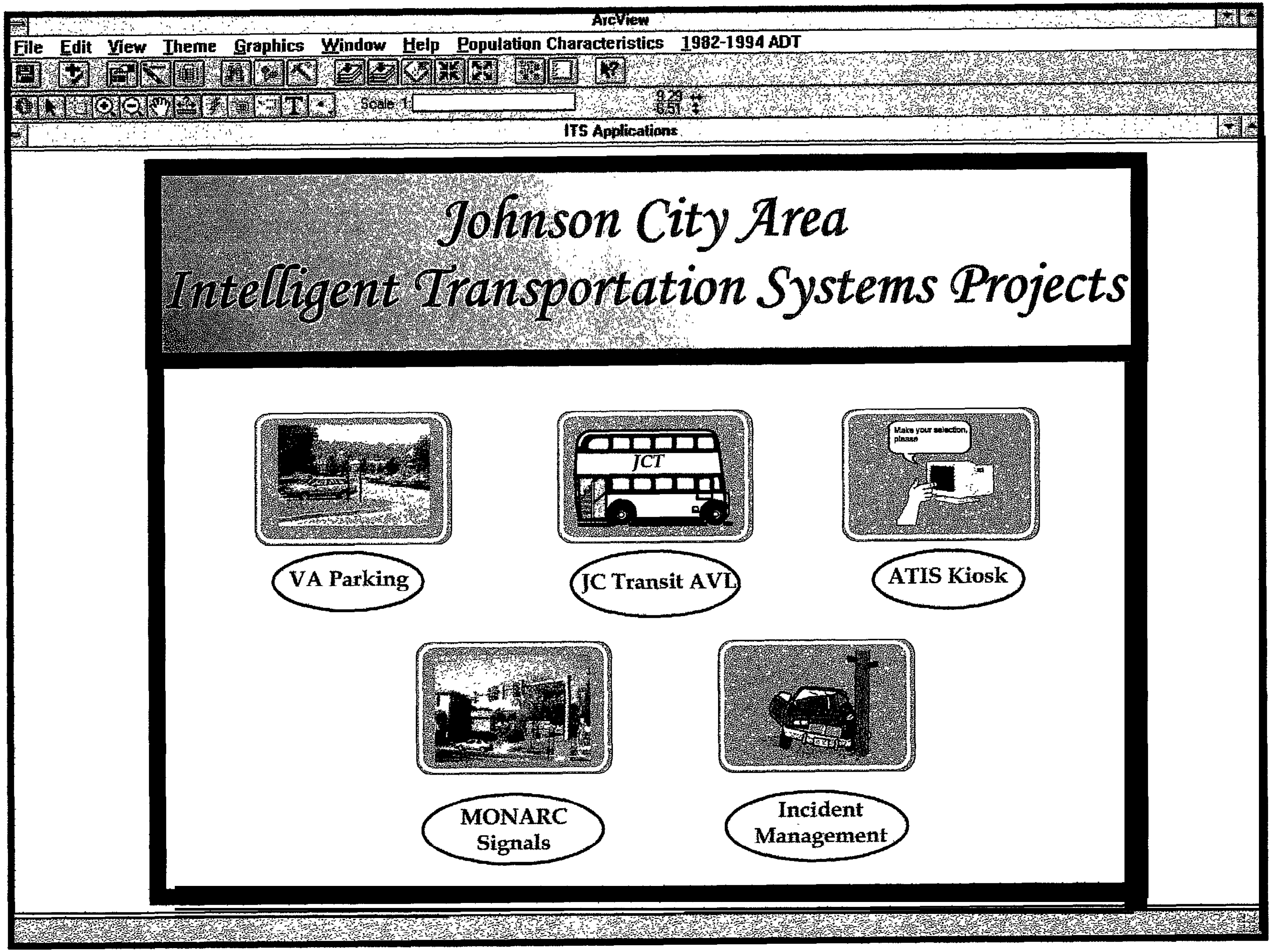


Figure 8
MTPO TRAILBLAZER GIS Project
ArcView Traffic Counts View Screen - Elizabethton

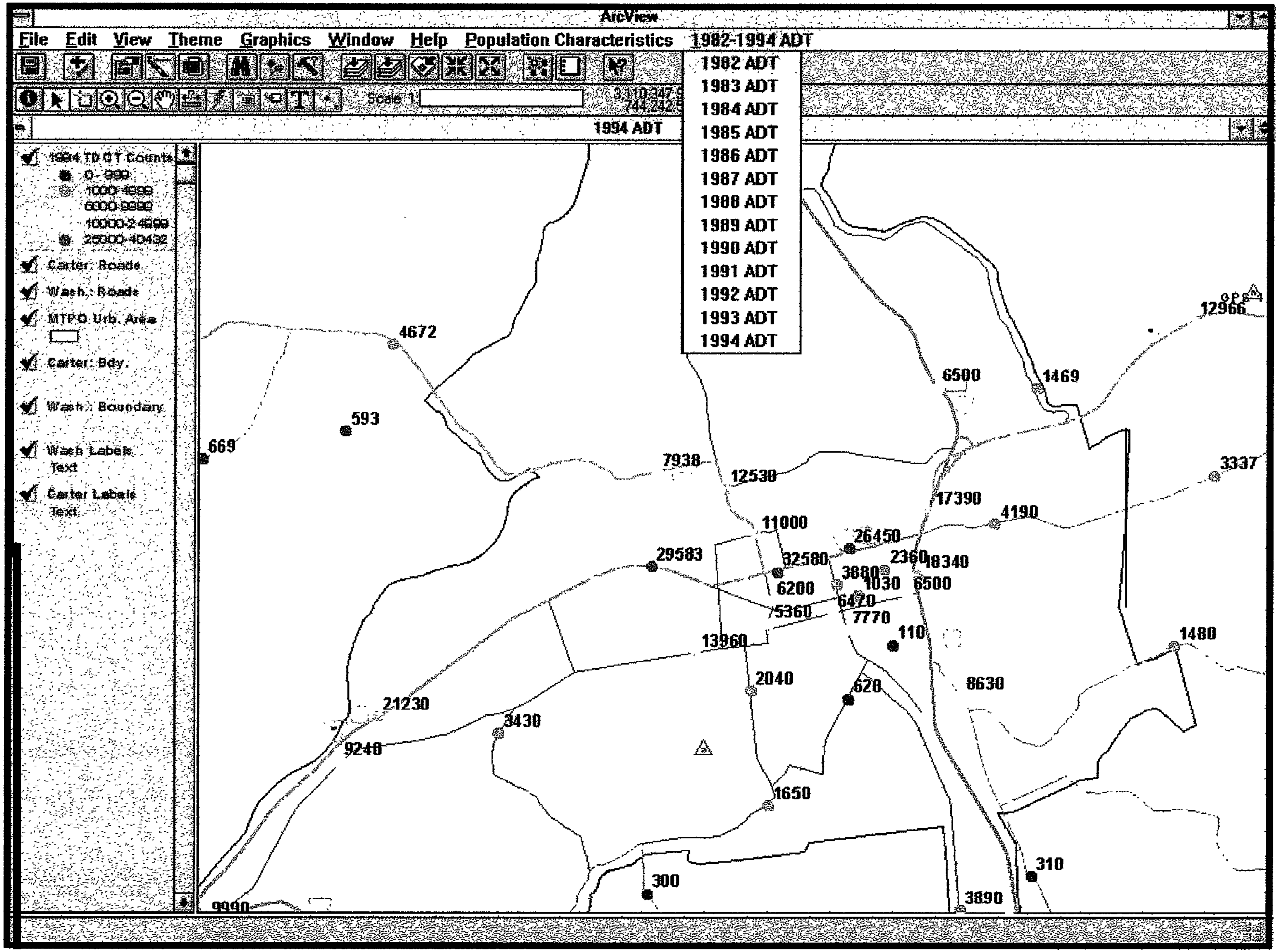


Figure 9
MTPO TRAILBLAZER GIS Project
ArcView Traffic Counts View Screen - MTPO Region

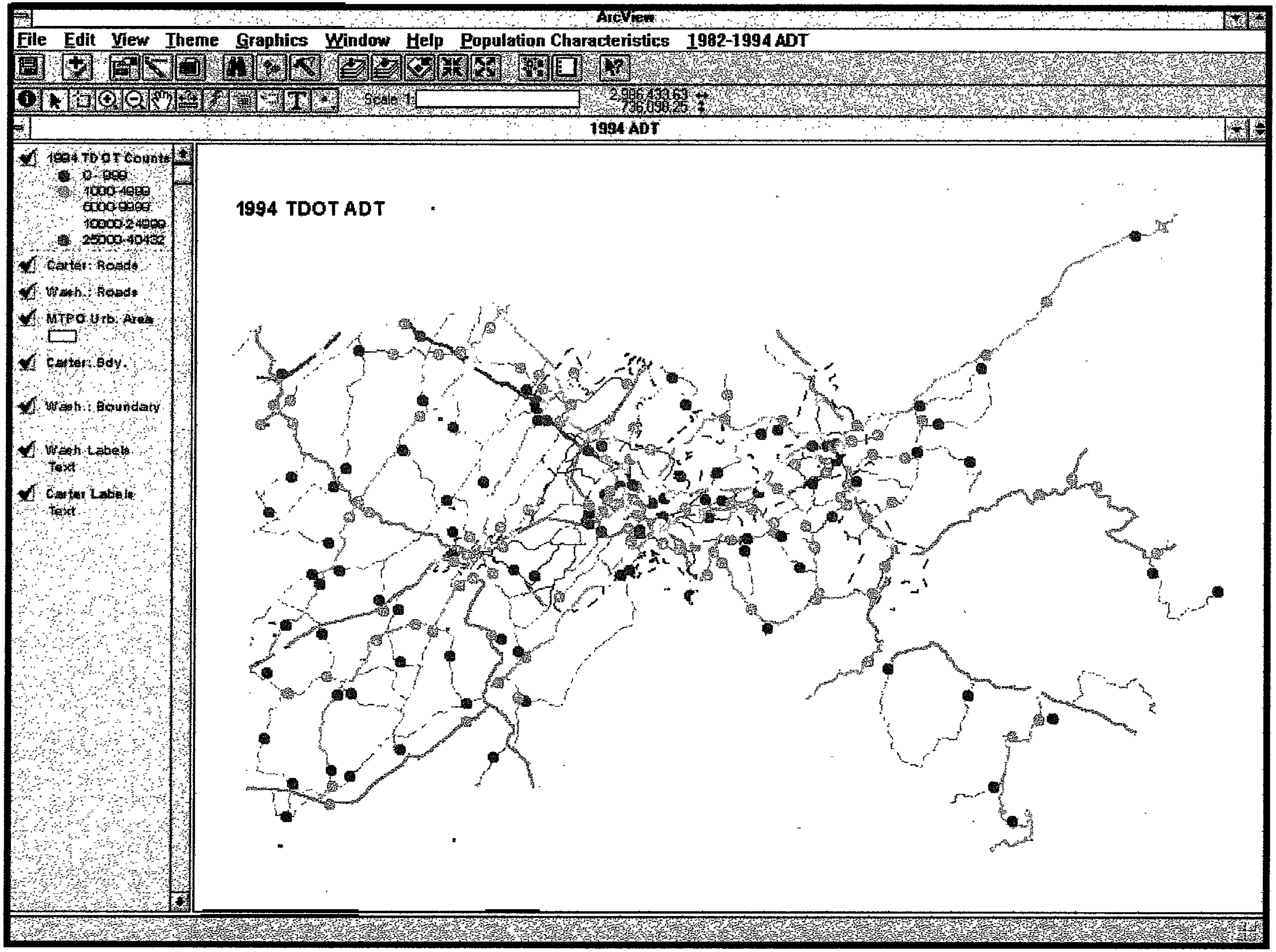


Figure 10
MTPO TRAILBLAZER GIS Project
ArcView Traffic Signals View Screen - Elizabethton

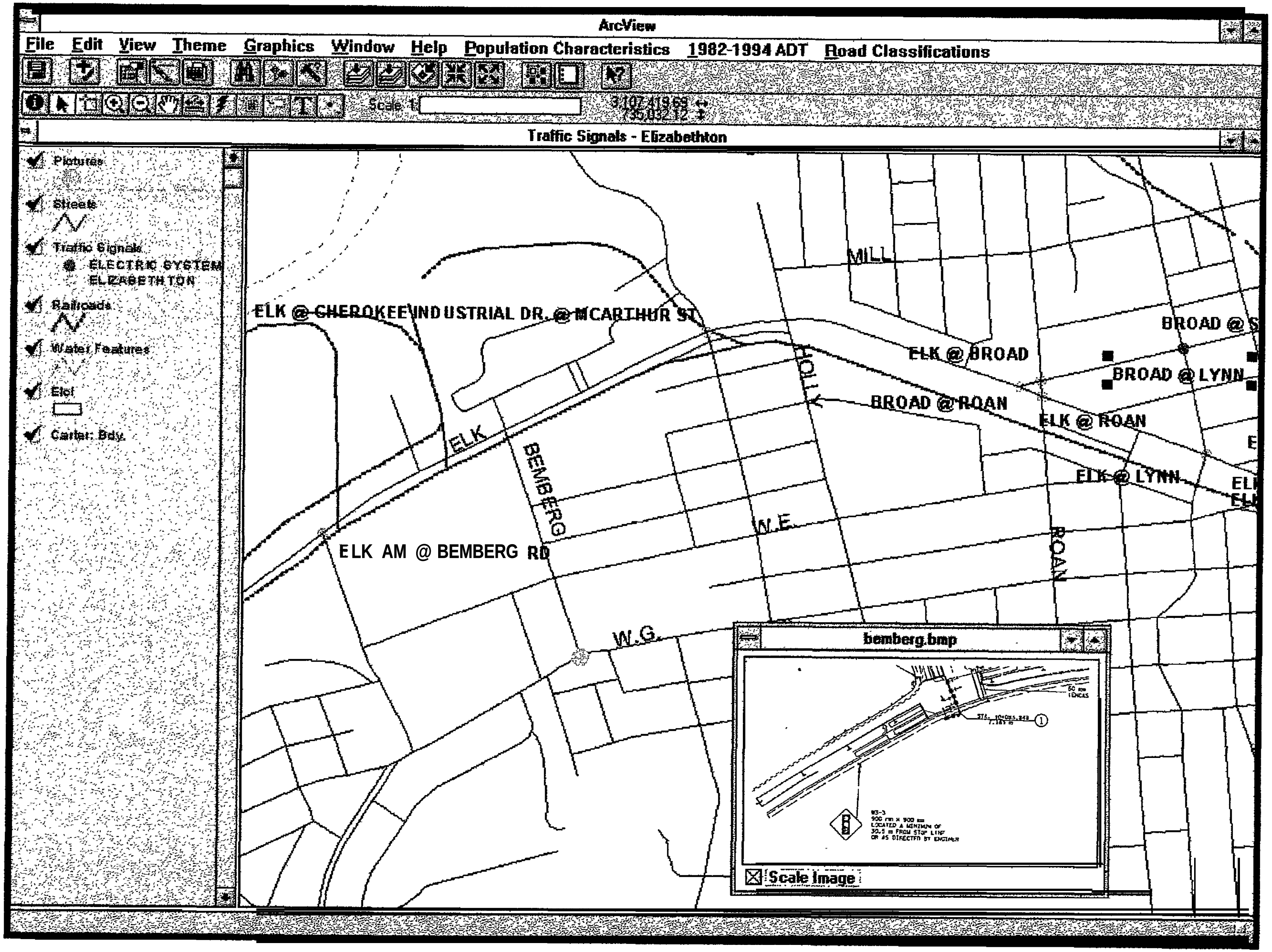
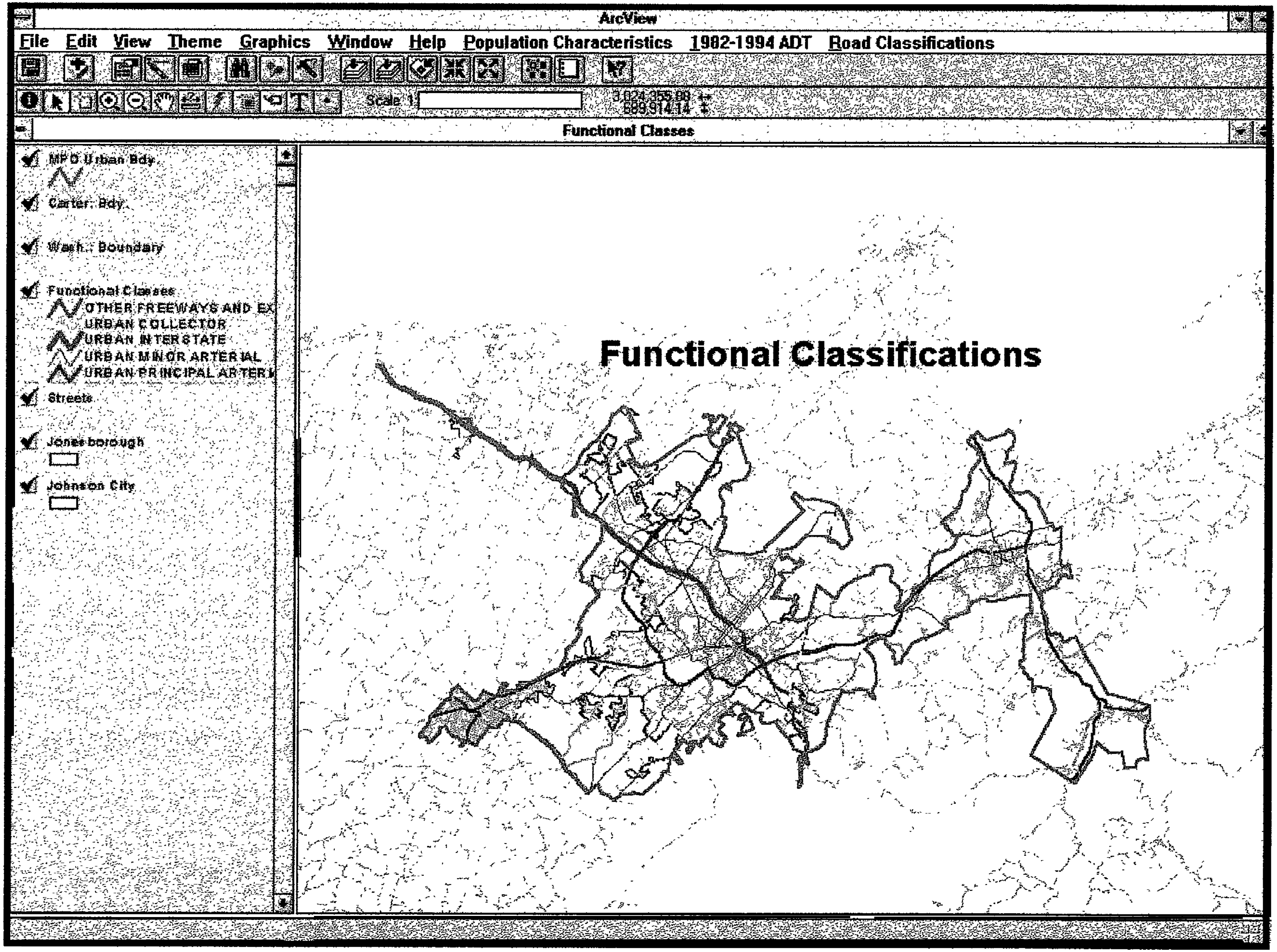


Figure 11
MTPO TRAILBLAZER GIS Project
ArcView Functional Classes View Screen - MTPO Region



(for ArcView) or INFO (for workstation ARC/INFO). Intersections/controllers or other features would have to be commonly referenced in some manner, whether through an identification number, street names, geographic coordinates, or some other method.

Eagle/American Signal was contacted in reference to their previous experience in designing and implementing an on-line interface between MONARC and the ARC/INFO product line. They have not to this point performed any of this work, although a strong interest was indicated if Johnson City is interested. What then, are potential approaches for linking the two systems? Figure 12 presents a schematic view of a possible on-line linkage of the two systems. Any such link should include the following elements:

- Interapplication communications using Microsoft's ODBC (Open DataBase Connectivity) standard for ArcView SQL connections.

- Interapplication communications using ARC/INFO's Database Integrator module for workstation ARC/INFO SQL connections.

- Data transferred in ASCII-delimited (commas or tabs), dBase (DBF), or INFO format.

- A common geographic or coded reference between MONARC and ARC/INFO for signal/head/detector locations. This may involve translation of coordinates between real-world GIS coordinates and screen-based MONARC coordinates.

- A communications method to actually transfer the data. As the systems are presently in two widely-separated buildings, this may not be feasible right away. Hard-wired networks between MTPO and Engineering are not presently available, and the cost of wireless communications would likely be prohibitive. Several other options are possible, including off-line downloading of information, high-speed modem data transfer, and locating ArcView at the same place as MONARC.

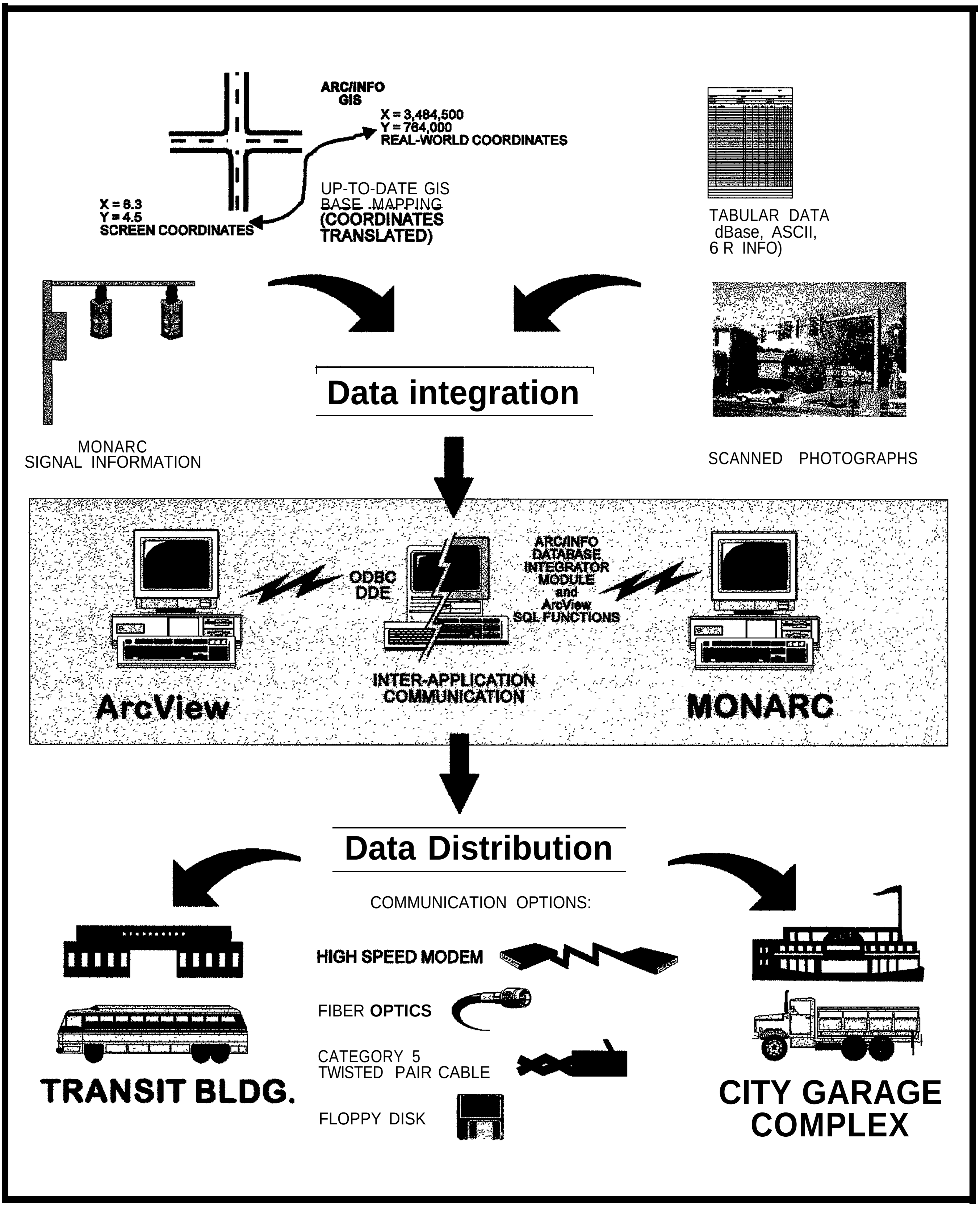
- A method to continuously update the City's MONARC street/intersection layer as maintained in GIS. This would be critical for keeping the two systems operating concurrently with the same map base.

- A recommended enhancement to the MONARC system, also usable through ArcView, would be collection of 35mm color photos taken from a City bucket truck at an elevated angle. These photos can be incorporated into the MONARC graphic display and similarly referenced in ArcView and ARC/INFO.

In summary, it appears feasible to link MONARC and GIS (ArcView and/or ARC/INFO) in an on-line setting, or at least to transfer graphics and data products back and forth. Any further implementation actions will need to be discussed among the relevant parties upon review of this report.

For linking MONARC further with other ITS elements, remote communication systems that might be established to link GIS with other systems (PARIS, kiosks, Johnson City Transit buses) should be similar to that required to access MONARC data on-line from the Johnson City Engineering Department.

Figure 12
Proposed MONARC - GIS Linkage



Automated Vehicle Location (AVL) Svstems

The Johnson City Transit System operates several fixed passenger bus routes and a paratransit on demand system. Computerized records are kept of ridership on both types of routes. Currently, scheduling and routing of the paratransit system is performed on a manual basis by a dispatcher. Locations of the vehicles are known only by descriptive information relayed by two-way radio by drivers. Client locations have been manually mapped, but there is no computerized method used to schedule and route vehicles.

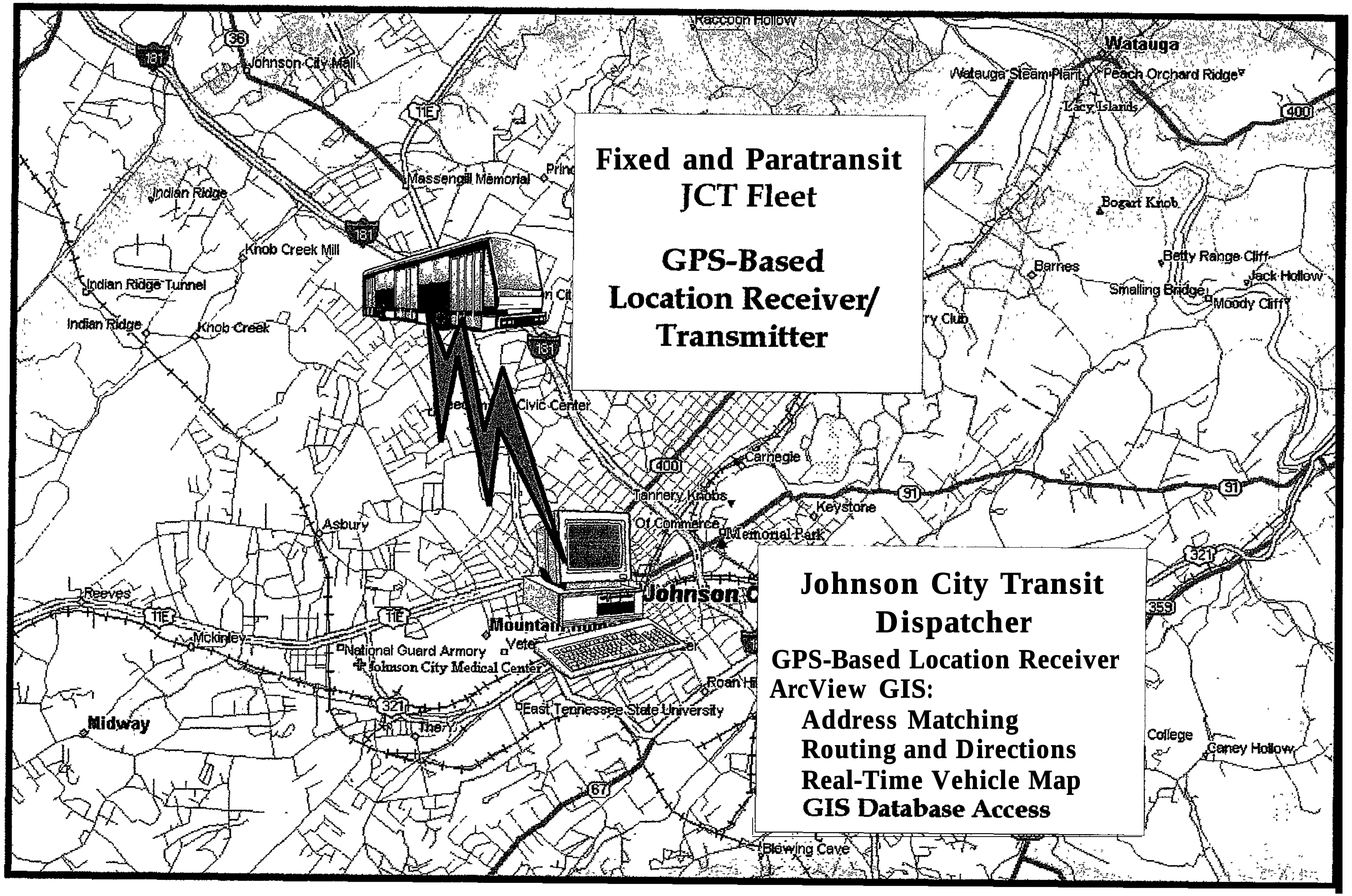
Automated Vehicle Location (AVL) systems have been in existence for some time. There are several methods used to track vehicles. The most popular type of system utilizes the GPS-based receiver/transmitter environment. In this system, a GPS receiver reads a series of signals from one or more satellites and computes and transmits a geographic location back to a computer that receives the data. In early versions of GPS-based AVL systems, a primitive map interface could be used to plot vehicle location. More recently, full GIS-based interfaces are being used to display dynamic vehicle locations. To achieve a full GIS display, raw GPS data in latitude/longitude format are processed in real time and usually converted to a coordinate system such as State Plane, since most GIS maps are in such a format. The ability of GIS to utilize open systems connectivity and programming can be employed to allow real time display of changing locations of vehicles. This has been done in a similar fashion already in Phase I of the Med-Tech project, where the PARIS parking database is polled each five seconds by the ArcView desktop GIS software, and a map display of parking space occupancy/vacancy is correspondingly updated.

While a GPS-based AVL system can be linked to ArcView for map display, GIS can offer additional functionality to improve usefulness of the system. For example, ArcView contains geocoding and address matching capability. This functionality would allow an operator to input a client address and, if successfully matched to the GIS address database, view the address location automatically on the map. In addition, the ArcView Network Manager module can be used to determine a shortest or best path route from the present vehicle location to the client to be served. Directions can be printed out (and if appropriate communications systems are in place, accessed remotely in the vehicle) for following the route. Parameters which affect or define the "best" route can also be incorporated, such as speed limits, traffic signal impedance, roadway directionality, turn restrictions, and other factors. Finally, a GIS-based AVL integrates the complementary mapping and data resources that already would exist. For example, a layer showing construction projects could be accessed and incorporated into routing determination; data showing client characteristics and use of the system could also be included; scanned photos of each client's residence (and of the client ID card) could be viewed. A prototype structure for development of an AVL system for the Johnson City Transit system is shown in Figure 13.

Advanced Traveler Information Systems (ATIS)

A growing ITS application with many potential design characteristics is Advanced Traveler Information Systems (ATIS). For the purposes of the Med-Tech Corridor ITS project, ATIS will be considered to be a kiosk-based system that has the ability to retrieve and display spatial locations of transportation features and other complementary data. As a link to the existing PARIS-based system, the ATIS should be capable of accessing dynamic parking data in a manner similar to that being developed on-site at the VA campus. In addition, the ATIS should have the ability to display other characteristics related to the transportation infrastructure in the Johnson City area, such as road projects, construction areas, bicycle routes, park and ride lots, and travel times. The ATIS should allow the user to print out directions and distances as input between two user-specified locations. Other data could be included for user interest, such as locations of restaurants, municipal and governmental offices, cultural points of interest, schools, major employers, libraries, post offices, and so on. The ATIS should incorporate display of textual and visual information describing such features. Interactive telephone connections can also be provided. Perhaps most importantly, the ATIS should be easy to use and relatively maintenance-free. Such systems are usually presented in a kiosk-type format, with touch screen

Figure 13
Prototype GIS-Based AVL Structure



interfaces.

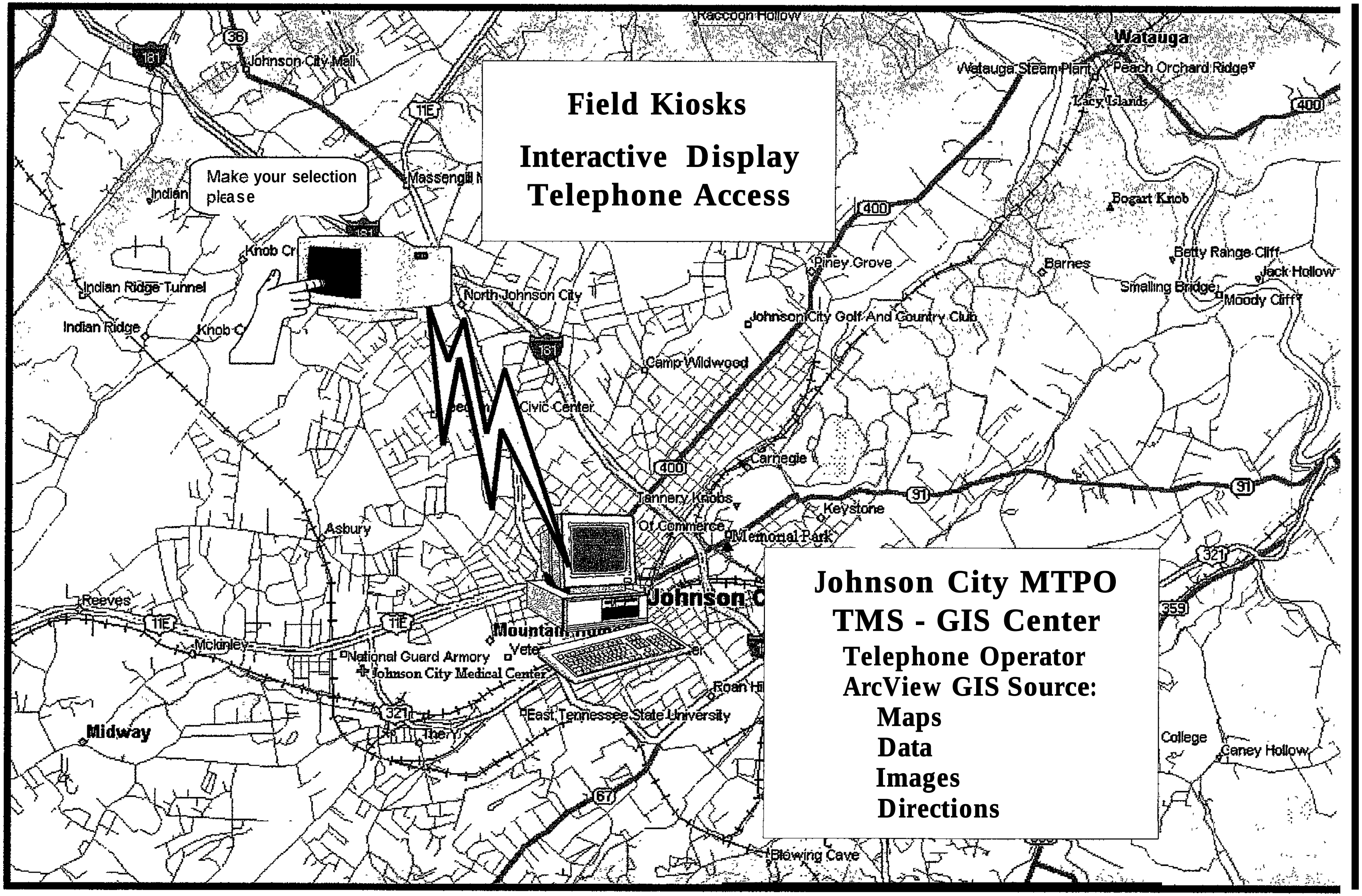
GIS, and more specifically ArcView, can be configured to operate in a kiosk environment. A touch screen interface can be supported, and Avenue programming allows for development of user-friendly functionality to switch among multiple displays. Enhancement of the display with buttons, forms, and other elements can be included through the use of a program such as Visual Basic. Different geographic areas and scales of maps can be displayed via user-supplied parameters. Other operations, such as viewing images and printing data reports, can be supported. The entire ArcView-based program can also be made available by publishing the application on CD-ROM in a license-locked version that cannot be modified by the user-in essence, providing functionality that cannot be corrupted or edited. Portions of the ATIS also could be updated using remote communications systems such as that being employed for the PARIS system. A possible structure for establishing GIS-based ATIS capabilities is shown in Figure 14.

Internet Access to ITS

Many of the same characteristics that apply to ATIS functionality would also apply to development of an Internet site for Johnson City MTPO TMS applications. A functional Internet site might include the following:

- A description of the MTPO, with mission statements and major programs
- MTPO personnel and Board descriptions, photos, and biographies
- Contact addresses, telephone numbers, and links to e-mail
- Major ongoing transportation projects, with locator maps when appropriate
- Intermodal facility descriptions (and maps) such as bicycle routes
- Johnson City Transit route maps, schedules, and contact information
- Work Program descriptions, funding, phasing
- Selected transportation data (traffic volumes, projections, accidents, etc.) displayed on

Figure 14
Prototype GIS-Based ATIS Structure



GIS-derived maps

- MTPO meeting notices
- Progress reports on the Med-Tech Corridor ITS project, perhaps with a real-time link to dynamic parking maps
- Selected MTPO reports and documents, available for downloading
- Hypertext links to other relevant sites, including the City's home page, the Johnson City GIS, and TDOT.

The GIS relationship to an Internet site would be developed primarily through clickable maps connected to data files. This "primitive" GIS would not actually be based upon a program such as ArcView, but could retain many of the same elements found in GIS. Different scales of display maps could be incorporated. Programming for such an interface would be accomplished with the standard Internet development tools available. Figures 15 through 20 document some existing examples of Internet capabilities that could be applied to development of a site that utilizes GIS-type graphics.

Figure 15
Example Internet DOT Home Page: Florida DOT

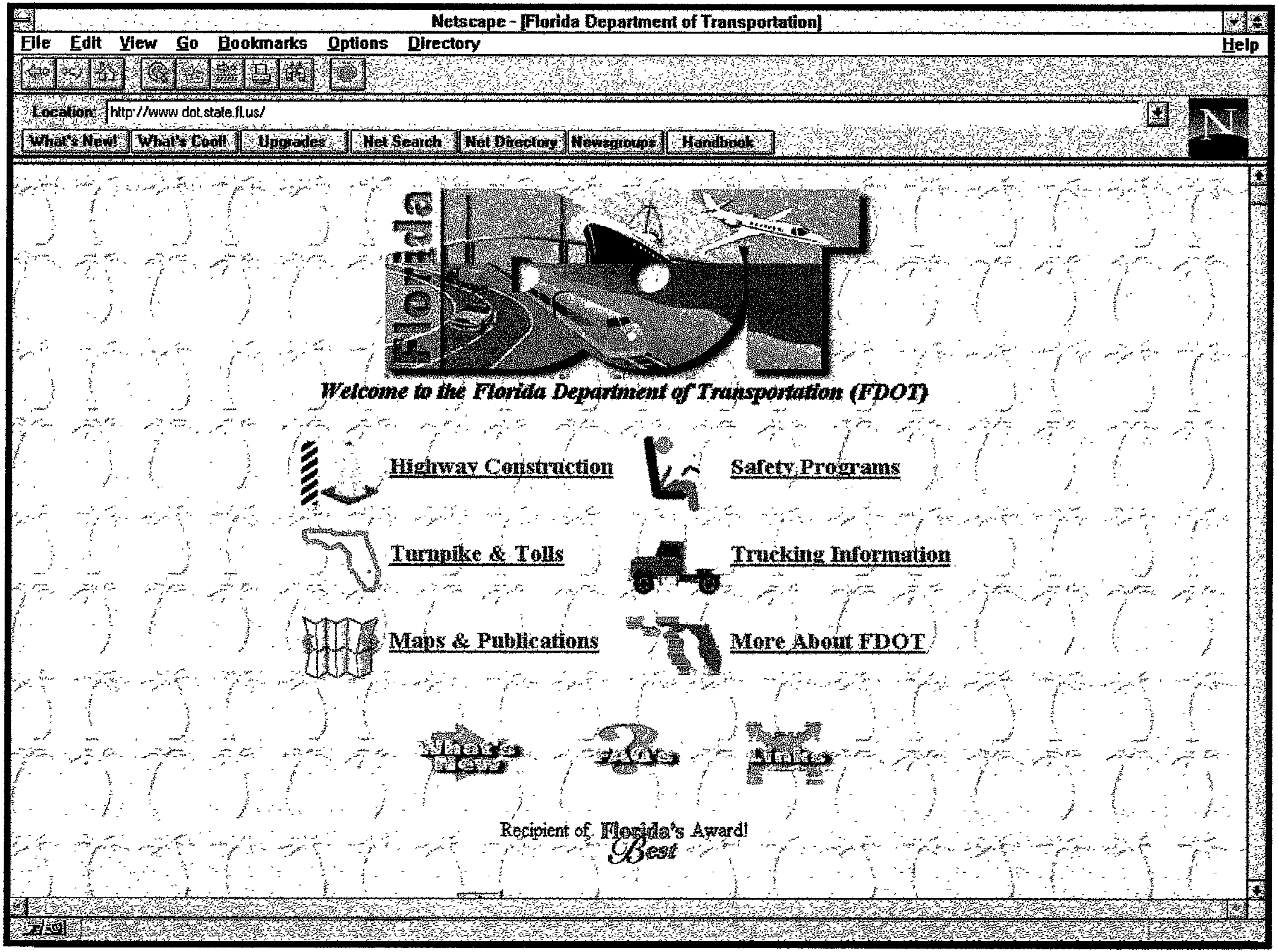


Figure 16
Johnson City GIS Home Page

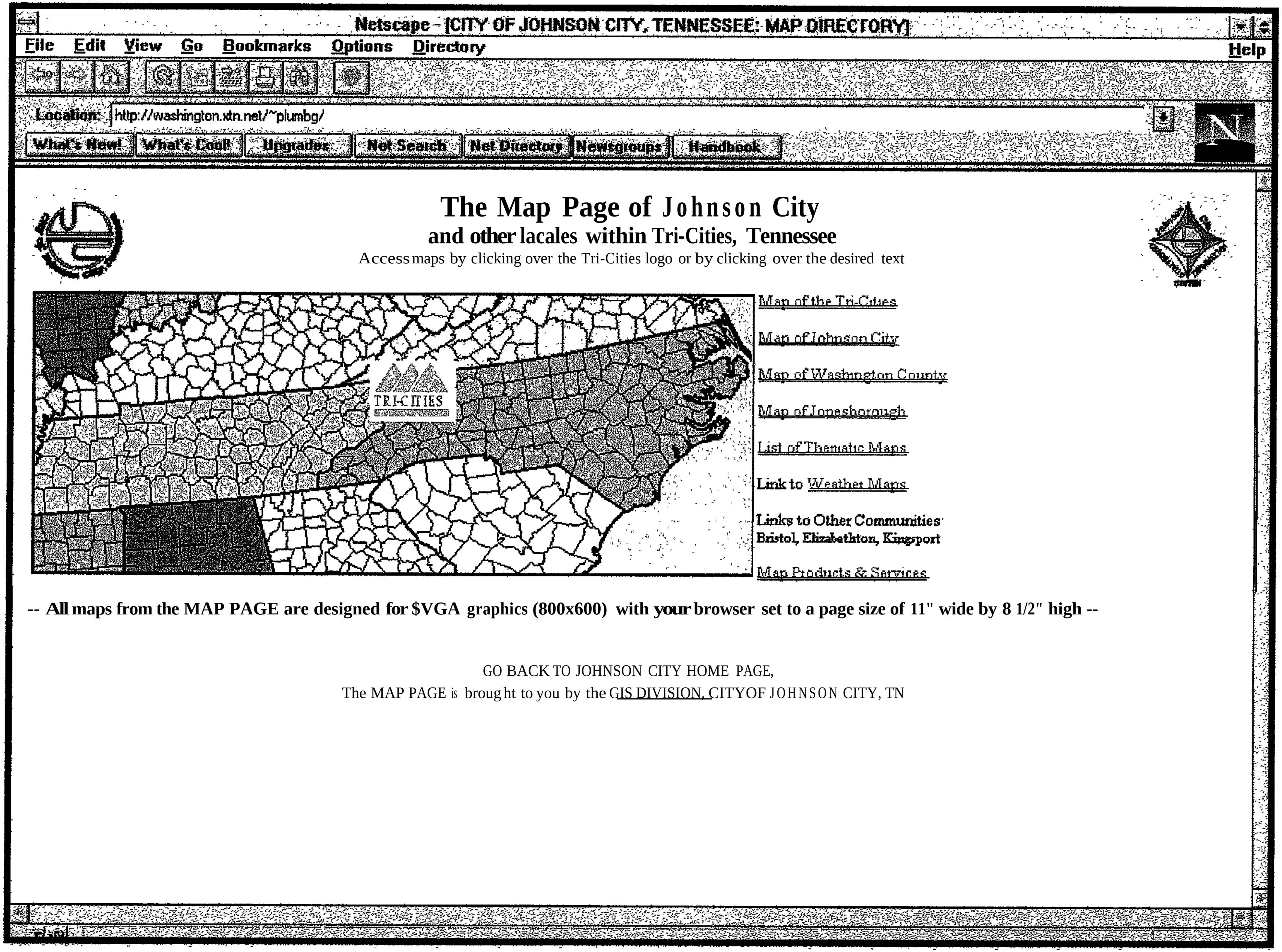


Figure 17
Example Transportation Internet Clickable Maps: Virginia Department of Transportation

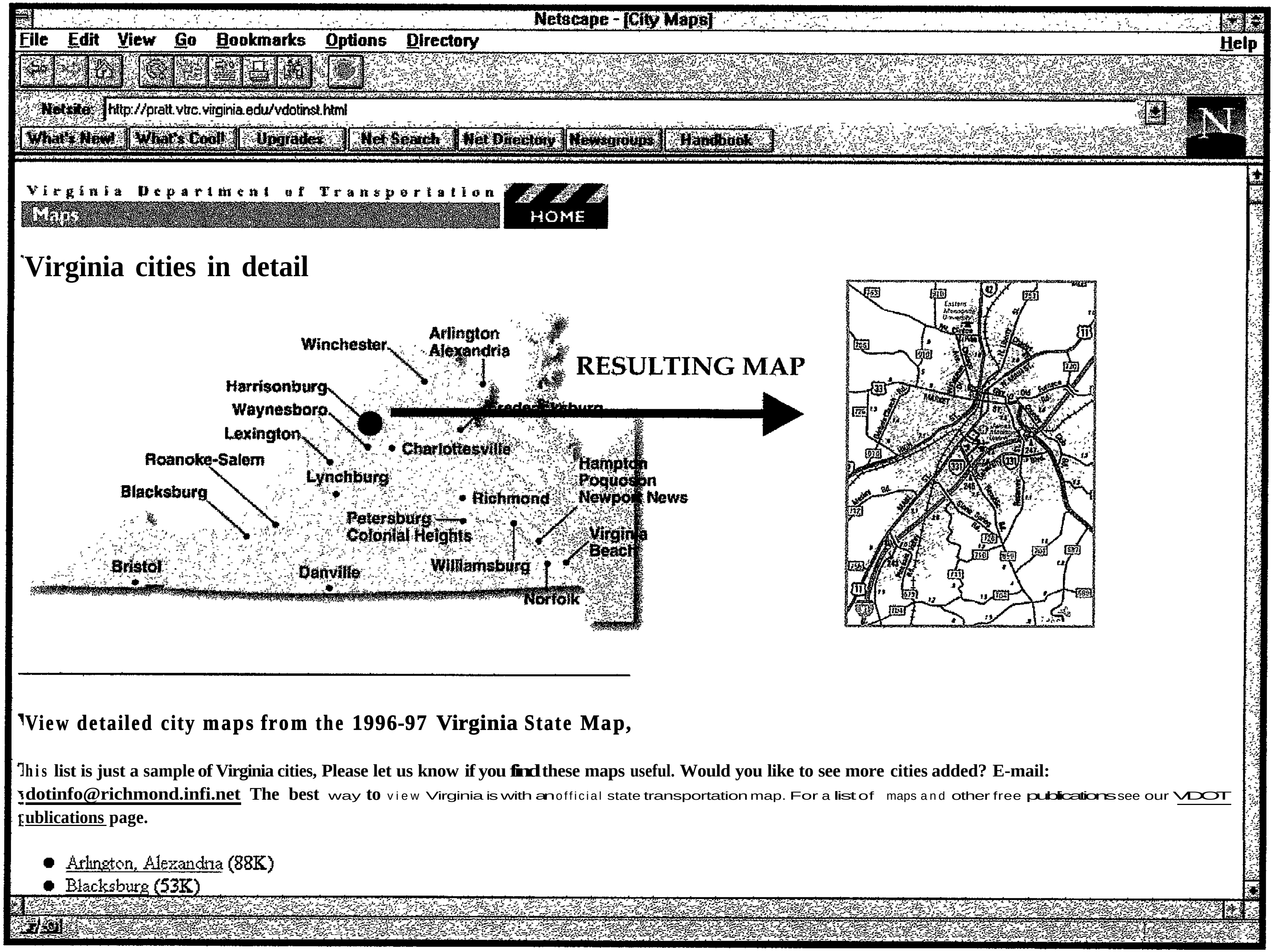


Figure 18
Example Internet Transit Site:
Seattle Real-Time Traffic Conditions

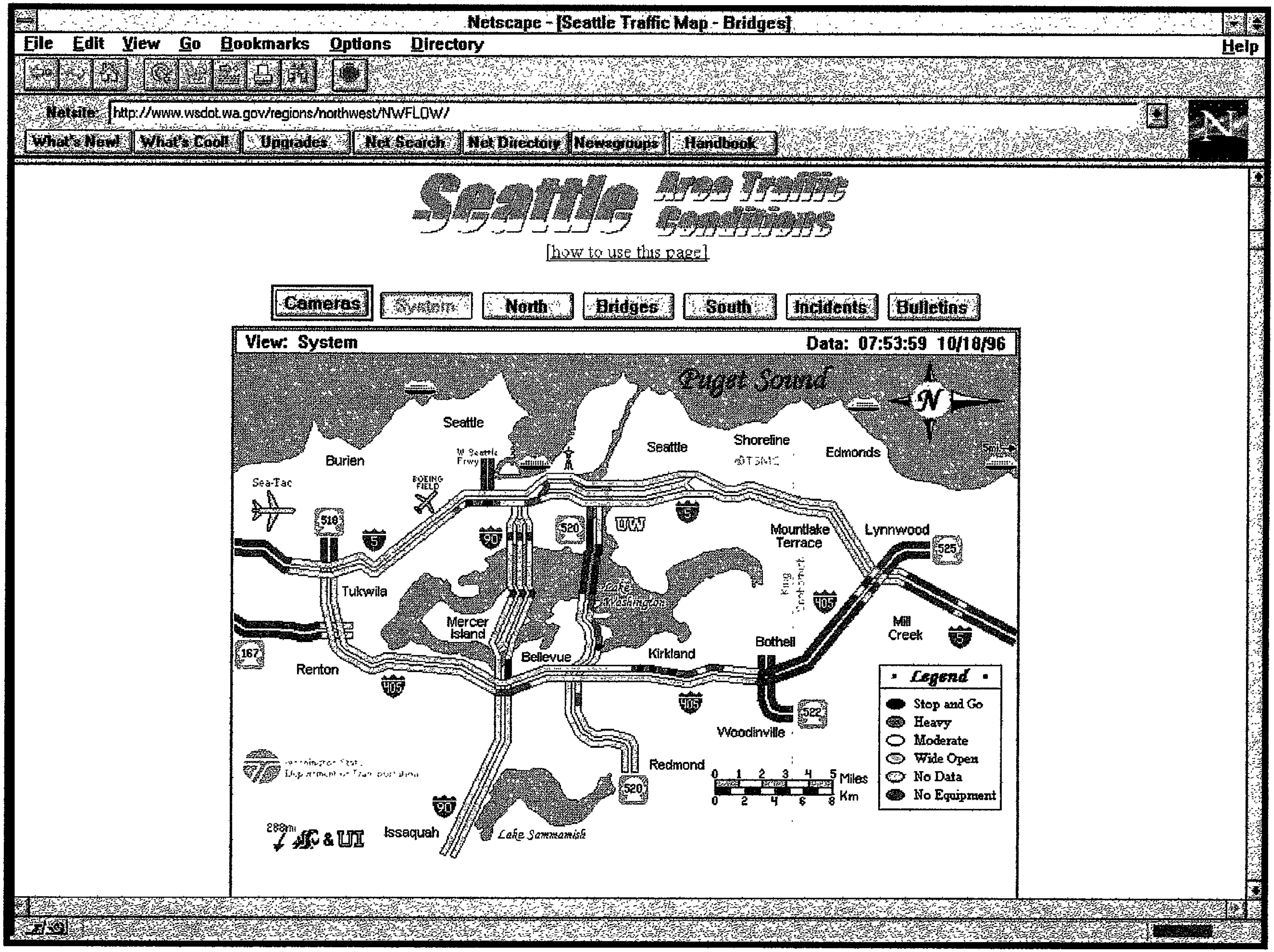


Figure 19
Example Internet Transit Maps:
Montgomery County, MD Transit System

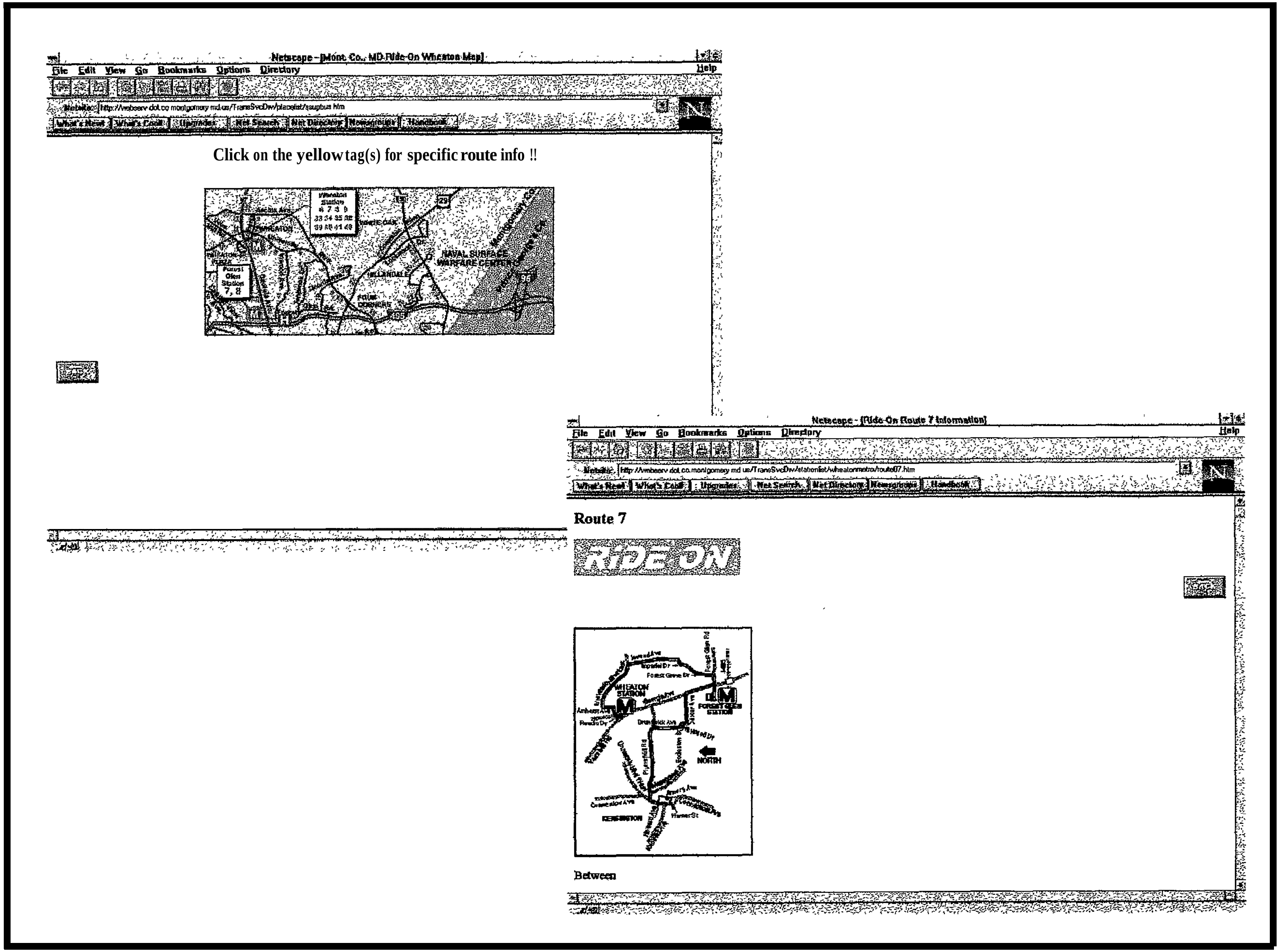


Figure 20
Example Transportation Internet Maps:
Construction Zones, Virginia Department of Transportation