Applying GIS Technology to Improve Transit Accessibility

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ABSTRACT: Traffic congestion is becoming an increasingly rampant problem throughout the United States. As new technologies develop, however, new tools become available to combat this problem. How can a small city use these tools to confront this problem and work to improve the quality of its transportation system? This paper describes the strategy utilized by the City of Rockville, MD to fight congestion by taking the battle off the streets and focusing on the promotion of alternative modes of transportation. By applying GIS, laptops, Pocket PCs and GPS technologies, City staff evaluated existing transit service, using three performance goals—1) maximize walk-accessible transit service to City residents, 2) increase the number of residents within a 10 minute travel time to a Metrorail station using local bus service, and 3) maximize the transit frequency of service. Staff assessed City pedestrian and transit networks to calculate Rockville's performance for these measures.

The City of Rockville was awarded a federal grant to study the accessibility of all modes of transportation in the City in order to identify how to improve transportation networks. To accomplish this objective, staff ran distance and travel time analyses on City vehicular, bicycle, pedestrian and transit networks. This report focuses on how Rockville has used technology to map transit and pedestrian networks and how this data is subsequently being used to study the City's transit system as a whole.

Rockville has a comprehensive transit system with a total of 20 bus routes that begin, end, or traverse the City. Seventeen of these routes are operated by Montgomery County's Ride-On service, while the Washington Metropolitan Area Transit Authority (WMATA) runs the remaining three. All of these bus routes have a Metro station as a main destination point. Two Metrorail stations are located within the City limits, and another one block off the City limit.

Gathering and compiling the data necessary to complete pedestrian and transit GIS networks took one year to accomplish. Data collection began with existing GIS layers (centerlines, bus routes, sidewalks), which were obtained from Montgomery County.

Transportation networks were developed around these layers using a combination of aerial photography and actual surveys for quality control.

Transit Lines

City staff acquired a transit network line file from the County. This layer, once cleaned and updated, was used in preparation for network analysis. Each of the 20 bus routes was assigned one line segment that traced the length of its route through the City. Each route had scheduled time points with approximate bus departure and arrival times. Using schedule charts and manuals obtained from Montgomery County and WMATA, City staff determined and split each line segment where these time points were located. The difference in time from one time point to the next was assigned to that particular line segment. This variable represents the time cost that Network Analyst uses in running the network. Consequently, the resulting travel times are based on the buses' actual schedules.

The lines comprising each bus route were also divided at points where one bus line meets another to allow for transfers. A turntable was created to add delays for these transfers, account for the directionality of some routes, and to prevent unwanted turns and U-turns. The delay for a transfer was assumed to be one half of the headway for the bus route to which a transfer was made.

Bus Stops

City staff used Trimble Global Positioning System to map out bus stop locations throughout the City. The County-assigned bus stop ID was entered as an attribute for each stop. With these IDs, staff were able to link the networks created in the City's GIS to existing County

databases containing information for each bus stop such as bus stop amenities and bus ridership information.

Sidewalk (Pedestrian) Network

The sidewalk GIS network was critical to this study because sidewalks are the main access methods for the bus stops. The sidewalk network was modeled by following either side of an existing street network (centerline) with the addition of mid-block crossings, off-street paths, and cut-through routes. This network was constructed by tracing over aerial photography of the City and field checking the results. Lines were broken not only at intersections but every time the type of pedestrian facility changed. These facilities were classified as existing sidewalks, missing sidewalks, street crossings, commercial driveway crossings, overpasses or stairs. Presumably, a pedestrian will travel at a different speed when he encounters each of the different types of facilities. Areas with no sidewalk were included to account for the fact that pedestrians can (and do) traverse these areas by either walking in the street, shoulder, or grass strip alongside the street. The cost factor assigned to a given line segment was based on the type of facility and the length of the segment. The basis for this logic is the notion that the absence of a sidewalk will slow pedestrians down, as would a street or driveway crossing where they must look for cars before walking.

Analysis

ArcView 3.X, the only platform that supports Network Analyst, was the main software used in this analysis. The integration of the aforementioned GIS layers allowed City staff to view the actual scope and efficiency of the Rockville transit system. With these tools in place,

staff were able to make computerized models that would otherwise have taken months to simulate. Usage of actual data and information allowed staff to perform analyses that reflected real-world conditions.

Objective 1: Maximize Walk-Accessible Transit Service To City Residents

Figure 1 (below) displays route walk buffers, assuming _ mile for each bus stop and $^{7}/_{10}$ mile for Metrorail stations. This map was constructed based on the assumption that all residents can walk "as the crow flies" to a transit stop. Yellow areas represent locations without walkable service.

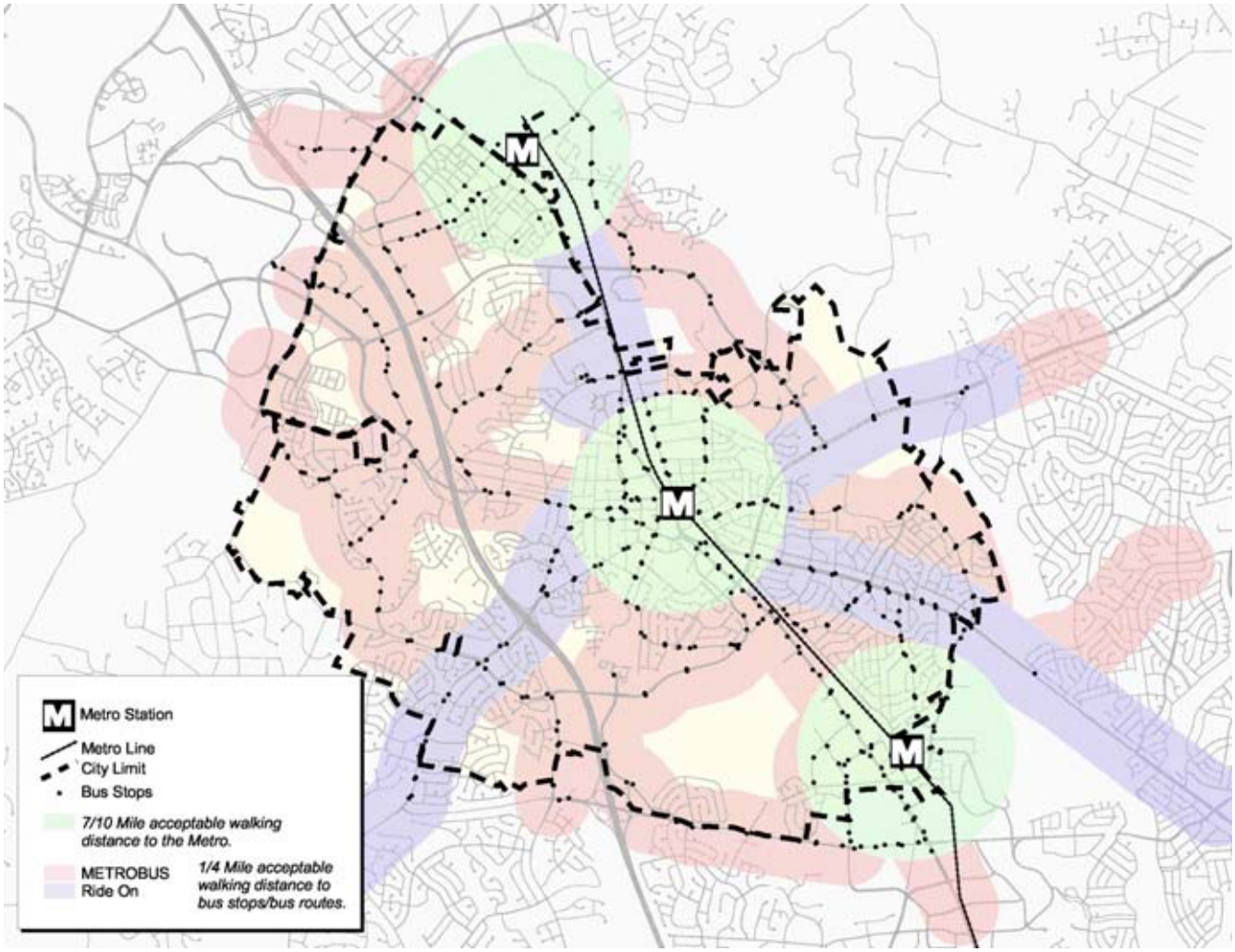


Figure 1

In reality, pedestrian facilities are missing, physical barriers exist, and busy roadways must be crossed. To calculate actual walk sheds, staff traced the pedestrian network to each bus stop. The following map displays pedestrian routes, color-coded by travel time. Areas without color represent problem locations.

Figure 2

On a City-wide scale, (Figure 3) one can see how this type of analysis produces a more real-world view of actual walk sheds available to access transit service. Areas outside blue shaded areas are those beyond _ mile access to transit service.

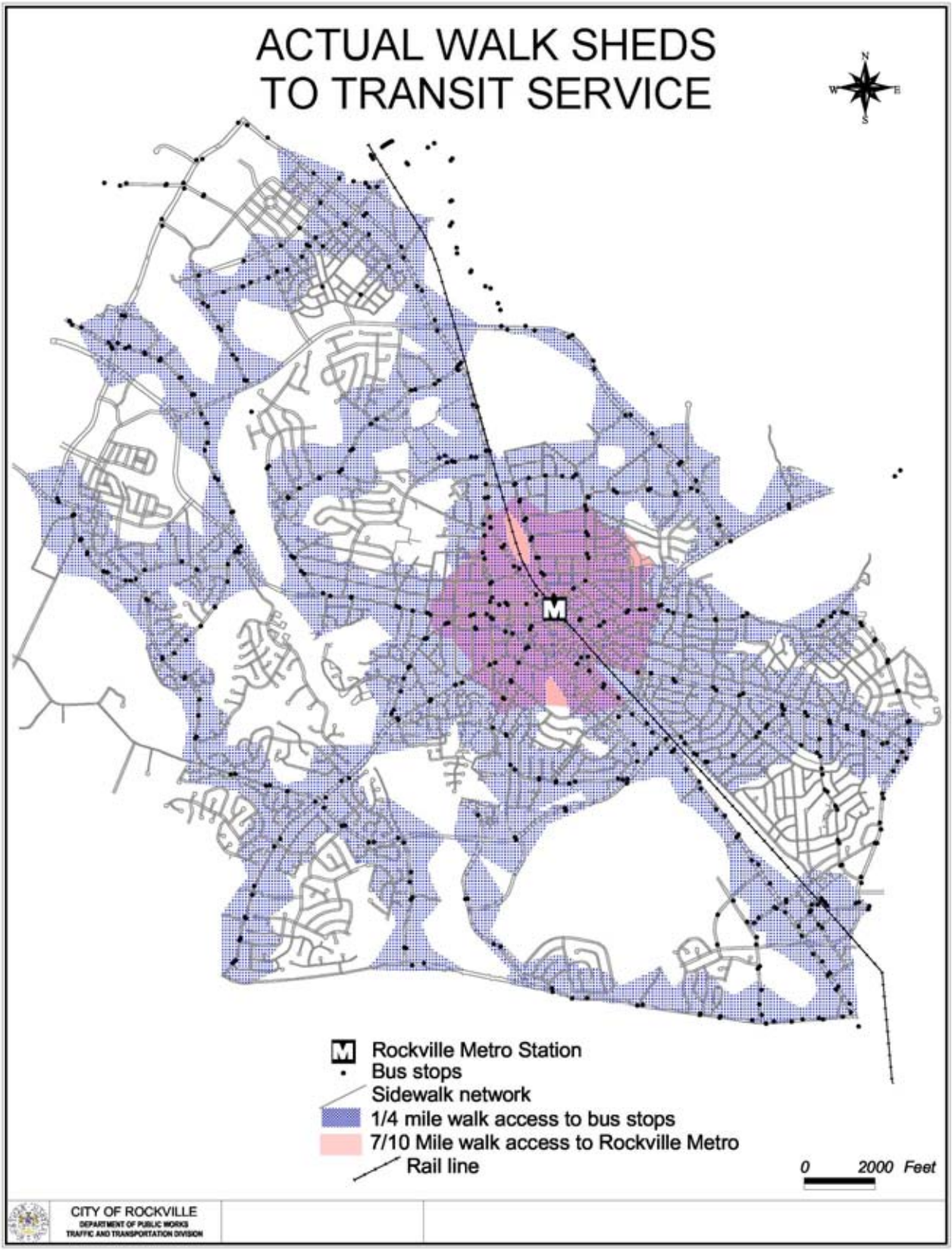
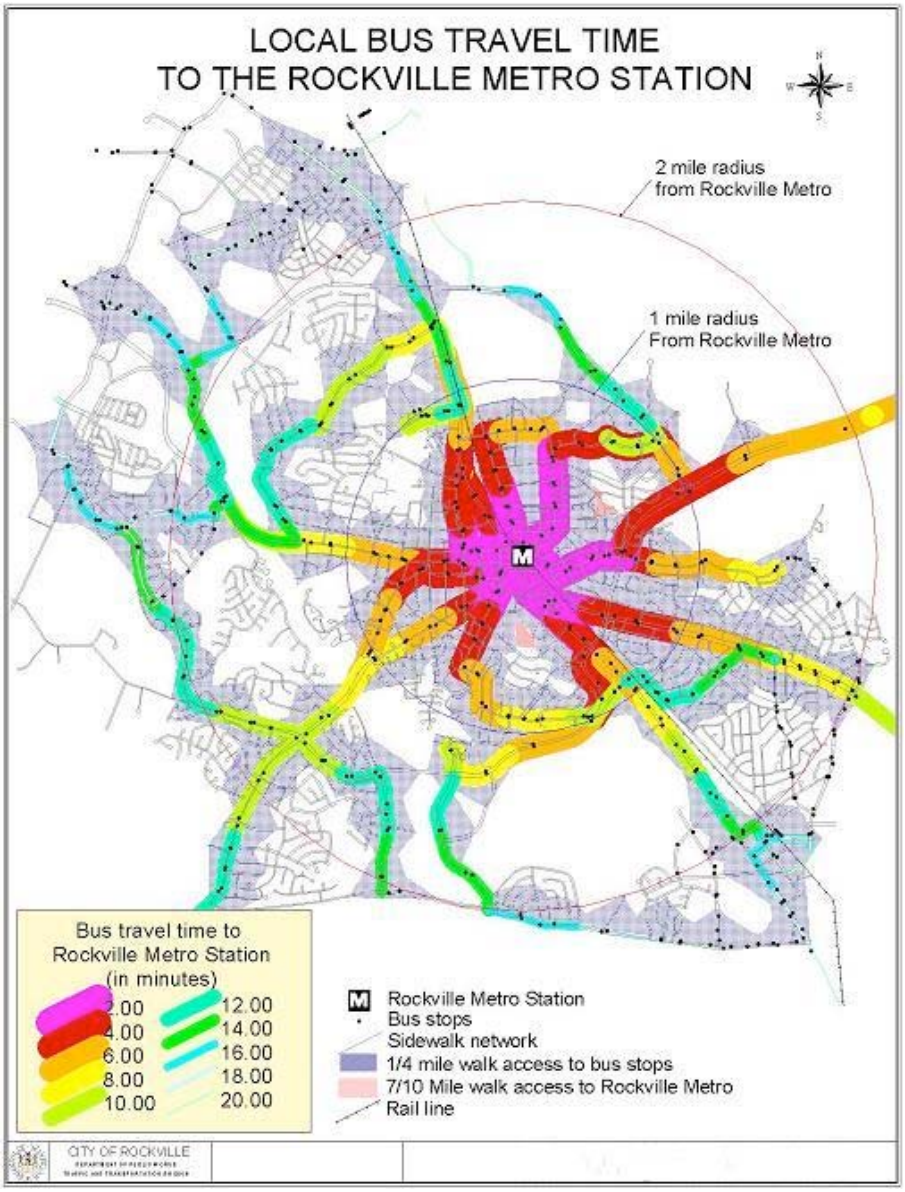

ACTUAL WALK SHEDS
TO TRANSIT SERVICE
N
W
E
S
M
Rockville Metro Station
Bus stops
Sidewalk network
1/4 mile walk access to bus stops
7/10 Mile walk access to Rockville Metro
Rail line
0
2000 Feet
CITY OF ROCKVILLE
DEPARTMENT OF PUBLIC WORKS
TRAFFIC AND TRANSPORTATION DIVISION

Figure 3

Walk sheds were cross-referenced with Census data to estimate population inaccessible to transit. Of the 47,388 residents, 23 percent (11,314) cannot access transit without a car.

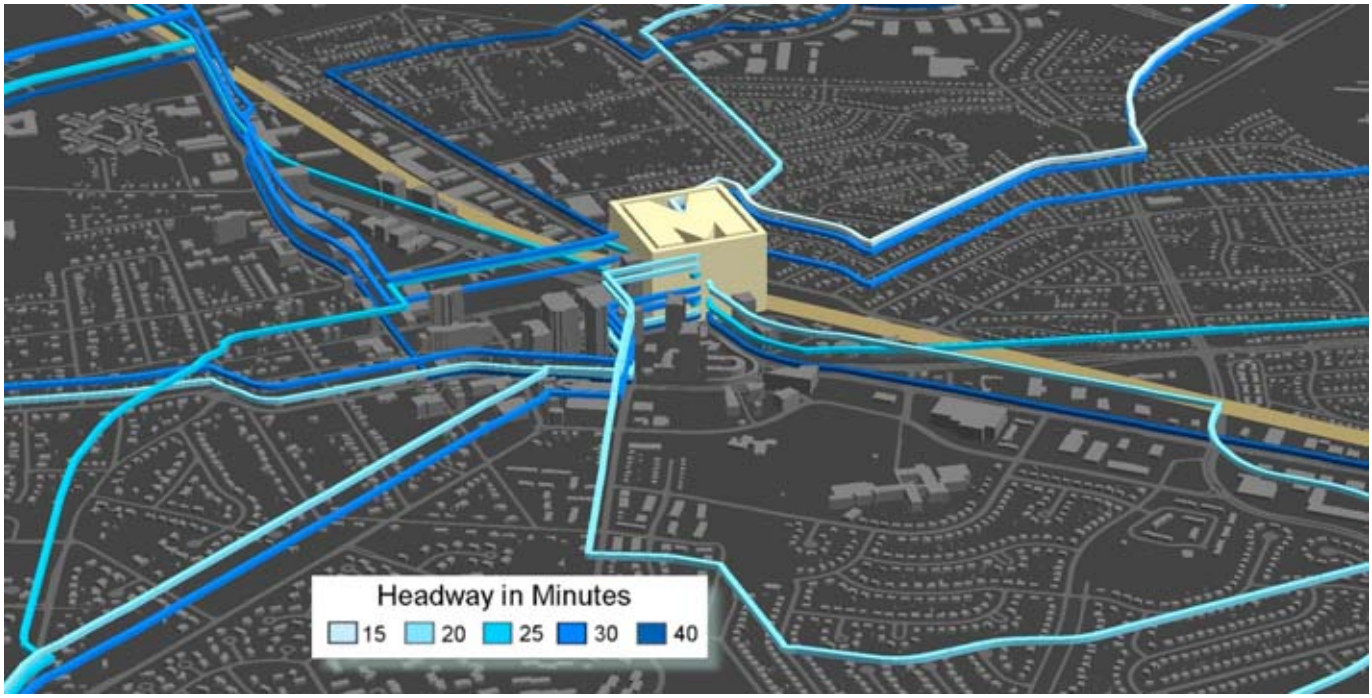
Objective 2: Increase the Number of Residents within a 10-Minute Travel Time to a Metrorail Station, Using the Local Bus Service

To evaluate access to the Rockville Metrorail station, the GIS model was used to integrate the results of Objective 1 with transit performance. Transit lines are color-coded, reflecting the travel time to the Rockville Metrorail station. Areas within the light green color meet the 10-minute threshold, as shown below.



Objective 3: **Maximize the Transit Frequency of Service**

Finally, the quality of transit service in Rockville was assessed using data on the frequency of transit service and the population/employment base. Below is a graphic displaying the results of this analysis, including overlapping service.



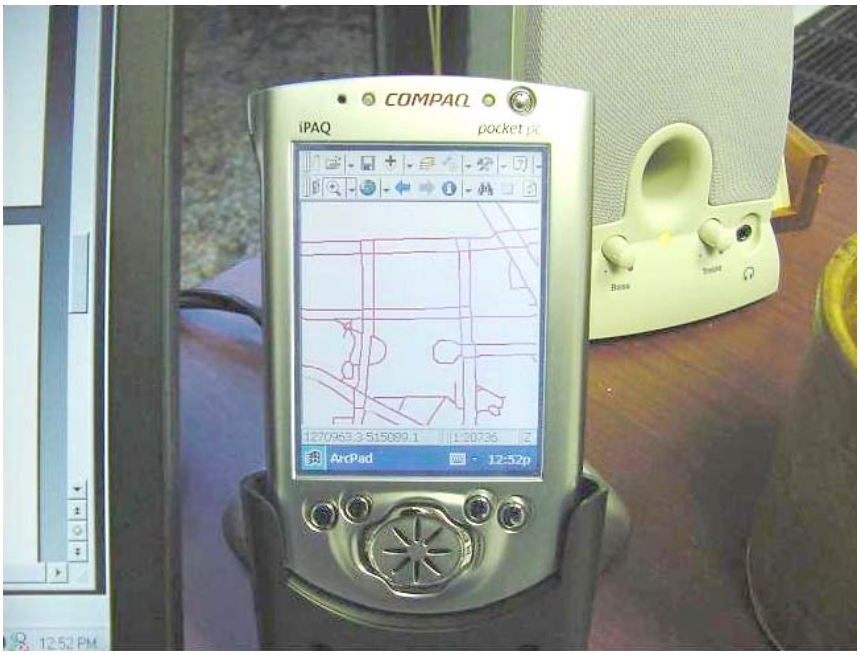
Staff evaluated the findings of this study, recommending the following modifications to the transit system, depending on the central issue in a given area:

(a) modify the route(s),
(b) add or change bus stop locations,
(c) add shuttle service.

Technology Applications -

Using GIS, laptops, Pocket PCs, and GPS technologies, the City collected, refined, and evaluated information critical to assessing its pedestrian and transit networks. Not only were these technologies indispensable during the data compilation stage, staff can also use these

technologies to continue to apply this information to tackle transportation questions and problems as they arise. For example, data is accessible by PocketPC software on iPAQ devices for quick reference for staff use. Web-based applications will follow upon completion of the refinement process. Below is a picture of sample information available on an iPAQ.



Initial research concludes that Rockville will be the first jurisdiction to complete a comprehensive multi-modal model and database. Further, these tools will be fully mobile, allowing City staff to access all the above referenced information anywhere at anytime.