

**Program Information:** Montgomery County, Maryland  
**Program Title:** Making Bicycling Easier In A Digital Way  
**Program Category:** # 14, Information Technology  
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## 1. Abstract of the Program

The Montgomery County, Maryland, Department of Technology Services – Geographic Information Systems (DTS-GIS) team and Department of Transportation (DOT) have published a detailed County bicycling map application with several unique tools. Additionally, a similarly styled poster-sized paper map has also been offered to the public.

## 2. The Problem / Need for the Program

Over the last ten years, DTS-GIS and DOT had previously attempted to display GIS data about bikeways in a couple of different formats, including a printed map booklet as well as an online application. A few problems diminished the utility of these earlier products for the end users, the cyclists of the County.

First, the GIS data used for the earlier products was a rough compilation of data sets created and maintained by several groups: different municipalities within Montgomery County, the Maryland-National Capital Park and Planning Commission, and the Department of Transportation. Some parts of the data geographically matched aerial photos very well, while other parts of the data simply didn't line up well when viewed in at a large scale (zoomed in close). Some of the data was categorized differently than others, including applying different trail categories for paved trails within parks and other paved trails, which, while useful for planners, was of little or no use to the end-user bicyclist. Furthermore, many popular on-road bike routes that weren't signed as official bikeways were largely ignored on the maps.

Second, so many bikeways over such a large geographic area presents a cartographic challenge. In the County, there are 280 miles of paved trails, 129 miles of unpaved trails, 72 miles of bike lanes or rideable shoulders, and 424 miles of on-road routes. Without careful cartographic planning, it is easy for this much linear data on a map to become illegible – a mess of different colored spaghetti splattered around the County. Depending on the scale and map size, detail may have to be sacrificed for the sake of legibility, and some of that map detail is highly desired by the cyclists. Also, with lines representing bikeways all over the map, it's easy for the design of the basemap – the streets, streams, parks, and other locations on which the bikeways are overlaid – to contribute to a noisy, difficult to read map.

Furthermore, County cyclists who contact DOT requesting bikeway maps are disproportionately male, and deuteranopia (common color-blindness) affects 5% of the male population. A map with colors and symbology not chosen to be sensitive to color

blindness easily could be useless to cyclists with this condition. If a user can't distinguish between an on-road bicycle route and a paved or unpaved trail, the map becomes of questionable value to that user.

Several years ago, DTS had tried to alleviate some of the challenges of mapping County bikeways using an ArcIMS-based online mapping application. While this application did succeed in showing users less detail when viewing the entire County and more detail when zoomed in on a neighborhood, it fell short in many respects. It was ugly. It was slow. The screen would take several seconds to refresh after each click of the mouse. While streets on the basemap were labeled, the bikeways themselves were not. It was challenging to zoom to an area of interest, survey the available bikeways, and plan the optimal riding route. If a user found a desirable route on the application, printing that route was often a frustrating experience. A separate option was provided, but the printed map often appeared very different from what the user viewed on-screen within the application. Also, the printing function of the application was designed to automatically add information such as a legend, data sources, and a disclaimer about the data, all of which took up valuable real estate on the user's printed page.

Finally, this earlier online application was very limited in what it could do and show, in large part restricted by the capabilities of the ArcIMS software – try to do or show too much and the application would have slowed to a crawl, and its clunky button controls would have grown more complex than what the average user would want to use.

### 3. Description of the Program

The revised map is a product of several steps, all taken with lots of input from County bicyclists. First, the bikeways GIS data set was greatly improved to overcome shortcomings of the past. Also, the map style and symbology was completely and carefully redesigned to emphasize what County cyclists want to see and eliminate unnecessary “map noise.” A simple but attractive base map was designed, and the needs of color blind users were addressed. Finally, the application was created using ArcGIS Server 10 and Flex API 1.3, providing quick screen refreshes. The technology also allowed DTS to provide more features than the earlier application, but with a more attractive and simpler interface.

The map was completely redesigned to be more aesthetically pleasing and legible. The data was reorganized to use just four bikeway categories: Shared Use Paths (paved trails), Natural Surface Trails (unpaved), Shared Roadways, and Bike Lanes / Shoulders. Colors were carefully chosen and reviewed for colorblind-friendly viewing with the aid of Color Oracle, a colorblindness simulation software. To make the basemap contribute less noise to the map, it was given an orange background with streets showing up as simple white lines. The few highways in the County on which bicycling is prohibited by State law were highlighted in a bold yellow. Because there were a large number of Shared Use Paths, a subcategory was added to the data to mark the main commuter trails, so all the smaller trails could be shown with a thinner, less “noisy” line. Bike shops were also added to the map.

Updated drafts of this map at poster size were posted regularly in PDF format to the DTS-GIS web page. DOT linked to this page and requested input from cyclists, especially active participants in an organized group that meets monthly with the DOT Bikeways Coordinator to discuss bicycling issues in the County. For several months, e-mails poured into DTS-GIS via DOT from citizens who noticed missing trails and, especially, popular but unofficial and unsigned roadway routes. DTS-GIS updated the bikeways GIS data accordingly.

To adapt this map and data into a smoothly running web application with shorter refresh times than the earlier application, the basemap data layers had to be processed separately from the bikeways-related data layers. ArcGIS Server allows a basemap layer to be cached, or rasterized at different scales; instead of calling up 30 data layers at each screen refresh, a cached application brings up an image of the basemap and overlays any data layers that are more likely to change, such as the bikeways. Furthermore, to show less detail when the user views the entire County and progressively more detail and landmarks as the user zooms in closer, the basemap layers needed to be carefully calibrated to turn on and off at different scales. Landmarks that appear when viewing at a very close scale include shopping centers, schools, and parks, all labeled. This scale-dependent viewing of layers with a lot of trial and error produced a cached basemap that is designed to show as much detail as can still be legible at each zoom level.

The ArcGIS Server application uses buttons for basic tools, but, unlike its ArcIMS predecessor, relies on widgets rather than button controls for many of the advanced functions the user can apply. This aspect of the newer technology has several advantages. First, widgets can be hidden and easily called up when needed, freeing up more of the valuable space on the screen for the map itself. They are also arguably more aesthetically pleasing on the screen. Because each widget has its own set of functions, the user more intuitively sees the connection between related functions grouped under the same widget.

Perhaps the greatest advantage of using widgets is the ability to offer more varied and improved functionality. The print function on the new application, for example, is applied from a widget that gives the option of generating a PDF map of the screen, exactly at the zoom level and visible features as set by the user; this PDF not only can be printed but also exchanged with others. Another widget offers “bookmarks” to quickly zoom in to cities or other areas of the County and even allows the user to create their own bookmark, stored in a cookie on their PC for future visits to the site. Where the older web application simply allowed contour lines to be shown on the map to get a feel for how “hilly” a ride would be, the new application also offers a “surface profile” widget. The user can trace a route with their mouse, and the widget will return a graph showing the profile of hills along the route. Another widget provides the user with a direct line to DOT’s bikeways coordinator via e-mail to report problems such as bad trail conditions, needed trail signage, or potential map improvements.

Under the tools menu at the top of the screen, additional widgets can be found and added to the desktop. One of these puts up traffic camera locations with a link to see live traffic conditions at that particular site. Another widget allows viewing of oblique aerial photos, a.k.a. “Bird’s Eye View,” from Bing, as well as, where available, Google StreetView. Bicyclists can literally see what a trailhead looks like before they set out to ride a new route the first time.

Figure 1: Initial countywide view with the Bikeways Map Viewer

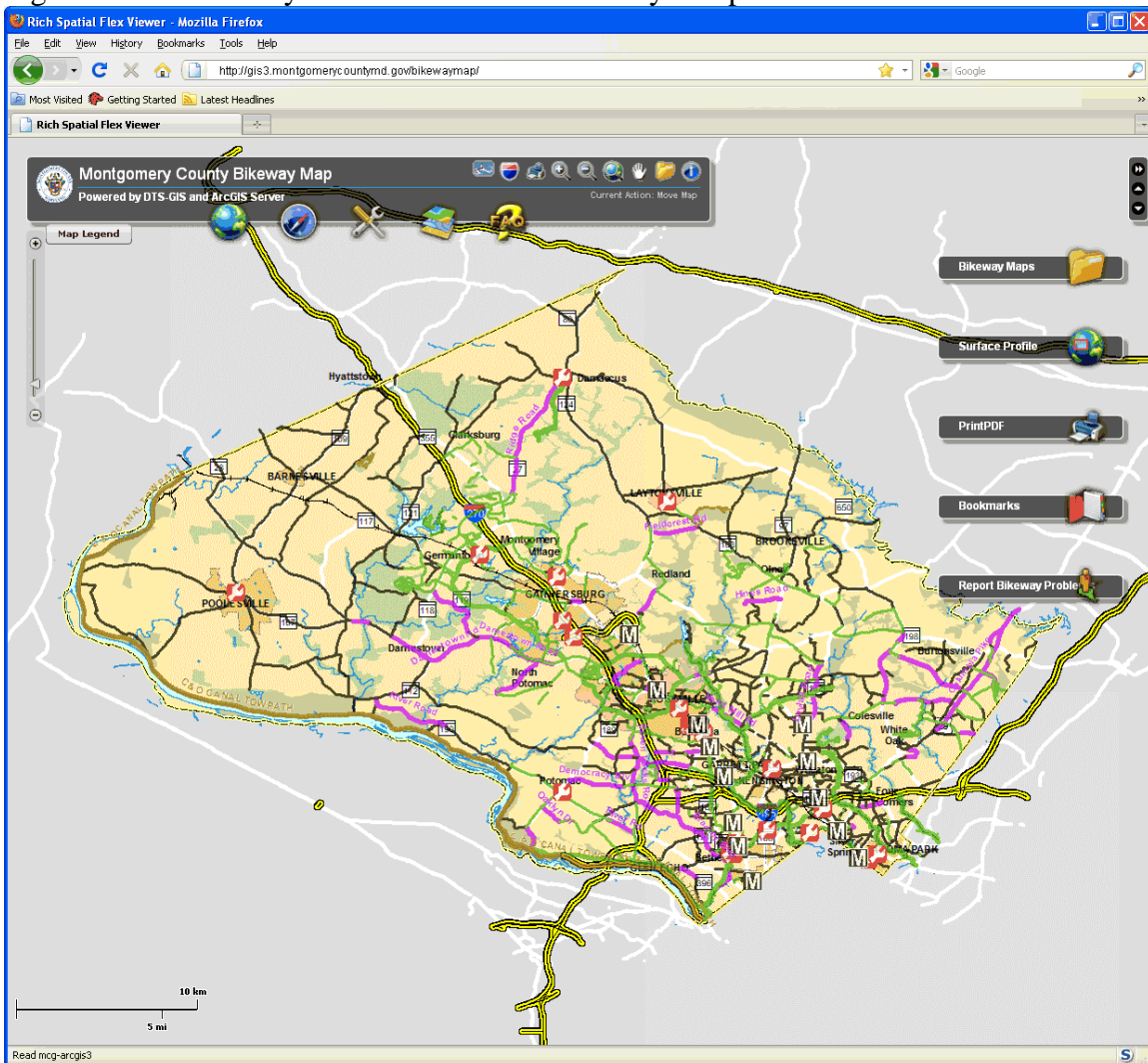


Figure 2: More basemap detail progressively shown as user zooms in closer, including shopping centers and schools, as well as edge of pavement of roads

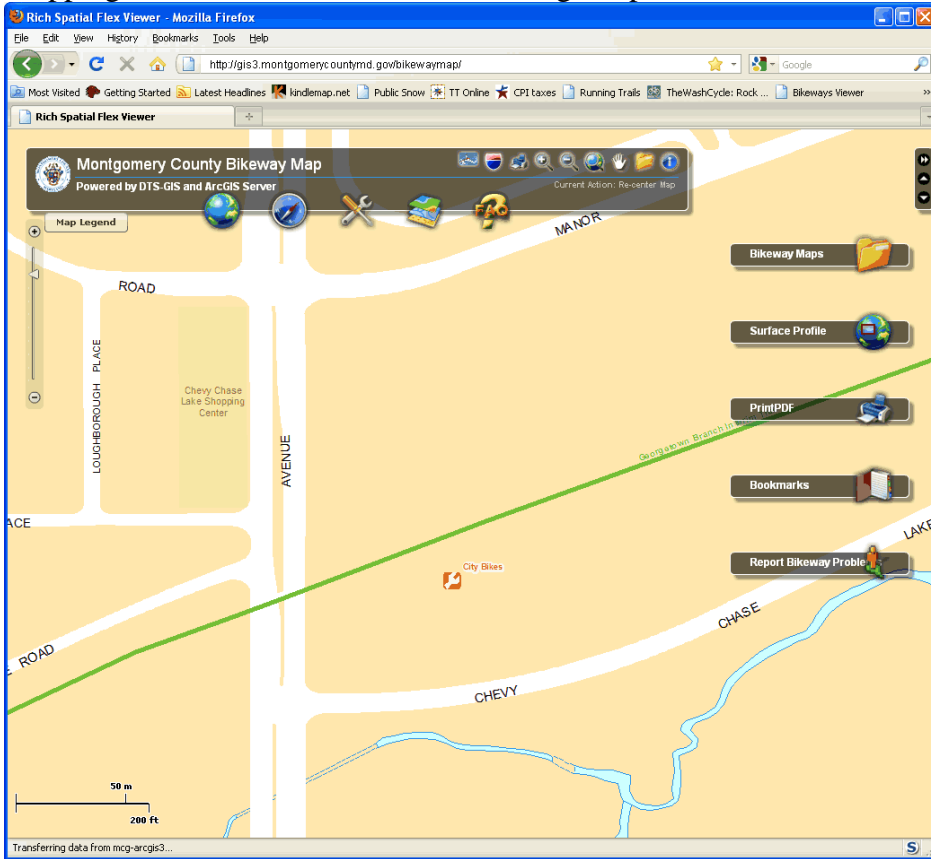


Figure 3: Bookmarks widget used to automatically zoom in on the Germantown area

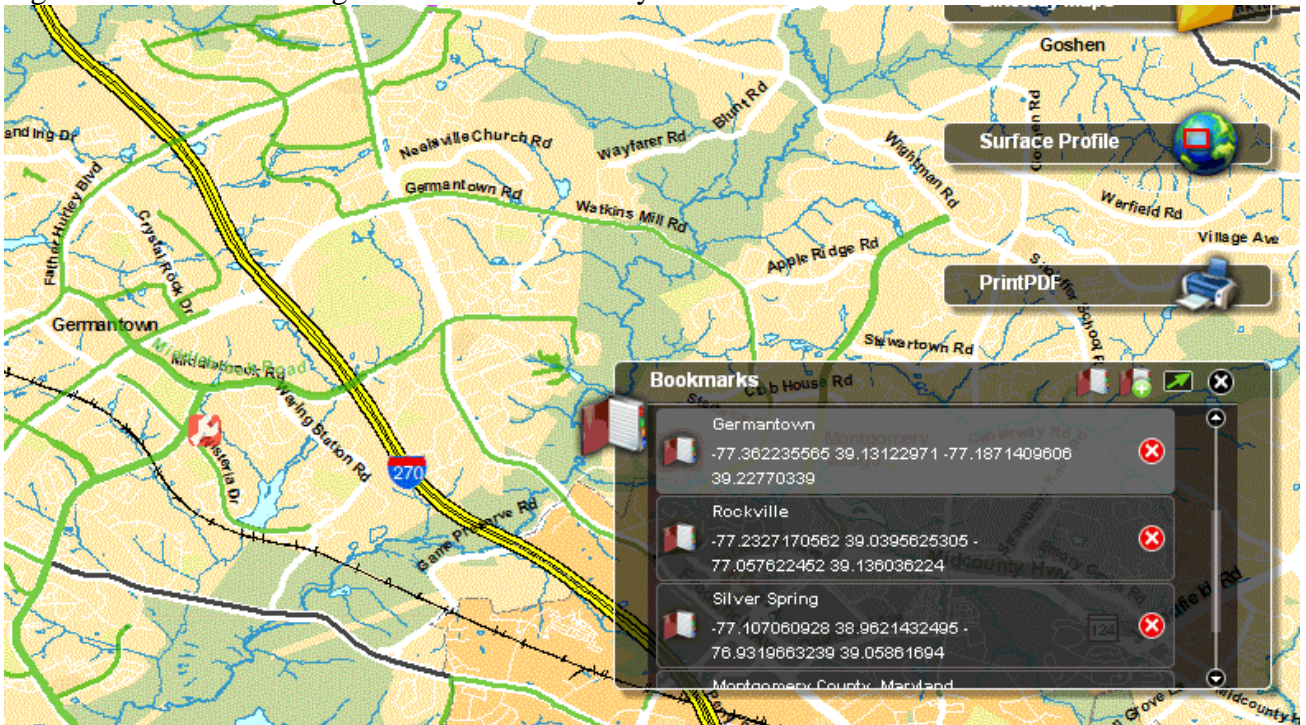


Figure 4: Surface profile (hills) along a traced bike route

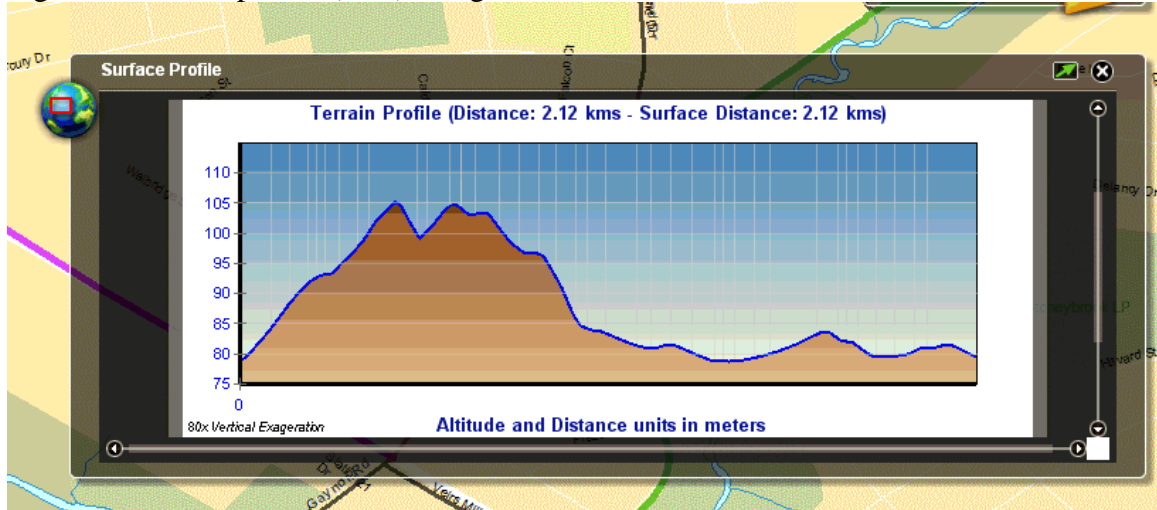


Figure 5: Widget allows users to report problems to DOT Bikeways Coordinator

4. Responding to Economic Downturn – Not Applicable

5. Use of Technology

The bikeways GIS data was edited and the basemap for the web application created using ArcMap 9.2 software. The poster-size paper map was further prepared for publication using Adobe Illustrator CS4. Color Oracle 1.1 was used to simulate colorblind viewing of the map and web application design. The latest ESRI ArcGIS Server and Flex API were adopted, we adopted the pre-built templates used for other high-end mapping projects to cut down the development time

6. The Cost of the Program

The *ArcGIS Server* license and the application server box were bought for enterprise-wide uses; therefore, there was no additional cost to this project alone! A senior

cartographer has been working part-time for several years to make the bikeway data and map increasingly more accurate and esthetically more pleasing. The total development time for the Flex map viewer is about 5 hours given the extensive experiences dealing with other high-end mapping projects.

## 7. The Results / Success of the Program

The first version of Bikeways Map Viewer went live in January 2011. The viewer can be accessed on the Internet at <http://bikemap.montgomerycountymd.gov>.

DOT received positive feedback and a few suggestions about the viewer from bicycling advocates who attended a recent DOT monthly meeting. Generally, they praised both the printed version of the map and the web application derived from it. The chairperson of the group even stated that he felt this was the best bicycling map of the County to date and that this map “finally got it right.” Several improvements per recommendations of the group were made throughout 2011 following the initial launch.

A poster-size PDF of the printed version of the map is available for download at <http://www.montgomerycountymd.gov/content/gis/bikeways.asp>. A full sized bike route map was published for use by the public and distributed on National Bike To Work Day in May 2011 at the County’s ten “pit stop” sites.<sup>1</sup> The public has indicated a use and a need for the printed map as well as the other types of applications.

## 8. Worthiness of Award

The project showcases a successful collaboration—a long term working relationship (10 years and counting) between the GIS Cartographer and the DOT Bikeway Coordinator. The formal patiently and painstakingly analyzed user’s (changing) needs and created a near-perfect Bikeway data layers. The poster-size PDF map created is of highest quality and is well liked by the cycling community.

The project also showcases the close collaboration between the cartographer and the GIS web app developer. The tidily selected GIS data layers, well designed presentation and map symbols made the web developer’s job easier and the end product that much more attractive.

The project also exemplifies the ArcIMS to ArcGIS Server migration success story. Speed is increased; maps are more attractive; functions/features are increased. The migration is painless!

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<sup>1</sup> The map received the People’s Choice Award at the 2011 ESRI Mid-Atlantic User Conference, Hunt Valley, Maryland. December 6-7, 2011.