

Program Information: **Montgomery County, Maryland**
Program Title: **Online Snowplow Tracking System**
Program Category: **# 14, Information Technology**

1. Abstract

The Montgomery County, Maryland, Storm Management Operations Map, developed by the Department of Technology Services (DTS) in close collaboration with the Department of Transportation (DOT), provides a new online tool that makes it easier for citizens to decide when to safely venture out following a snowstorm. The online map tool shows the progress of snow plows throughout the County and indicates when emergency routes, primary roads and neighborhood streets have been cleared. Using the map's search capability, residents can immediately focus on the plow status of their street and surrounding streets and then zoom out to check on the status of their entire route.

Each road category, whether an emergency/main route or neighborhood street, is designated on the map by a different color. Patterns are used to show whether plowing has started, is in progress or complete. The map also provides residents instant access to live views from any of the County's nearly 200 traffic cameras along with other helpful information, such as the location of bus stops, Metro stations and all public schools throughout the County. Residents may also use the online map to easily report an intersection that needs additional sand or salt, a missed street, or a damaged mailbox during a snowstorm.

By using in-house resources, the County was able to develop a system that more effectively met the County's needs at a considerable lower cost than the current systems available on the market. Following the County Executive's press conference on the subject, our online Snowplow Tracking System was widely featured by the area media such as NBC, CBS, Fox News and the Washington Post.

2. The Problem / Need for the Program

Last winter, Montgomery County, Maryland endured 3 major snowstorms with each snow event dropping over 2 feet of snow across the County. Many County residents were stranded in their homes for days, as the Department of Transportation worked on the priority emergency routes before sending plows to the less-traveled neighborhood routes. Following these record-breaking snowfalls, Montgomery County Executive Isiah Leggett challenged the County Government to find better ways to communicate with frustrated residents during snow storms.

During these major snow events, citizens need to know the condition of the roads beyond their current location in order to make an informed decision to travel. DOT policy is to clear all emergency roads and primary neighborhood roads to the pavement prior to sending plows to clear the secondary neighborhood roads. While citizens can determine the status of their road outside of their home by looking out a window, they need more information on all of the roads in their planned route in order to make an informed decision to travel (or stay home).

If citizens can be informed of the status of all the roads in their surrounding area, they may choose the route which has been cleared and avoid an alternate route which has not been cleared or may contain a closed intersection. Additionally, if the neighborhood roads in the immediate vicinity are all impassible, citizens may choose to hike out to the nearest bus stop or Metro station if they can determine the condition of the roads in those locations as well as the distance and the route they would need to hike.

When a major storm occurs, such as the snowstorm on February 5-6, 2010 that dropped 22 to 28 inches of snow on County roads (with drifts over 3 feet), residents may not see snow plows on their secondary neighborhood roads for days. For residents with critical needs (needing medicine, food, heat, medical attention, etc.), an informed decision to travel in the correct direction can make a major difference in outcomes.

3. Description of the Program

The solution chosen by the County was to develop an online Storm Management Operations Map, built in-house using *ArcGIS 10*, including *ArcGIS Server* and *ArcGIS Desktop* software. The system leverages *ArcGIS Server*, ESRI's Flex API 1.3 and Sample Viewer. The system was developed by the DTS Geographic Information System (GIS) and Application Development (ADT) teams in close collaboration with the Department of Transportation, Division of Highway Services. The development and implementation timeframe was very tight. The authorization to proceed, indicated by the signing of the Project Charter was obtained in August 2010. The deadline for implementation was the beginning of the snow season in December 2010.

Two versions of the Storm Management Operations Map were developed:

- A public view which is available on the County's Internet page during a snowstorm
- An internal view for the DOT Storm Operations Center (SOC) staff. The internal version contains regions for each of the County's snowplow routes and provides the capability for DOT SOC staff to publish road status after it has been verified.

Storm Management Operations Map – Public View

Map and Navigation menu – The public can access the map from County's Internet site. Figure 1 shows the initial map view and tool features; buttons for the zoom-in/out navigation, reference layers (bus stations, traffic cameras, Metro stations) and intersection search widget were built on top of the banner.

The Map Legend is displayed on the left, providing the key to the color codes used to mark streets based on their type (Emergency, Primary Neighborhood, Secondary Neighborhood) and plow status (Not Started, In Progress, Complete).

Residents are immediately prompted with a search widget to "Find My House" and then click the "Locate" button. The map application will validate the address and then display a ¼ mile radius of the neighborhood surrounding the address, as shown in Figure 2. Additionally, the text box that accompanies the address on the map will indicate whether the road is County maintained, the Plow Priority (Emergency, Primary Neighborhood, Secondary Neighborhood) and the current plow status (Not Started, In Progress, Complete).

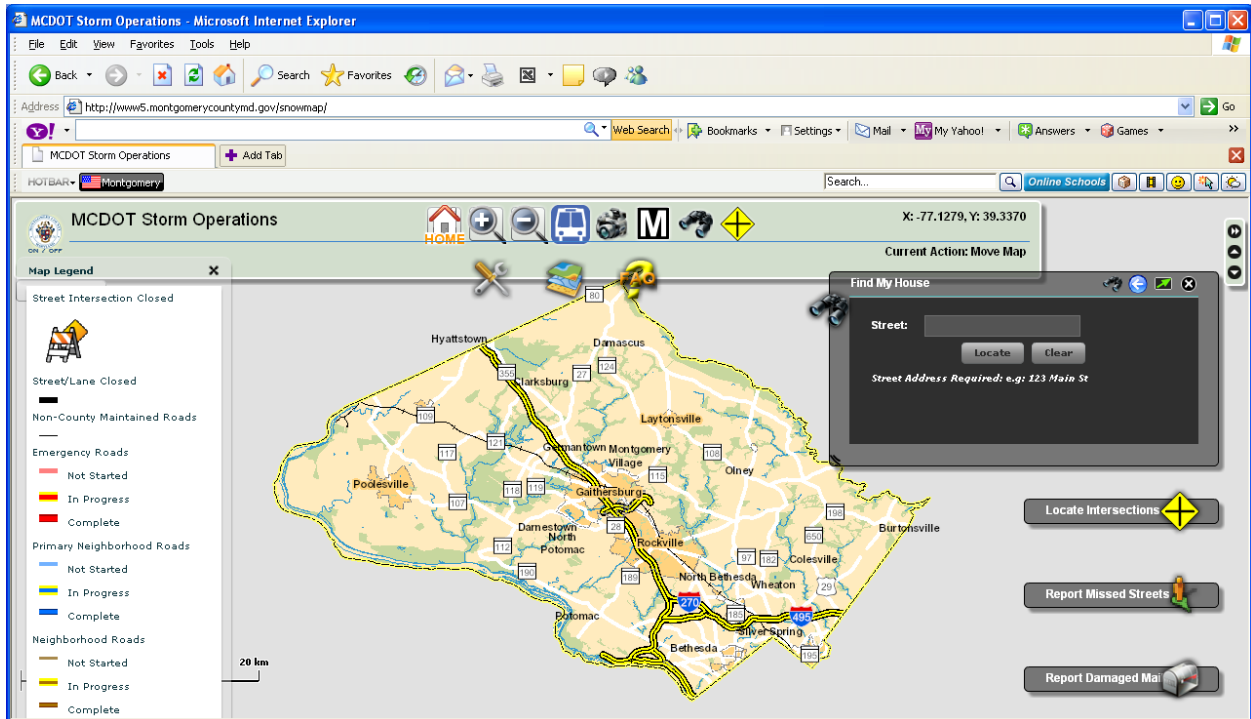


Figure 1 – Storm Management Operations Map (Initial View)

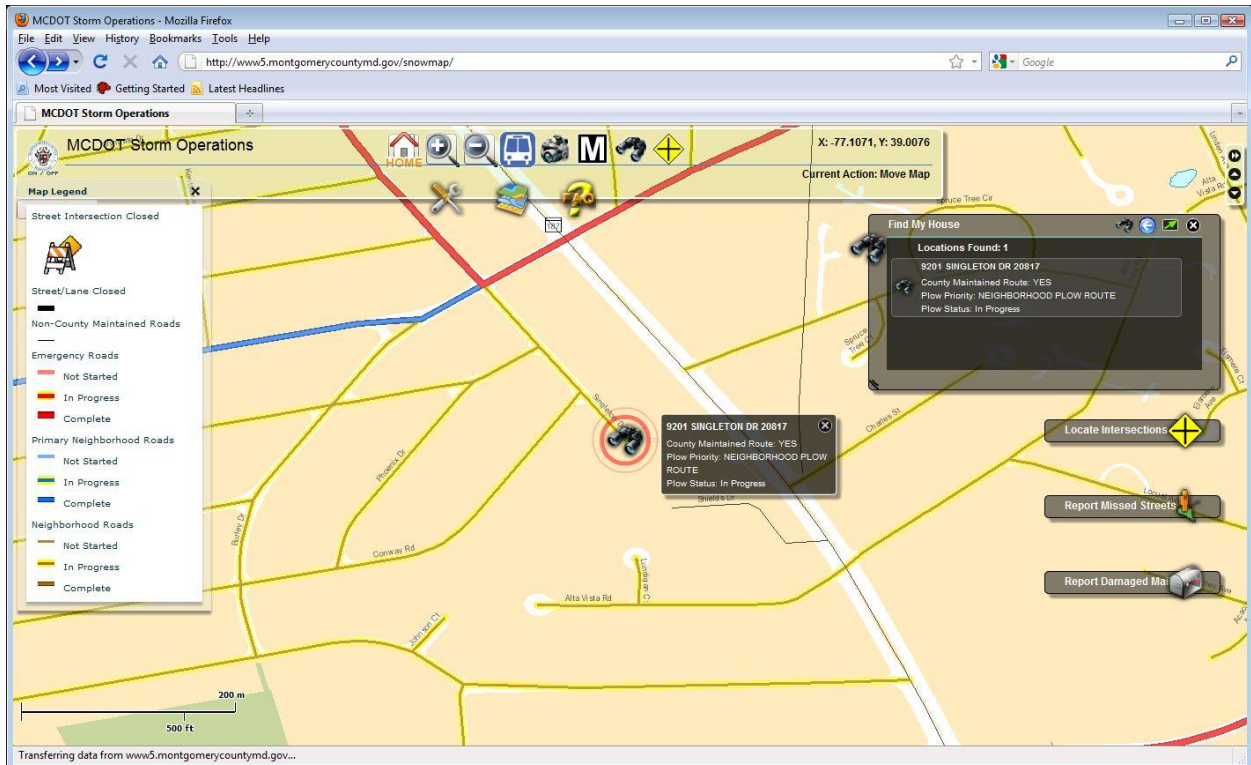


Figure 2 – “Find My House” search result, displaying a ¼ mile radius surrounding the resident’s address.

Once an initial address is located on the map, the resident may use the “zoom-out” and “zoom-in” features of the navigation bar to display more (or less) of the surrounding area on the map. Figure 3 displays the result of two “zoom-outs”, now displaying approximately 1 mile radius surrounding the address. Notice the sawhorse icon indicating “Street Intersection Closed” less than ½ mile northeast of the resident’s location.

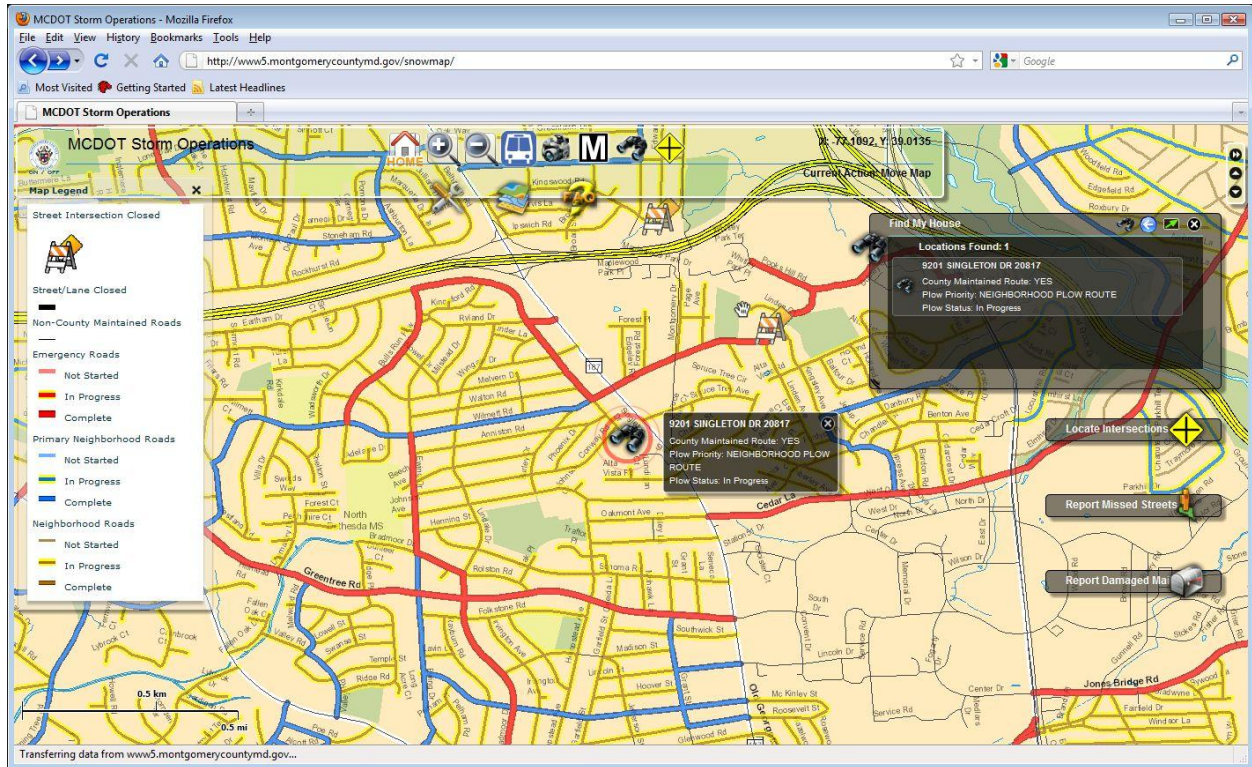


Figure 3 – “Find My House” search result, zoomed out 2 times.

Tools Menu – The Tools Menu contains two useful features for residents: “Report Missed Streets” and “Report Damaged Mailboxes”.

Once a street has been marked as “Complete”, a resident may submit a Missed Street Report to the DOT indicating that the street is not completed. Each Missed Street Report will show up as a flag on the internal DOT version of the map and will result in re-scheduling a snow plow to resolve the problem. The application pre-populates the resident’s address from the “Find My House” search result into the “Report Missed Street” form. See Figure 4 for an example.

Residents may also report a mailbox damaged by snow clearing equipment during a snowstorm using a very similar map widget. Damaged mailbox reports from the map are sent to a backend complaints resolution application for resolution.

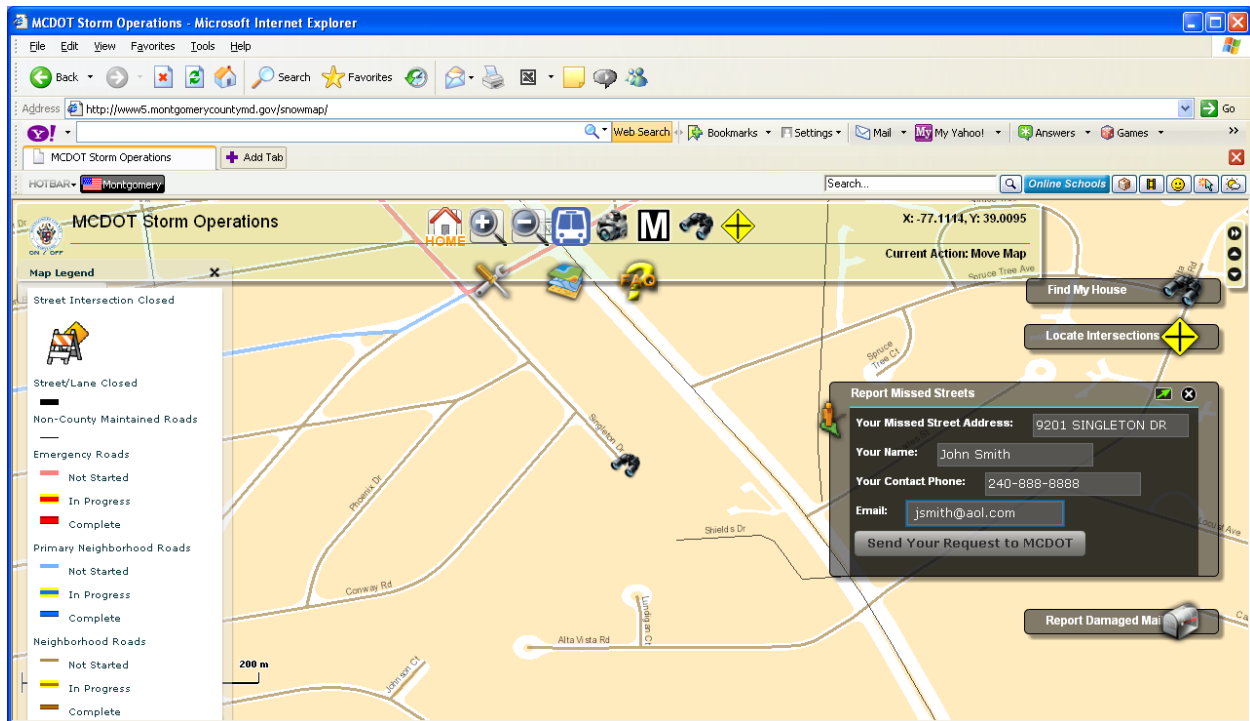


Figure 4 – “Report Missed Street” map widget

Live Feeds Menu – The Live Feeds menu toggles on/off additional layers of the map, including “Traffic Cameras”, “Metro Stations”, “Elementary Schools”, “Middle Schools”, “High Schools”, “Hospitals” and “Fire Hydrants”. In addition, there are menu options for the “Find My House” and “Locate Intersections” search locators. Figure 5 shows the map with layers for Metro Stations (black “M” icon), hospitals (blue “H” icon), traffic cameras (camera icon) and elementary schools (blue building with flag icon) enabled.

Residents can click on any of the traffic camera icons to immediately view a web page containing the live feed from the camera at that intersection (see Figure 6). During a snowstorm, residents can use the visual feed from these traffic camera to provide visual confirmation of the status displayed on the map as well as viewing current traffic conditions.

The icons for the other layers behave in a similar fashion. Clicking a Metro Station icon will display the Washington Metro Area Transit Authority (WMATA) webpage for that specific station. Clicking a hospital icon will display the webpage of the selected hospital. Clicking any public school icon will display the Montgomery County Public School (MCPS) emergency page, which contains information about school closings.

Fire hydrant locations are provided as an optional layer on the map so that residents, heeding County requests that residents clear snow around the fire hydrants in their immediate neighborhood, can easily locate the hydrants (see Figure 7).

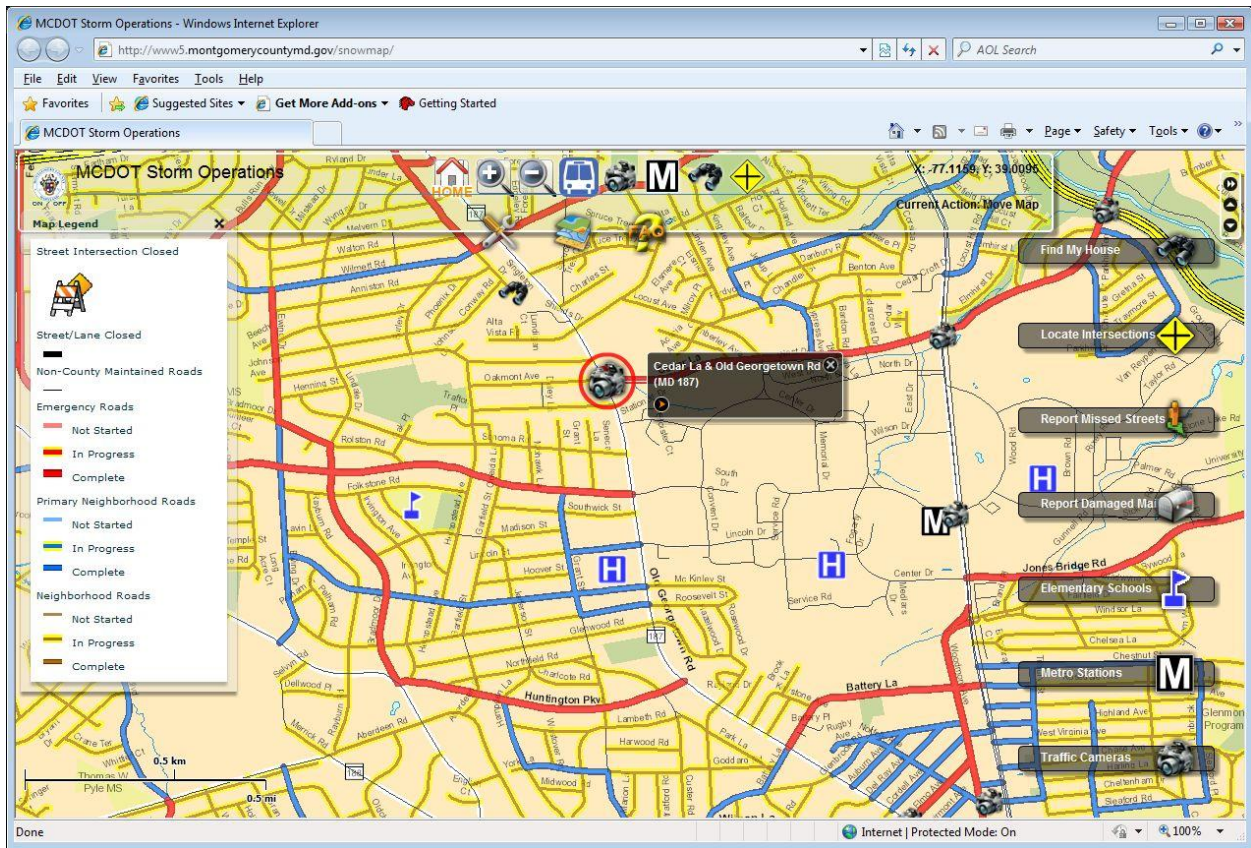
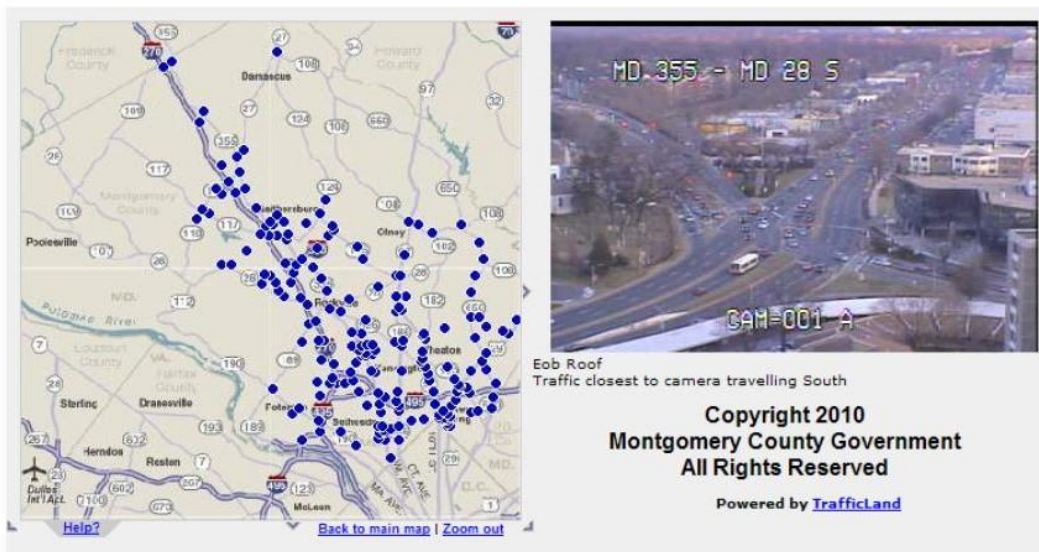


Figure 5 – Layers for Metro Stations, Hospitals, Traffic Cameras and Elementary Schools enabled.

Montgomery County Traffic Cameras



Which direction is the camera pointing? See: [Our Camera Titling Convention](#)

Figure 6 – Live Traffic Camera feed obtained by clicking the camera icon from the map.

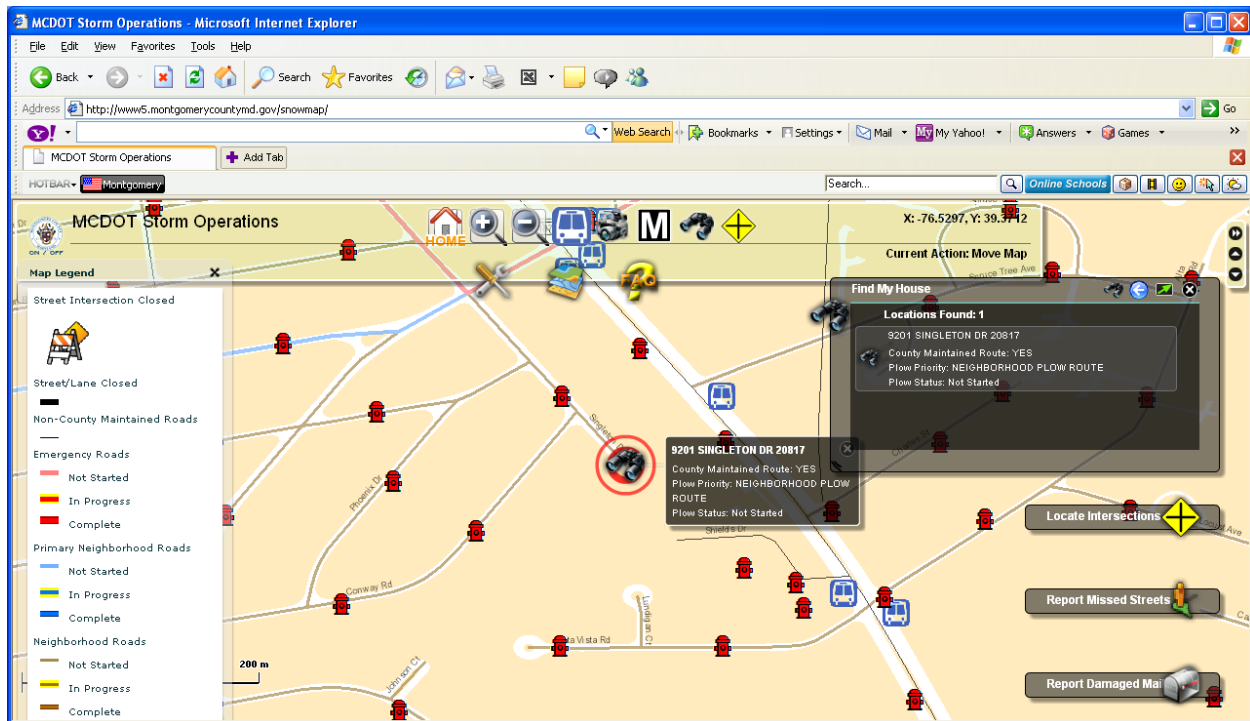


Figure 7 – Optional Fire Hydrant data layer.

Storm Management Operations Map – Internal DOT View

The internal DOT version of the Snow Operations Map contains all of the features of the public map, plus some additional functions required by DOT to assist in their management of snow removal operations. For example, the internal version of the map is divided and bookmarked into 7 depot area so that each County depot can go right to their area of responsibility. In addition, the hundreds of County snow plow routes are also identified on the internal version of the map (see Figure 8). The snow plow route numbers are important because when a snowplow operator radios in with status updates on his route, the depot manager can update the status by route number rather than street-by-street. Each snow plow route contains multiple streets and street segments.

The internal version of the map also contains a widget that calculates and reports real-time status in pie chart format for the entire County.

When residents report a missed street using the public version of the map, a red flag icon displays the location on the internal version of the map (see Figure 9). Similarly, a mailbox icon on the internal map displays the location of any mailbox damage reports.

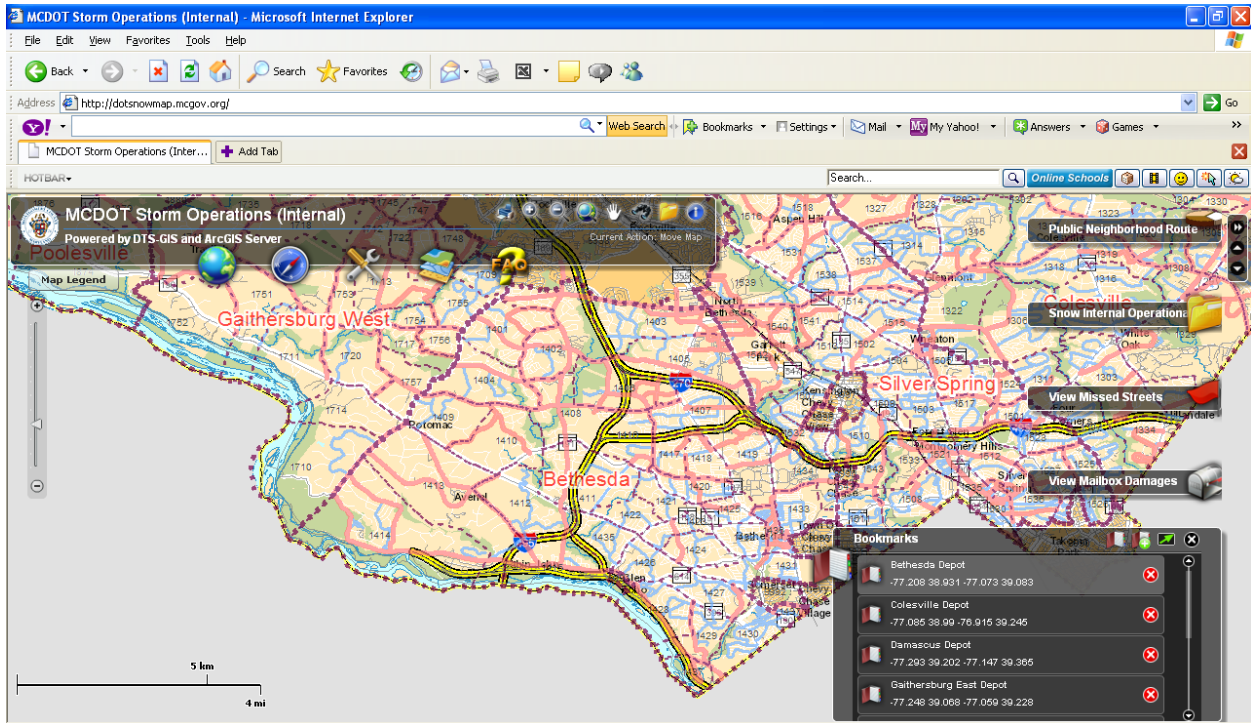


Figure 8 – Internal DOT version, identifying depot areas and snow plow route numbers.

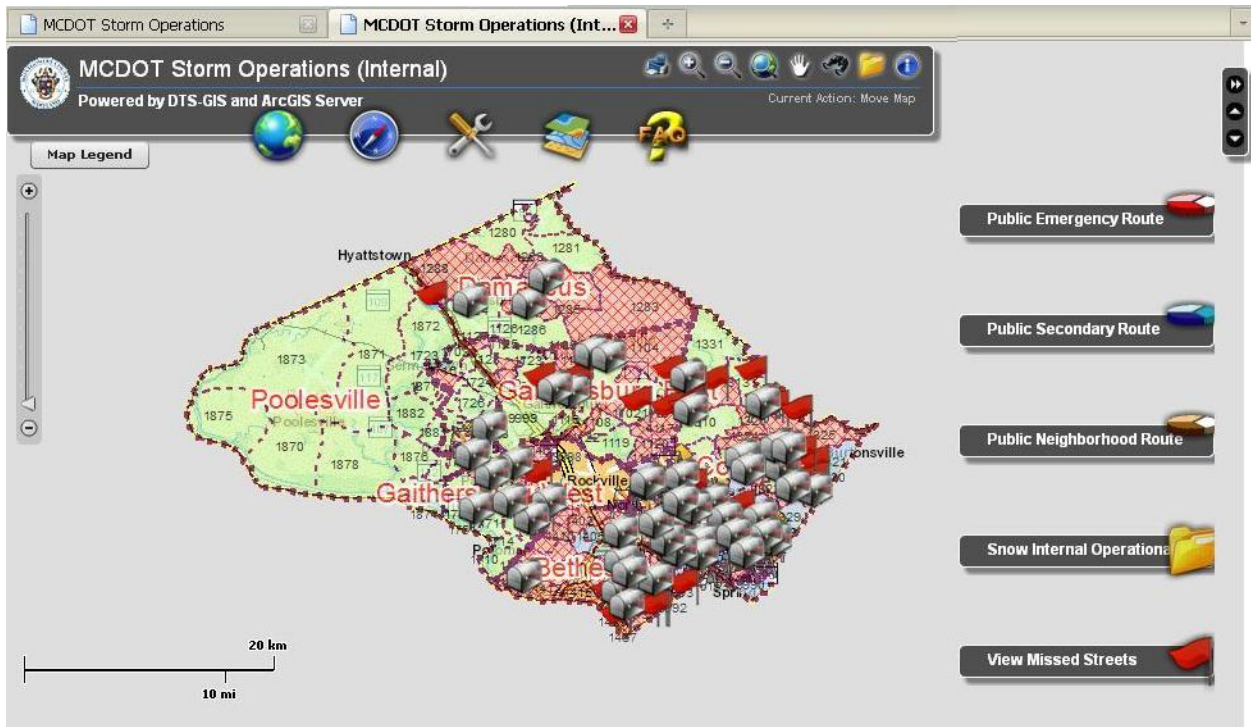


Figure 9 – Internal DOT version, showing flags indication the location of Missed Street Reports and mailbox icons indicating Mailbox Damage Reports.

4. Use of Technology

Both the public and internal versions of the Storm Management Operations Map were built by the County (in-house) using *ArcGIS 10*, including *ArcGIS Server* and *ArcGIS Desktop* software. The system leverages *ArcGIS Server*, ESRI's Flex API 1.3 and Sample Viewer and Adobe's Flash Action Scripts. During the usability and integration tests, the County determined that a significant number of the standard functions and tools provided with ESRI's flex sample viewer often resulted in misleading or incorrect results. Significant customizations were performed in-house to improve the granularity and accuracy of data presented.

Moving away from many Flex Map Viewers in the US which use ESRI's provided base map, the County's basemap uses the local planimetric layers so that the redisplay of the roads (emergency, primary neighborhood and secondary neighborhood) for displaying snowplow status overlay more accurately with the basemap.

This system was developed by the DTS Geographic Information System (GIS) and Application Development (ADT) teams in close collaboration with the Department of Transportation, Division of Highway Services.

5. The Cost of the Program

The total cost to the County for development and implementation of the Storm Management Operations Map was \$162,340. These costs cover software licenses, hardware and professional services staff augmentation. (In order to make critical County resources available to work on this project, it was required to procure funding for professional services contractors to complete other projects already in progress.) Additionally, in-house DTS resources were assigned to the project at no cost to DOT.

- Software licenses (ArcGIS Server, ArcGIS Desktop): \$23,630
- Hardware (2 standard servers, virtualized) : \$87,130
- Professional Services (staff augmentation): \$51,580
- Senior GIS Application Developer: 4 months, full time
- Senior GIS Data Specialist: 4 months, half time
- Senior Application Developer: 4 months, full time
- Application Quality Assurance: 2 months, half time
- Project Manager: 4 months, half time

Many of the commercial online map systems reviewed by DOT prior to the initiation of this project had price tags over \$1 million, which also did not contain the wealth of features provided with this in-house solution.

6. The Results / Success of the Program

The **Storm Management Operations Map** has accomplished the following:

1. Provides residents of the County with the most up-to-date road status available for their location and any location in the County they may be considering traveling to during a

snowstorm. Additionally, if residents are considering public transportation, the status of the roads along the bus routes and Metro station is available.

2. Notifies residents of intersection/road closures during a snowstorm, allowing them to plan an alternate route before leaving their homes or offices.
3. Supports businesses in the County by providing the information they need during a snowstorm in evaluating their decision to continue or suspend operations.
4. The Snow Management Operations Map averages over 2,000 unique visitors and over 10,000 hits during a snowstorm of 4 inches or more.
5. Supports the County's Storm Operations Center by providing graphical location information for missed streets during a snowstorm. Storm Operation Center managers can more easily redirect snow removal equipment in the area to resolve the issues.
6. Extensive tuning on applications and servers (web and app) to ensure that we can support 30,000 concurrent users with less than 2 seconds responses.

7. Worthiness of an Award

The Storm Management Operations map delivers a rich set of map layers and information to County residents during snowstorms. Much of this information, such as the snowplow status of individual roads and closed intersection is not available anywhere else. The combination of GIS information, direct links to alternate transportation options and live traffic camera feeds provides residents with the most up-to-date information all in one place. Using this information, residents can make much better decisions about how to travel, when to travel and in which direction to travel if they need to travel during a snowstorm.

Additionally, the experience gained in developing this application has generated many more ideas for GIS-based application to provide better and more timely information to County residents.

In developing this application, the County spent many hours learning and in some cases improving upon the functionality of ESRI's Flex API and Sample Flex Viewer. Some of the major technical highlights of unique solutions:

- The "Find My House" widget was customized to locate not only the address but also the plow status. ESRI's original Locator widget often reported an incorrect plow status. ESRI spent over 23 hours of support from 8 SDK primary support staff with no improvement in results. The County was able to come up unique solutions to resolve the issue.
- The "Report Missed Streets" and "Report Mailbox Damage" widgets are pre-populated with addresses from the "Find My House" locator widget using the info communication channel to submit the service request to the backend intake programs. We have not found any other program which is able to pass address information between the widgets.

Finally, the low cost of development for this application, especially when compared to commercial offerings makes this a great value for County residents in times of sever budget crisis.