



A CDI Company

*Report for*

# State of West Virginia Broadband Field Testing Region 9

*Prepared for*

## State of West Virginia Geological and Economic Survey And Office of GIS Coordination

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ARCHITECTURE • ENGINEERING • COMMUNICATIONS TECHNOLOGY

AVIATION | CIVIL | CONSTRUCTION SERVICES | DATA SYSTEMS | ENVIRONMENTAL  
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## TABLE OF CONTENTS

|   |    |
|---|----|
| EXECUTIVE SUMMARY .....   | 1  |
| 1. METHODOLOGY .....  | 2  |
| 1.1 INITIAL DATA COLLECTION .....   | 2  |
| 1.1.1 West Virginia Statewide Addressing and Mapping Board 2011 Centerlines ..... | 2  |
| 1.1.2 West Virginia Statewide Addressing and Mapping Board 2011 Structures .....  | 3  |
| 1.1.3 Speed Test Points .....   | 3  |
| 1.1.4 West Virginia Statewide Addressing and Mapping Board 2011 Imagery .....     | 4  |
| 1.1.5 QoS Solutions Android Applications .....                                    | 4  |
| 1.1.6 AT&T Samsung Galaxy S III Phone .....                                       | 5  |
| 1.1.7 nTelos Samsung Galaxy S Phone .....   | 5  |
| 1.1.8 US Cellular Samsung Galaxy S III Phone .....                                | 5  |
| 1.1.9 Verizon Samsung Galaxy S III Phone .....                                    | 5  |
| 1.2 FIELD DATA COLLECTION .....   | 5  |
| 1.2.1 Roads Traveled .....  | 5  |
| 1.2.2 Speed Test Point Validation .....   | 6  |
| 2. TEST RESULTS .....   | 8  |
| 2.1 QPERF TEST RESULTS .....  | 8  |
| 2.1.1 AT&T QPerf Results .....  | 8  |
| 2.1.2 nTelos QPerf Results .....  | 10 |
| 2.1.3 US Cellular QPerf Results .....   | 12 |
| 2.1.4 Verizon QPerf Results .....   | 14 |
| 2.2 QCARRIER TEST RESULTS .....   | 16 |
| 2.2.1 AT&T QCarrier Results .....   | 16 |
| 2.2.2 nTelos QCarrier Results .....   | 17 |
| 2.2.3 US Cellular QCarrier Results .....  | 18 |
| 2.2.4 Verizon QCarrier Results .....  | 19 |
| 2.3 WEST VIRGINIA BROADBAND MAPPING SURVEY RESULTS .....                          | 20 |
| 3. CONCLUSION .....   | 26 |
| 3.1 CARRIER CONNECTIVITY .....  | 26 |
| 3.2 RECOMMENDATIONS .....   | 26 |
| 3.3 BROADBAND TECHNOLOGIES .....  | 26 |
| 3.3.1 Cable .....   | 26 |
| 3.3.2 Fiber Optics .....  | 27 |
| 3.3.3 Digital Subscriber Line .....   | 28 |
| 3.3.4 Wireless .....  | 28 |
| APPENDIX A—QOS SOLUTIONS ANDROID APPLICATIONS .....                               | 30 |

## TABLE OF FIGURES

|   |    |
|---|----|
| Figure 1—Initial WV SAMB 2011 Centerlines with Proposed “Drive Centerlines” ..... | 3  |
| Figure 2—Initial Speed Test Point Locations .....                                 | 4  |
| Figure 3—Roads Traveled During Drive-Testing .....                                | 6  |
| Figure 4—Final Speed Test Point Locations.....                                    | 7  |
| Figure 5—NTIA Speed Tiers.....  | 8  |
| Figure 6—AT&T Downstream Speed Values.....  | 9  |
| Figure 7—AT&T Upstream Speed Values .....   | 10 |
| Figure 8—nTelos Downstream Speed Values .....                                     | 11 |
| Figure 9—nTelos Upstream Speed Values.....  | 12 |
| Figure 10—US Cellular Downstream Speed Values.....                                | 13 |
| Figure 11—US Cellular Upstream Speed Values .....                                 | 14 |
| Figure 12—Verizon Downstream Speed Values.....                                    | 15 |
| Figure 13—Verizon Upstream Speed Values .....                                     | 16 |
| Figure 14—AT&T QCarrier Results, Based on RSSI_DM .....                           | 17 |
| Figure 15—nTelos QCarrier Results, Based on EC/IO .....                           | 18 |
| Figure 16—US Cellular QCarrier Results, Based on EC/IO.....                       | 19 |
| Figure 17—Verizon QCarrier Results, Based on EC/IO.....                           | 20 |
| Figure 18—Broadband Survey Participant Locations .....                            | 25 |
| Figure 19—Typical Download Speeds Using Standard Mediums.....                     | 27 |

## EXECUTIVE SUMMARY

L.R. Kimball respectfully submits this Findings Report for Broadband Field Testing (Findings Report) to the State of West Virginia Geological and Economic Survey and the Office of GIS Coordination (State). The State contracted with L.R. Kimball to provide broadband data verification tasks including statewide wireless broadband field testing. In August 2013, L.R. Kimball performed testing in the Region 9 Eastern Panhandle Regional Planning and Development Council area consisting of Berkeley, Jefferson and Morgan Counties, West Virginia.

The broadband field testing consisted of drive-testing the three county area while using specific app-enabled smartphones provided by the State. The purpose of this testing was to assess the spatial and attribute accuracy of the service area polygons that four providers, AT&T, nTelos, US Cellular and Verizon, submitted to West Virginia in March 2013 as part of the National Telecommunications Information Agency (NTIA) State Broadband Data and Development Program (SBDD). Comparisons between the field data collected and the provider-supplied service area polygons facilitated the identification of possible coverage and speed inaccuracies reported to the State by the providers. This findings report will discuss the methodology associated with the field collection and the results of said field collection.

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## 1. METHODOLOGY

The drive-testing phase of this project was initiated August 19, 2013 in Petersburg, West Virginia. It continued through August 22, 2013, with four days of field data collection, where L.R. Kimball field specialists spent a minimum of 10 hours each day driving through Berkeley, Jefferson and Morgan Counties. L.R. Kimball field specialists consisted of one two-person team, where one member served as the driver and the other as the navigator and data collector.

### 1.1 Initial Data Collection

Prior to drive-testing, L.R. Kimball prepared geographic information system (GIS) data layers to make the drive-testing more efficient and improve the quality of the data collected. These layers include the following:

- West Virginia Statewide Addressing and Mapping Board (WVSAMB) 2011 Centerlines, with pre-determined "Drive Centerlines" chosen prior to field work
- West Virginia Statewide Addressing and Mapping Board 2011 Structures
- West Virginia Statewide Addressing and Mapping Board 2011 Imagery
- NTIA Round 7 Wireless Data Coverage Submission
- Speed Test Point Locations

In addition, the State provided four smartphones for use during the drive-testing:

- AT&T Samsung Galaxy S III
- West Virginia PCS Alliance (nTelos) Samsung Galaxy S
- US Cellular Samsung Galaxy S III
- Verizon Samsung Galaxy S III

All of these phones were updated with the QoS Solutions Android Applications that measure carrier connectivity, also provided by the State.

The State asked L.R. Kimball to visit each planning and development council regional office during the initial stages of the fieldwork collection to discuss the objectives of the project and gain feedback from the region regarding specific areas of broadband concern within the region. L.R. Kimball field team met with Mr. Matt Mullenax, Transportation Planner/GIS Analyst on August 21, 2013. Mr. Mullenax requested that the field team add a speed test point in a small community in the northern part of Jefferson County.

#### 1.1.1 West Virginia Statewide Addressing and Mapping Board 2011 Centerlines

The WVSAMB 2011 Centerlines were downloaded from the West Virginia GIS Technical Center Website. The centerlines were then evaluated for potential use. Removed from the dataset were named driveways and dead-end streets. The centerlines were further reviewed and potential "Drive Centerlines" for the region were chosen. These potential "Drive Centerlines" were chosen based on several factors. They are a good representation within the submitted coverage areas. Also, they have residents living on them and did not appear to be "fade-away" roads (dirt roads that ultimately lead to nothing). In general, interstates were not included in the potential "Drive Centerlines" coverage because it is anticipated that they will be traveled/measured during normal travel to various locations and did not need to be formally routed.

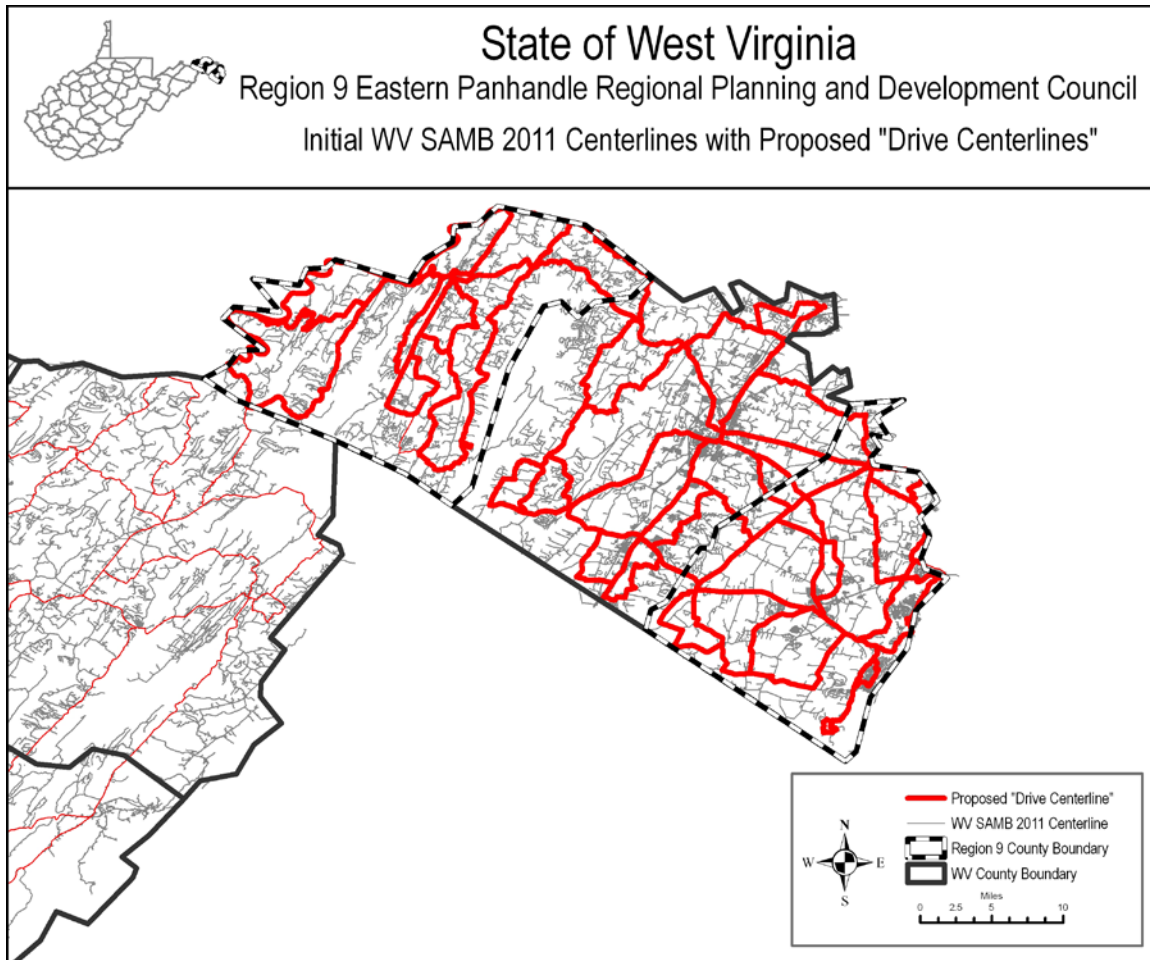


Figure 1—Initial WV SAMB 2011 Centerlines with Proposed “Drive Centerlines”

### 1.1.2 West Virginia Statewide Addressing and Mapping Board 2011 Structures

The WVSAMB 2011 Structures were downloaded from the West Virginia GIS Technical Center Website to use as reference only. There were no changes made to this layer prior to or during drive-testing.

### 1.1.3 Speed Test Points

The QoS applications allow for a carrier broadband speed test to occur every five minutes, or at user-selected points. As the application requires remaining in the same location until the test completes, and does not produce accurate results if traveling above 25 mph, QoS recommended selecting random test point locations to run the application throughout the region. L.R. Kimball chose random points in populated areas as a test of the broadband speeds in submitted coverage areas. The initial speed test point layer contained 29 speed test locations in Region 9.



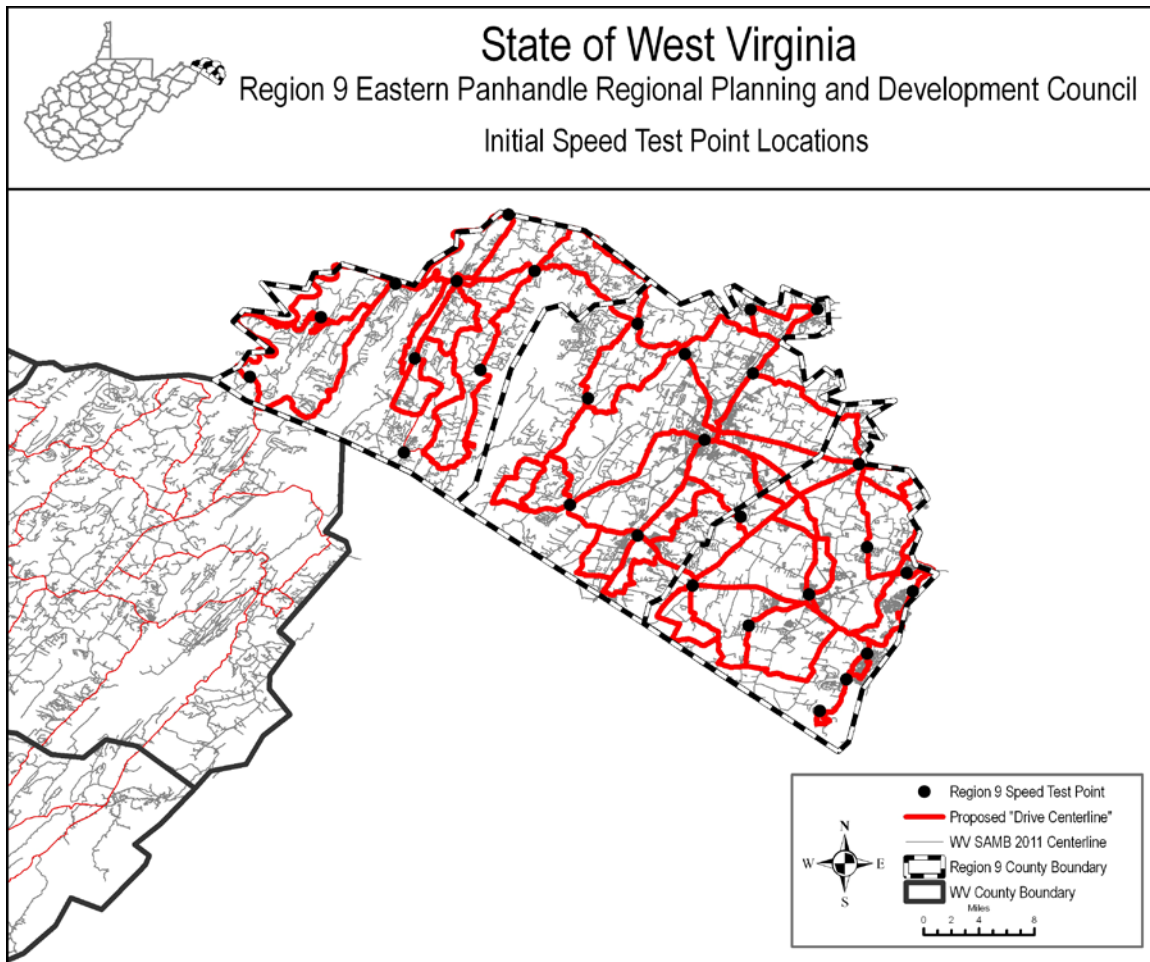


Figure 2—Initial Speed Test Point Locations

#### 1.1.4 West Virginia Statewide Addressing and Mapping Board 2011 Imagery

The WVSAMB 2011 Imagery was downloaded from the West Virginia GIS Technical Center Website for Region 9 counties to use as reference only. There were no changes made to these layers prior to or during drive-testing.

#### 1.1.5 QoS Solutions Android Applications

The QoS Solutions software that was provided by the State consisted of four Android Applications for use with smartphones. QCarrier measures carrier signal strength while driving with collected data stored directly on the phone. Rate of vehicle speed is not a factor in measuring signal strength. QWiFi locates and records Wi-Fi services with collected data stored directly on the phone. Rate of vehicle speed is not a factor in measuring Wi-Fi services. QPerf measures carrier connectivity at specific locations or during specific intervals with collected data stored on the

QoS Website. Rate of vehicle speed is a factor in measuring signal strength. QMapper is a mapping device used in urban areas where you want a more accurate reading of your location. It does not store any data, and is to be used as a physical location reference tool. Please see Appendix A; QoS Applications.

### **1.1.6 AT&T Samsung Galaxy S III Phone**

The State provided a Samsung Galaxy S III smartphone for L.R. Kimball field technicians to use with the AT&T network.

### **1.1.7 nTelos Samsung Galaxy S Phone**

The State provided a Samsung Galaxy S smartphone for L.R. Kimball field technicians to use with the West Virginia PCS Alliance (nTelos) network.

### **1.1.8 US Cellular Samsung Galaxy S III Phone**

The State provided a Samsung Galaxy S III smartphone for L.R. Kimball field technicians to use with the US Cellular network.

### **1.1.9 Verizon Samsung Galaxy S III Phone**

The State provided a Samsung Galaxy S III smartphone for L.R. Kimball field technicians to use with the Verizon network.

## **1.2 Field Data Collection**

L.R. Kimball field technicians spent four days drive-testing in Berkeley, Jefferson and Morgan Counties for the State. Equipment included a laptop computer pre-loaded with Environmental System Research Institute's (ESRI) ArcMap 10.1 software and the WV SAMB 2011 centerline, drive centerline, speed test point, and orthophotography layers, a GPS to use for reference and four smartphones provided by the State. In addition, a power inverter was used in the vehicle to keep all of the equipment charged while testing.

The L.R. Kimball field technician team consisted of a driver and a navigator. The navigator was responsible for mapping the route taken, as well as keeping track of the roads that were traveled and the points where speed tests were taken.

### **1.2.1 Roads Traveled**

Approximately 482 miles of roads were tested in Region 9 for carrier connectivity. The goal was to drive-test the carrier submitted NTIA wireless polygons using a good representation of roads without "back-tracking" a great deal. The terrain was what was expected for this section of Appalachia, with numerous mountainous and valley areas. In



some instances, anticipated road and/or weather conditions prevented the driver from traveling certain roadways and the initial drive centerlines and speed test locations in those areas were adjusted accordingly.

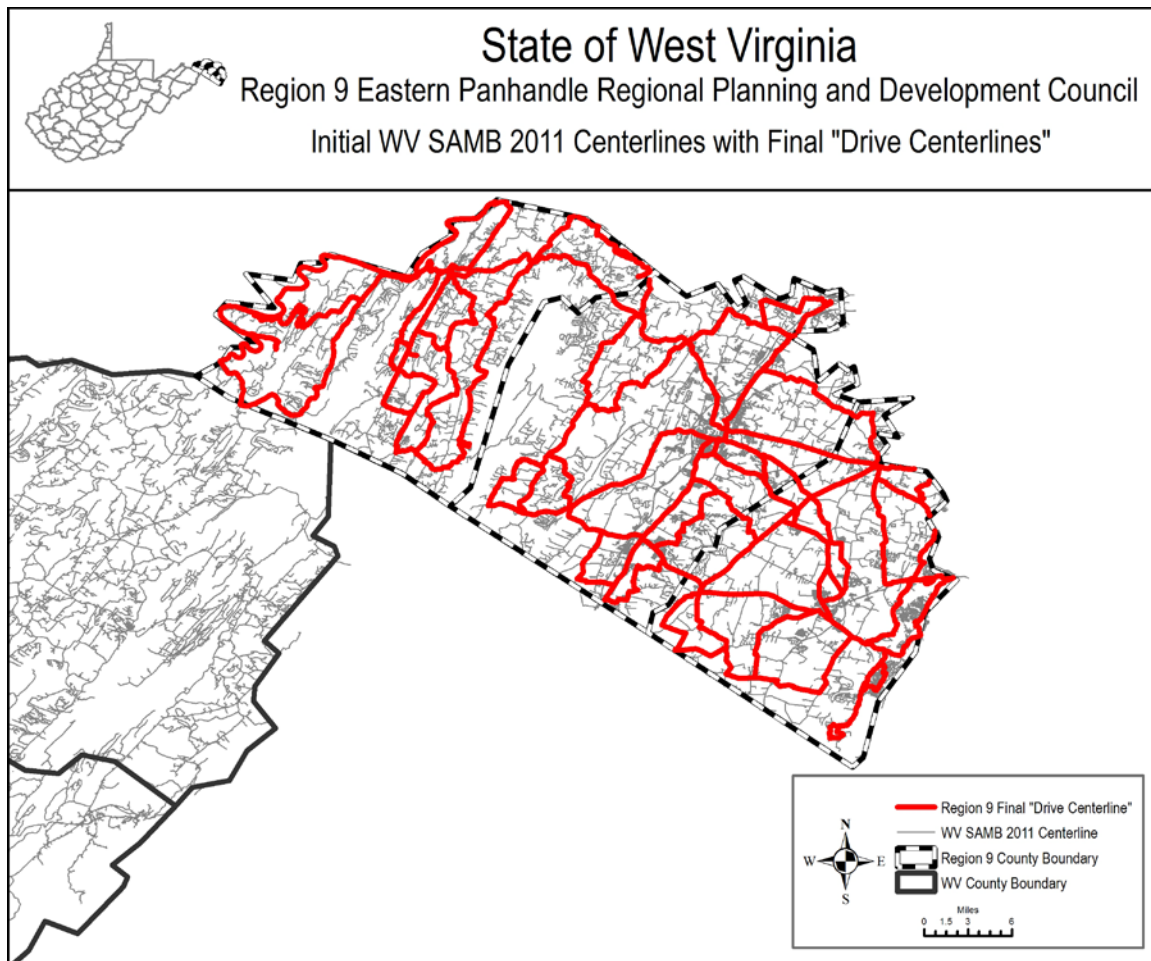


Figure 3—Roads Traveled During Drive-Testing

### 1.2.2 Speed Test Point Validation

There were a total of 30 speed test locations verified within Region 9.

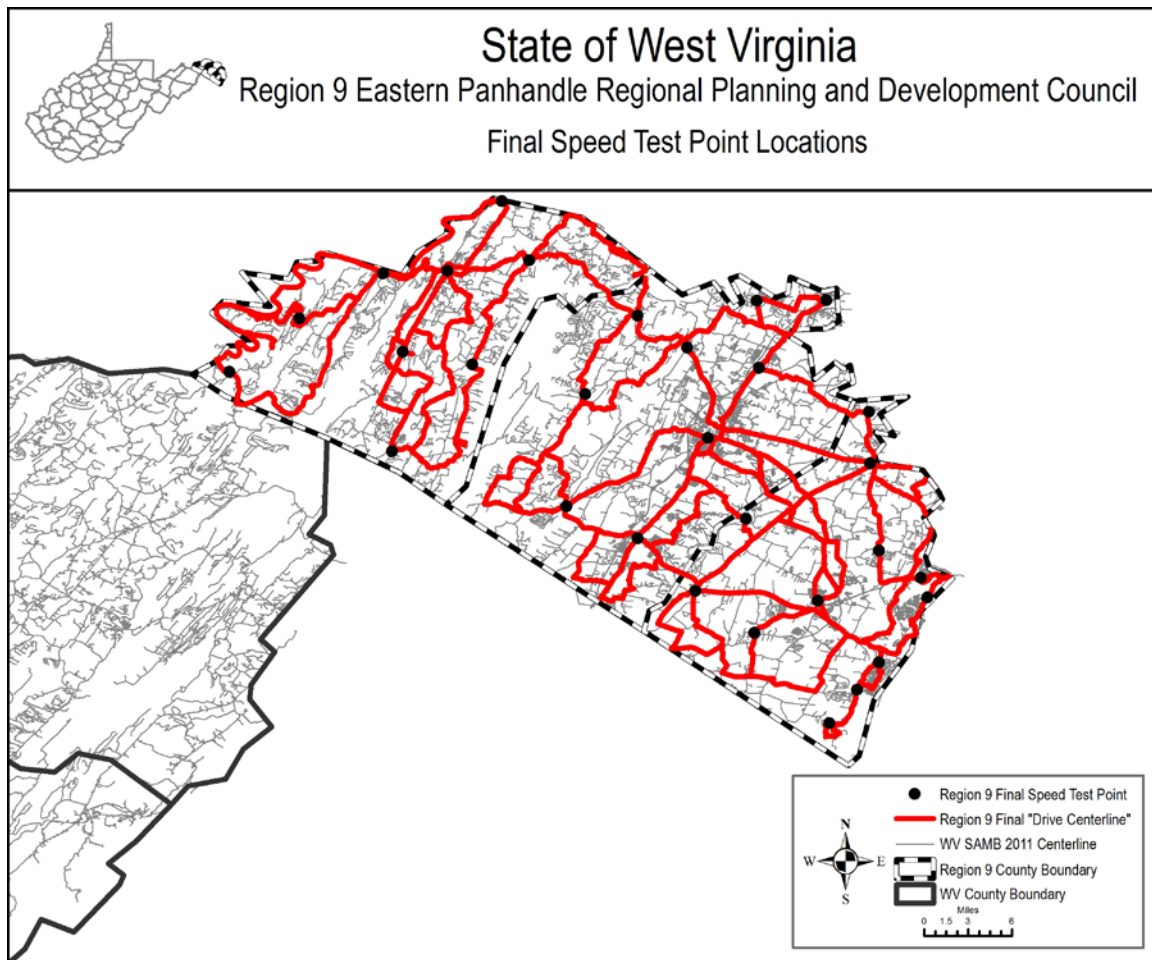


Figure 4—Final Speed Test Point Locations

## 2. TEST RESULTS

The drive-testing in Region 9 using smartphones was expected to show that good service exists in the urban areas and poor service in the rural areas of the region. In addition, it was expected that each of the providers being tested would have the service advertised in their NTIA submitted round 7 wireless coverage boundaries within the region. The QoS Software applications were user-friendly. It was easy to install the apps on the smartphones, and touching their icons on the screen opened them as expected. Analysis of the QoS Software application results involved the converting of .xml and .csv files into geodatabases and then making the appropriate comparisons.

### 2.1 QPerf Test Results

The QPerf application is a measure of carrier connectivity at specific locations, or speed test points. Data was uploaded to the QoS Website during the test. The data from the Website was downloaded as .csv files and converted into a geodatabase. The downstream and upstream speeds were then converted to the appropriate NTIA tier to match the Round 7 Wireless Coverage Polygons submitted by wireless providers as part of NTIA's Round 7 data collection effort. Analysis consisted of a location comparison, whereby the plotted locations of the test points were compared against their respective R7 coverage layer, as well as a comparison of the downstream and upstream speeds of the test points against the maximum speeds reported to the NTIA.

| Reference Chart #2: Speed Tiers |   |
|---------------------------------|---|
| Code                            | Speed Tiers   |
| 1                               | Less than or equal to 200kbps                           |
| 2                               | Greater than 200kbps and less than 768 kbps             |
| 3                               | Greater than or equal to 768kbps and less than 1.5 mbps |
| 4                               | Greater than or equal to 1.5 mbps and less than 3 mbps  |
| 5                               | Greater than or equal to 3 mbps and less than 6 mbps    |
| 6                               | Greater than or equal to 6 mbps and less than 10 mbps   |
| 7                               | Greater than or equal to 10 mbps and less than 25 mbps  |
| 8                               | Greater than or equal to 25 mbps and less than 50 mbps  |
| 9                               | Greater than or equal to 50 mbps and less than 100 mbps |
| 10                              | Greater than or equal to 100 mbps and less than 1 gbps  |
| 11                              | Greater than or equal to 1 gbps                         |

Figure 5—NTIA Speed Tiers

#### 2.1.1 AT&T QPerf Results

Of the 30 speed test point locations within Region 9, 30 were located within the Round 7 wireless coverage polygon submitted by AT&T and should have obtained QPerf speed test results. However, only 20 test points obtained results using the AT&T mobile network within Region 9 and all of them were within the AT&T submitted coverage polygon. Maximum advertised downstream values for the entire area are a value of four on the NTIA Speed Tier and maximum advertised upstream values for the entire area are a value of three on the NTIA Speed Tier. Of the 20 test

points obtaining results within the submitted coverage polygon, 17 met or exceeded the maximum advertised value for downstream coverage and 12 met or exceeded the maximum advertised value for upstream coverage.

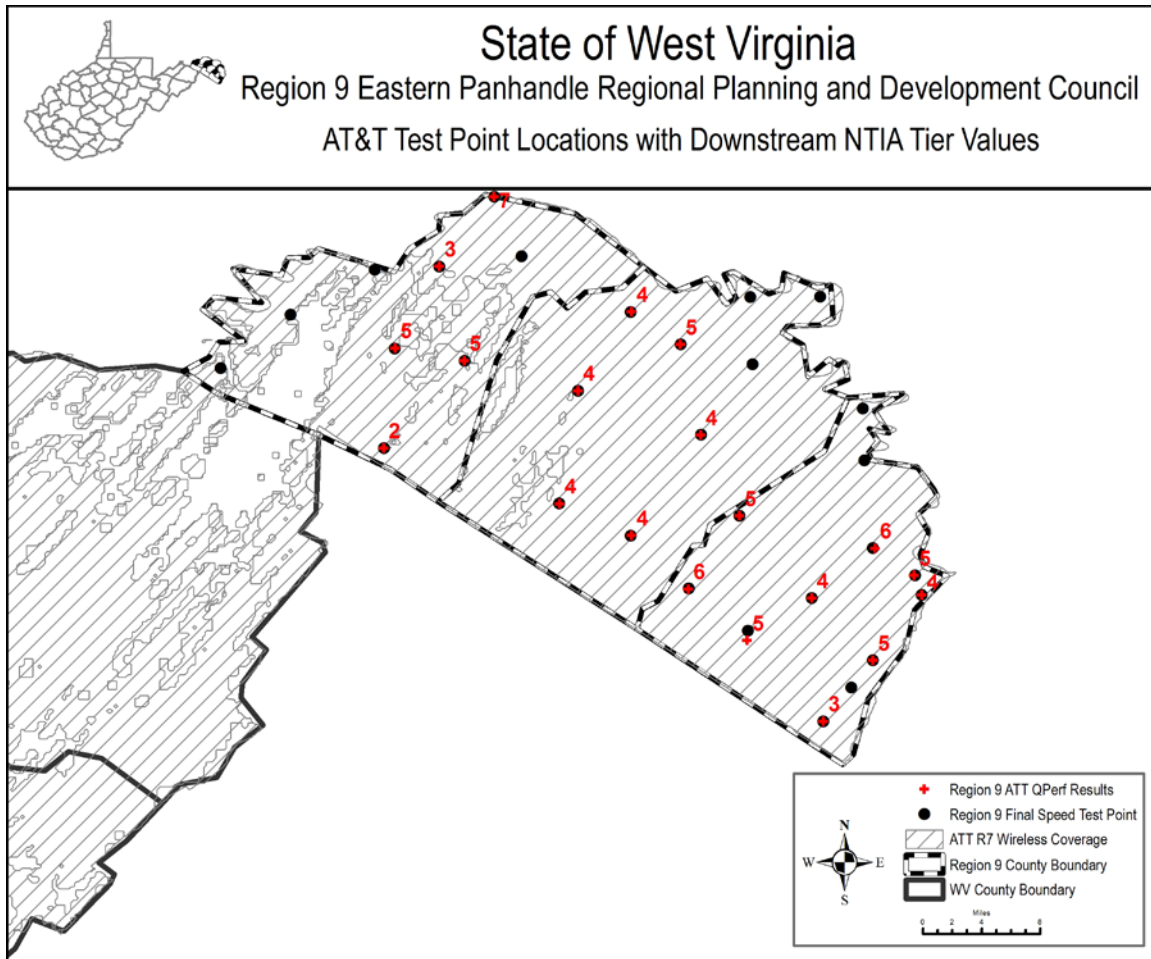


Figure 6—AT&T Downstream Speed Values



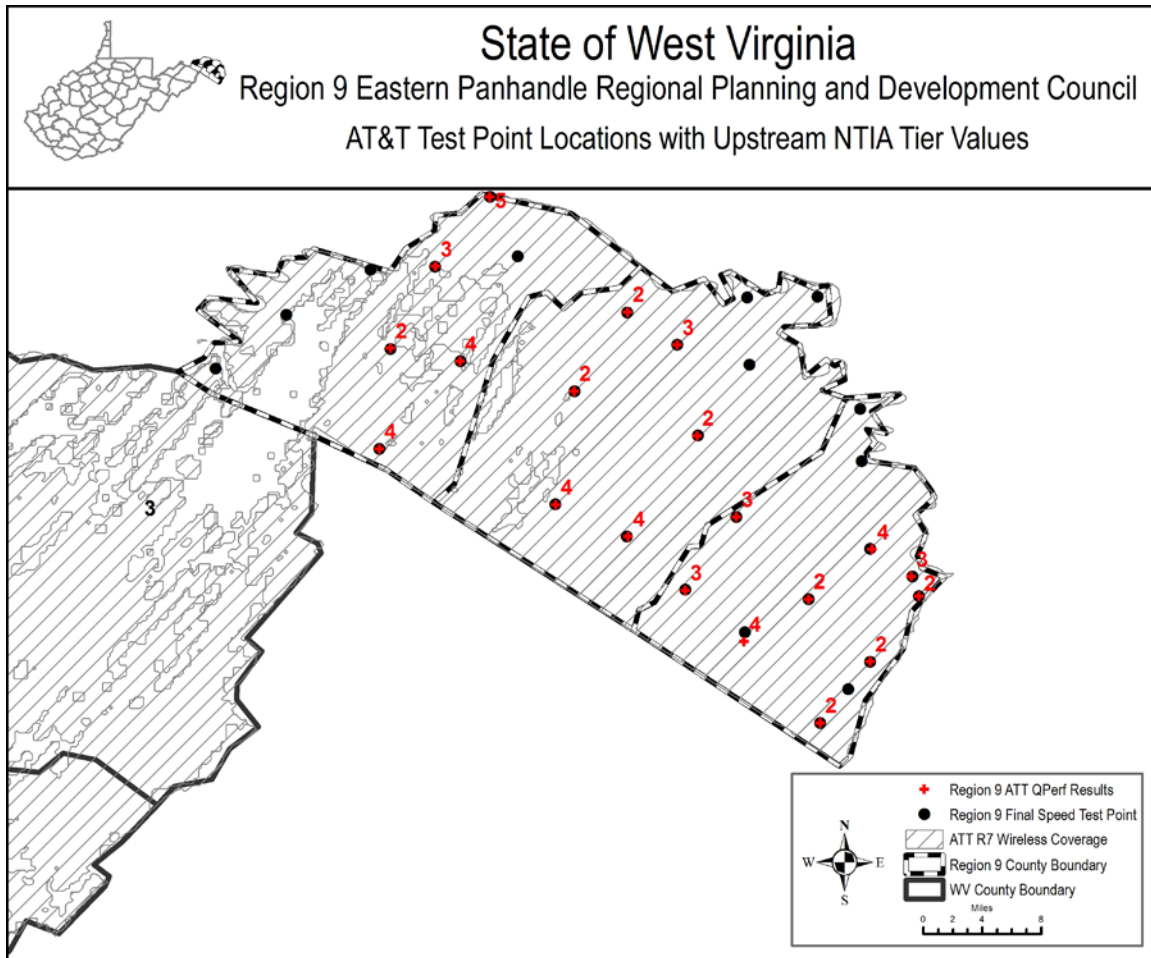


Figure 7—AT&T Upstream Speed Values

### 2.1.2 nTelos QPerf Results

Of the 30 speed test point locations within Region 9, none were located within the Round 7 wireless coverage polygon submitted by nTelos. However, 24 test points obtained results using the nTelos mobile network within Region 9.



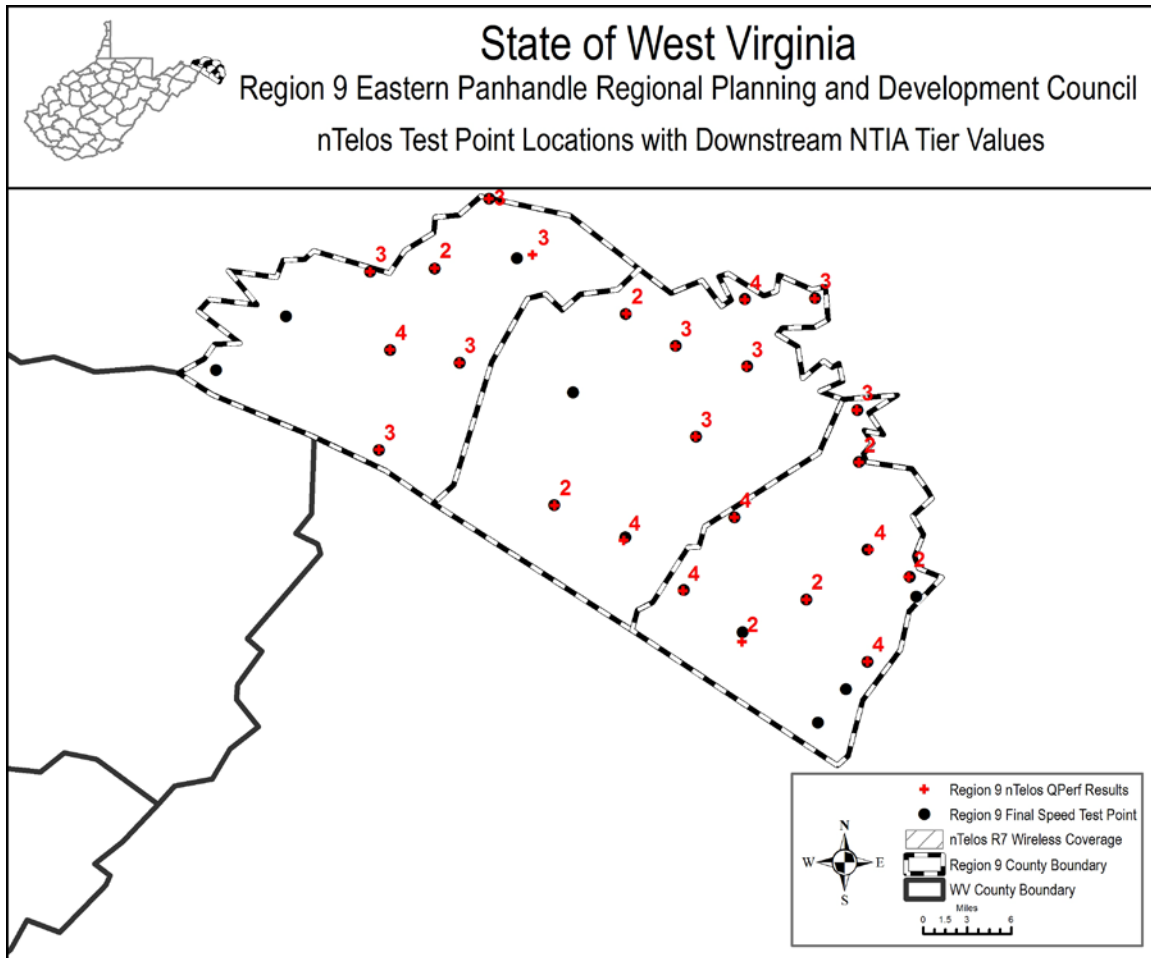


Figure 8—nTelos Downstream Speed Values

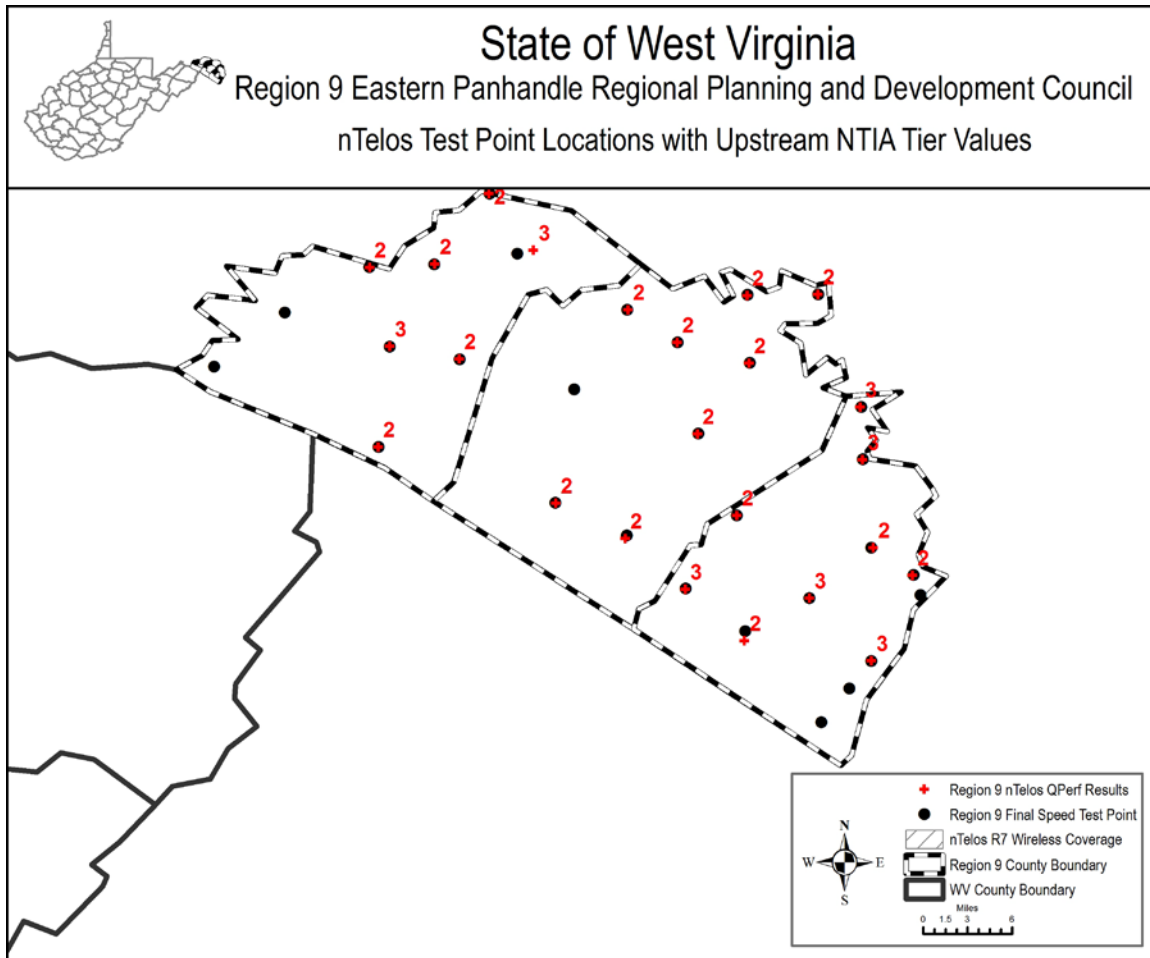


Figure 9—nTelos Upstream Speed Values

### 2.1.3 US Cellular QPerf Results

Of the 30 speed test point locations within Region 9, 27 were located within the Round 7 wireless coverage polygon submitted by US Cellular and should have obtained QPerf speed test results. However, only 22 test points obtained results using the US Cellular mobile network within Region 9. Of these 22 points, 21 were within the US Cellular submitted coverage polygon and one was not within the US Cellular submitted coverage polygon. Maximum advertised downstream values for the entire area are a value of three on the NTIA Speed Tier and maximum advertised upstream values for the entire area are a value of two on the NTIA Speed Tier. Of the 21 test points obtaining results within the submitted coverage polygon, 15 met or exceeded the maximum advertised value for downstream coverage and 20 met or exceeded the maximum advertised value for upstream coverage.

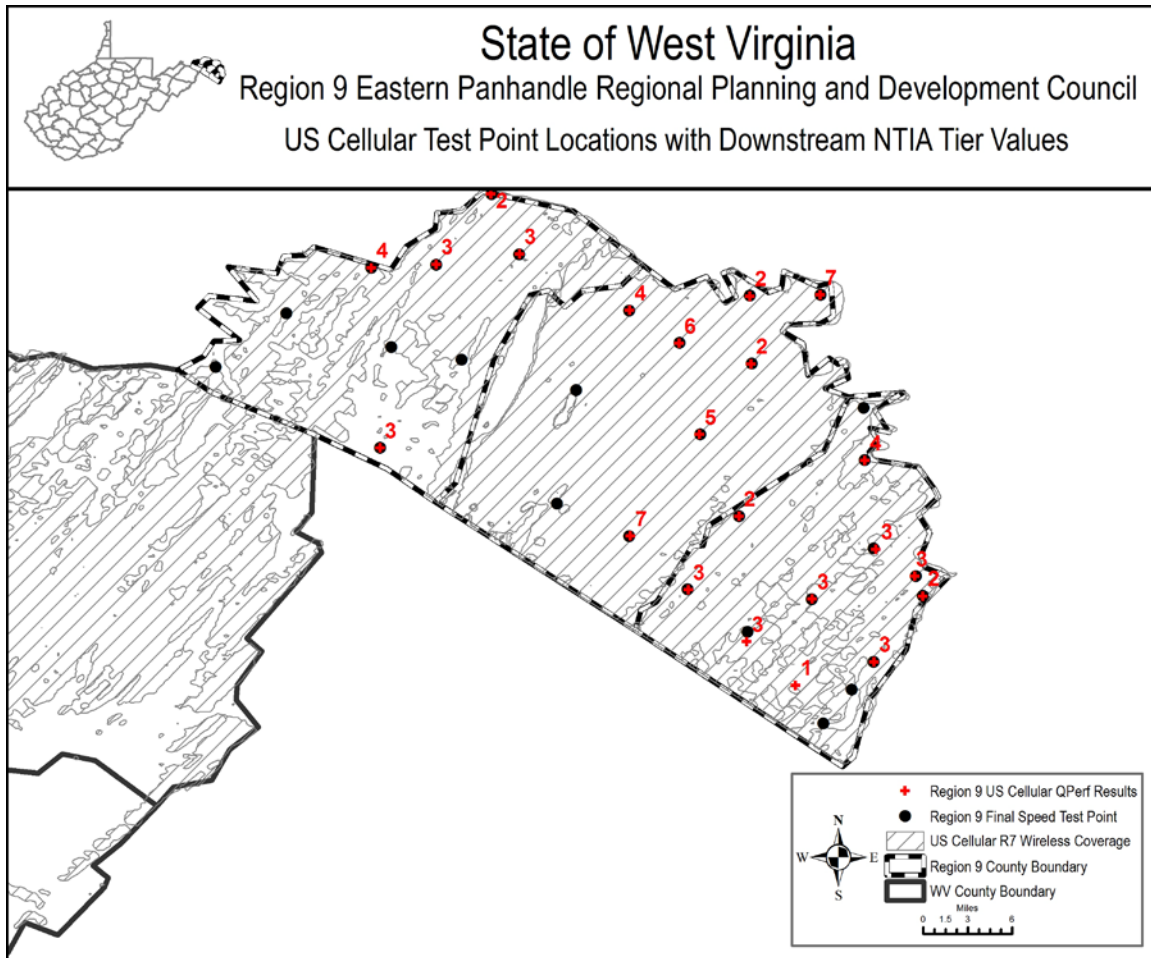


Figure 10—US Cellular Downstream Speed Values

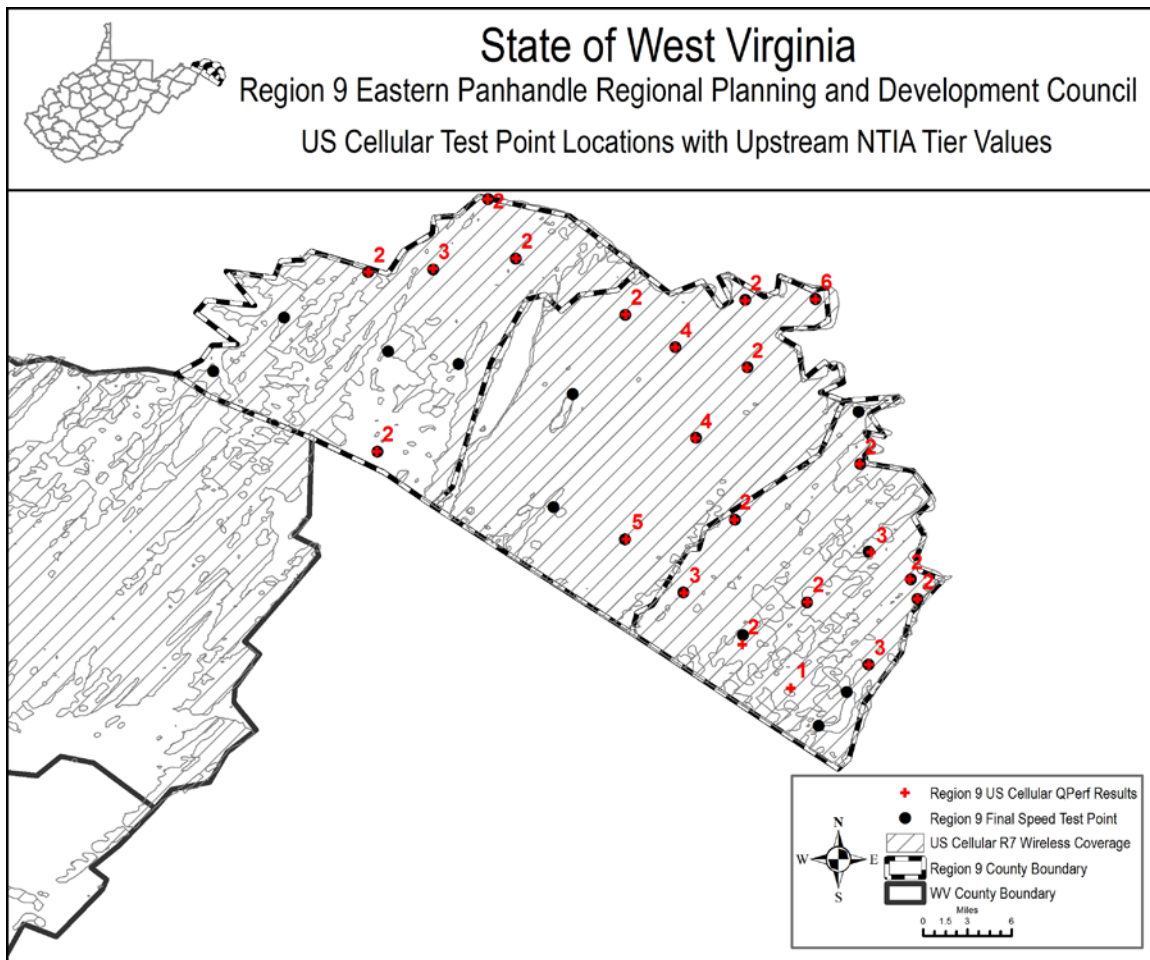


Figure 11—US Cellular Upstream Speed Values

#### 2.1.4 Verizon QPerf Results

Of the 30 speed test point locations within Region 9, 25 were located within the Round 7 wireless coverage polygon submitted by Verizon and should have obtained QPerf speed test results. However, only 14 test points obtained results using the Verizon mobile network within Region 9. Of these 14 points, 13 were within the Verizon submitted coverage polygon and one was not within the Verizon submitted coverage polygon. Maximum advertised downstream values for the entire area are a value of seven on the NTIA Speed Tier and maximum advertised upstream values for the entire area are a value of five on the NTIA Speed Tier. Of the 13 test points obtaining results within the submitted coverage polygon, nine met or exceeded the maximum advertised value for downstream coverage and nine met or exceeded the maximum advertised value for upstream coverage.





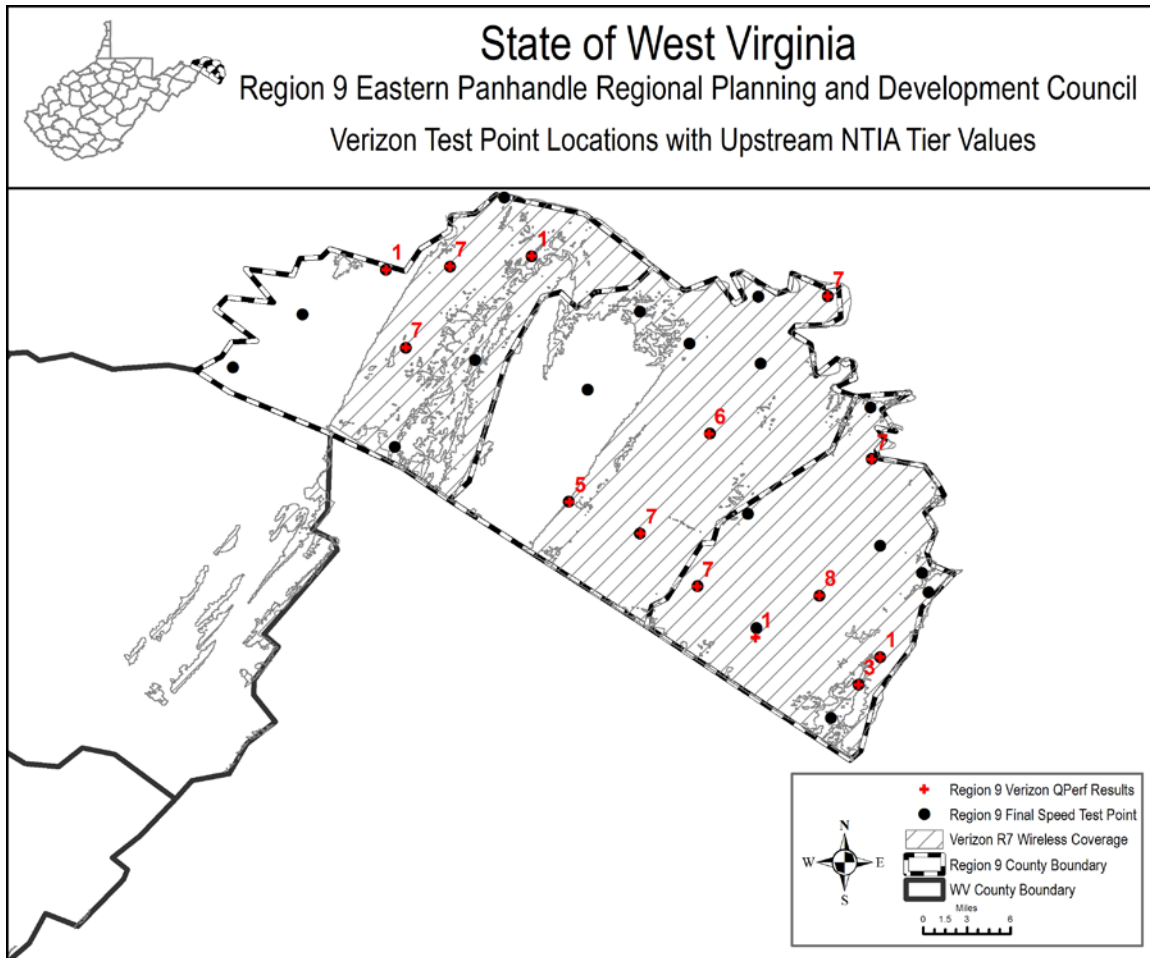


Figure 13—Verizon Upstream Speed Values

## 2.2 QCarrier Test Results

The QCarrier application is a measure of signal strength along the roads that were traveled during drive-testing. A record is created every 10 seconds or whenever the signal strength changes, and is stored in an .xml file directly on each phone. In general, it was found that there is acceptable coverage within the urban areas of the region and very limited coverage in the rural parts of the region for all carriers. Attributes used for analysis include the RSSI\_DM field which is Received Signal Strength Indication, measured in DBm, and the EC/IO field, which is the signal strength relative to interference, measured in dB\*10.

### 2.2.1 AT&T QCarrier Results

There were 12,282 points plotted within the AT&T network in Region 9. There were 429 points that obtained no data, indicating no signal strength. The signal strength ranged from -69 to -113 DBm. There was no EC/IO data collected

for these points, as AT&T uses a Global System for Mobile Communication (GSM), which does not measure this value. The final drive centerlines shown with no phone data overlaid indicate areas where the phone was not able to connect to a GPS satellite, had no cellular service, and was not able to track the location of the phone.

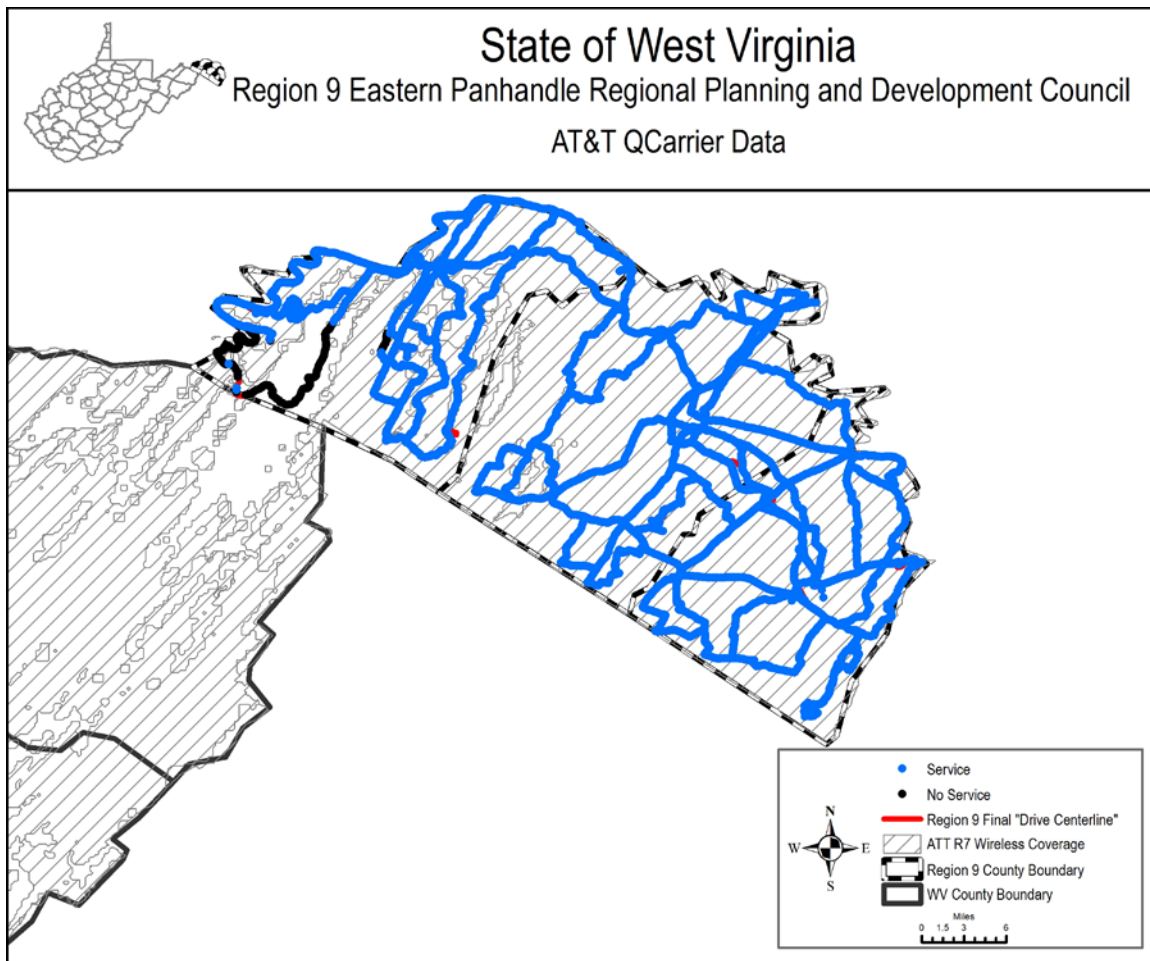


Figure 14—AT&T QCarrier Results, Based on RSSI\_DM

### 2.2.2 nTelos QCarrier Results

There were 17,390 points plotted within the nTelos network in Region 9. The signal strength ranged from -48 to -105 DBm. The EC/IO data ranged from -90 to -160, with the majority of points falling at -160. This indicates areas where calls cannot connect, or calls are dropped constantly.<sup>1</sup> The final drive centerlines shown with no phone data overlaid

<sup>1</sup> <http://www.telecomhall.com/what-is-ecio-and-ebno.aspx>

indicate areas where the phone was not able to connect to a GPS satellite, had no cellular service, and was not able to track the location of the phone.

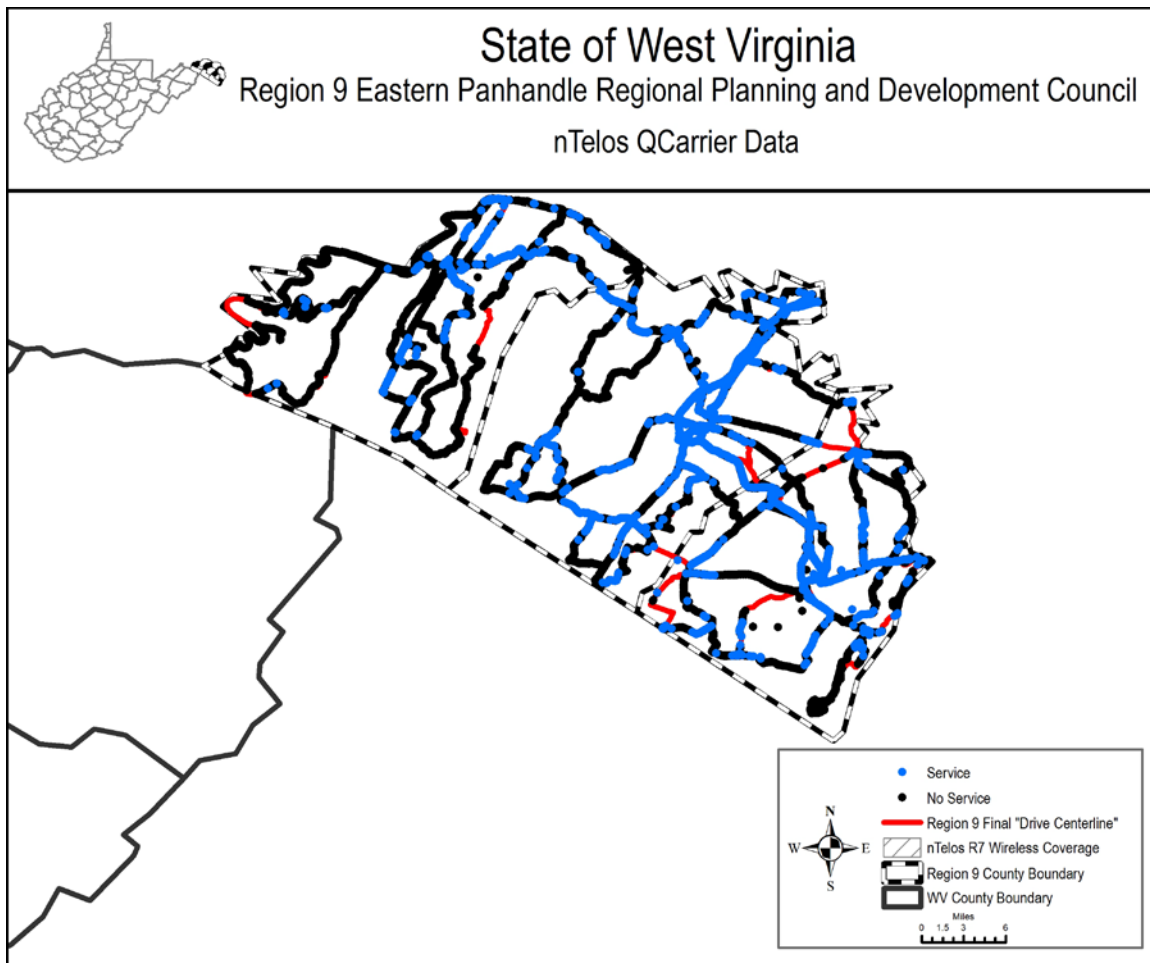


Figure 15—nTelos QCarrier Results, Based on EC/IO

### 2.2.3 US Cellular QCarrier Results

There were 12,910 points plotted within the US Cellular network in Region 9. The signal strength ranged from -54 to -125 DBm. The EC/IO data ranged from -5 to -160. EC/IO data of -160 indicates areas where calls cannot connect, or calls are dropped constantly.<sup>2</sup> The final drive centerlines shown with no phone data overlaid indicate areas where

<sup>2</sup> <http://www.telecomhall.com/what-is-ecio-and-ebno.aspx>

the phone was not able to connect to a GPS satellite, had no cellular service, and was not able to track the location of the phone.

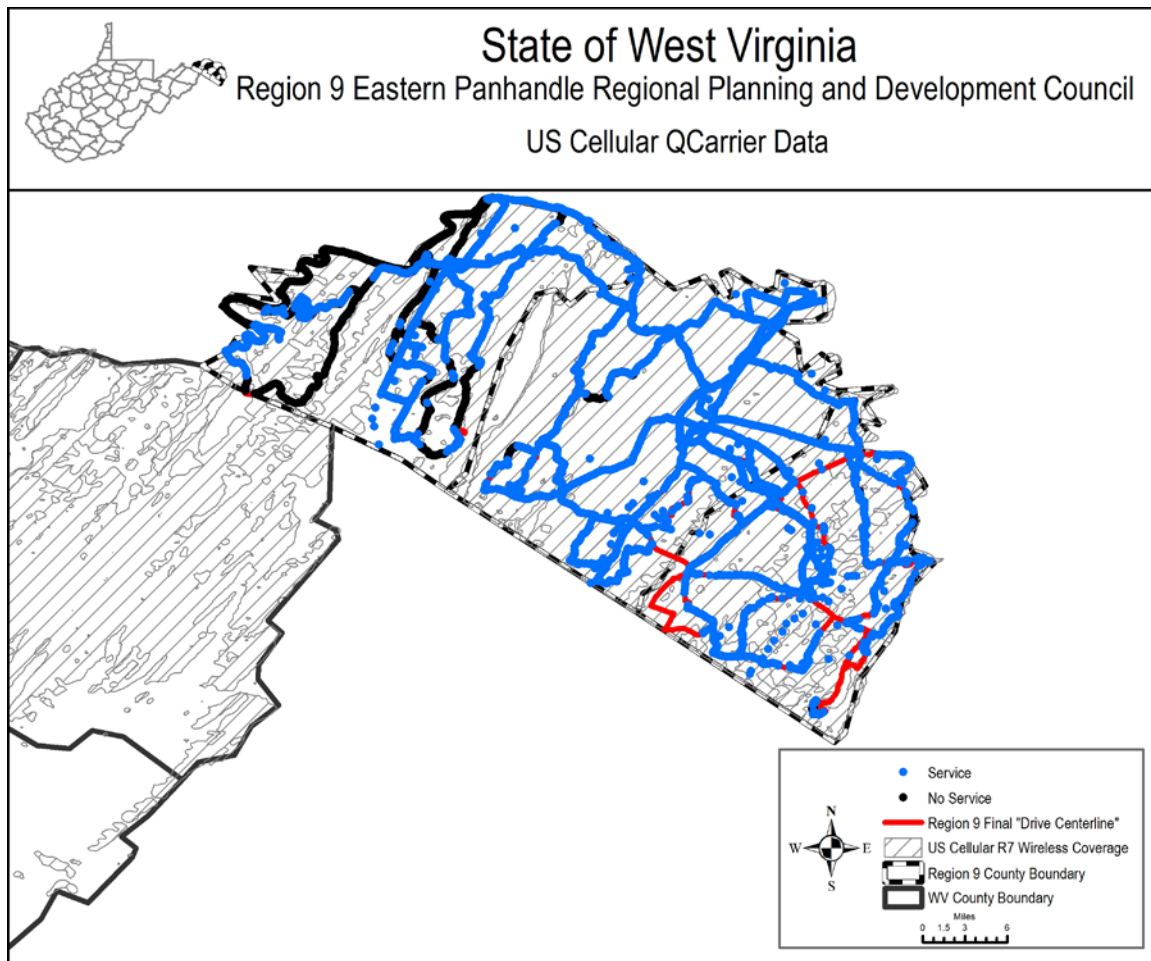


Figure 16—US Cellular QCarrier Results, Based on EC/IO

## 2.2.4 Verizon QCarrier Results

There were 12,796 points plotted within the Verizon network in Region 9. The signal strength ranged from -59 to -125 DBm. The EC/IO data ranged from -10 to -160. EC/IO data of -160 indicates areas where calls cannot connect, or calls are dropped constantly.<sup>3</sup> The final drive centerlines shown with no phone data overlaid indicate areas where the phone was not able to connect to a GPS satellite, had no cellular service, and was not able to track the location of the phone.

<sup>3</sup> <http://www.telecomhall.com/what-is-ecio-and-ebno.aspx>



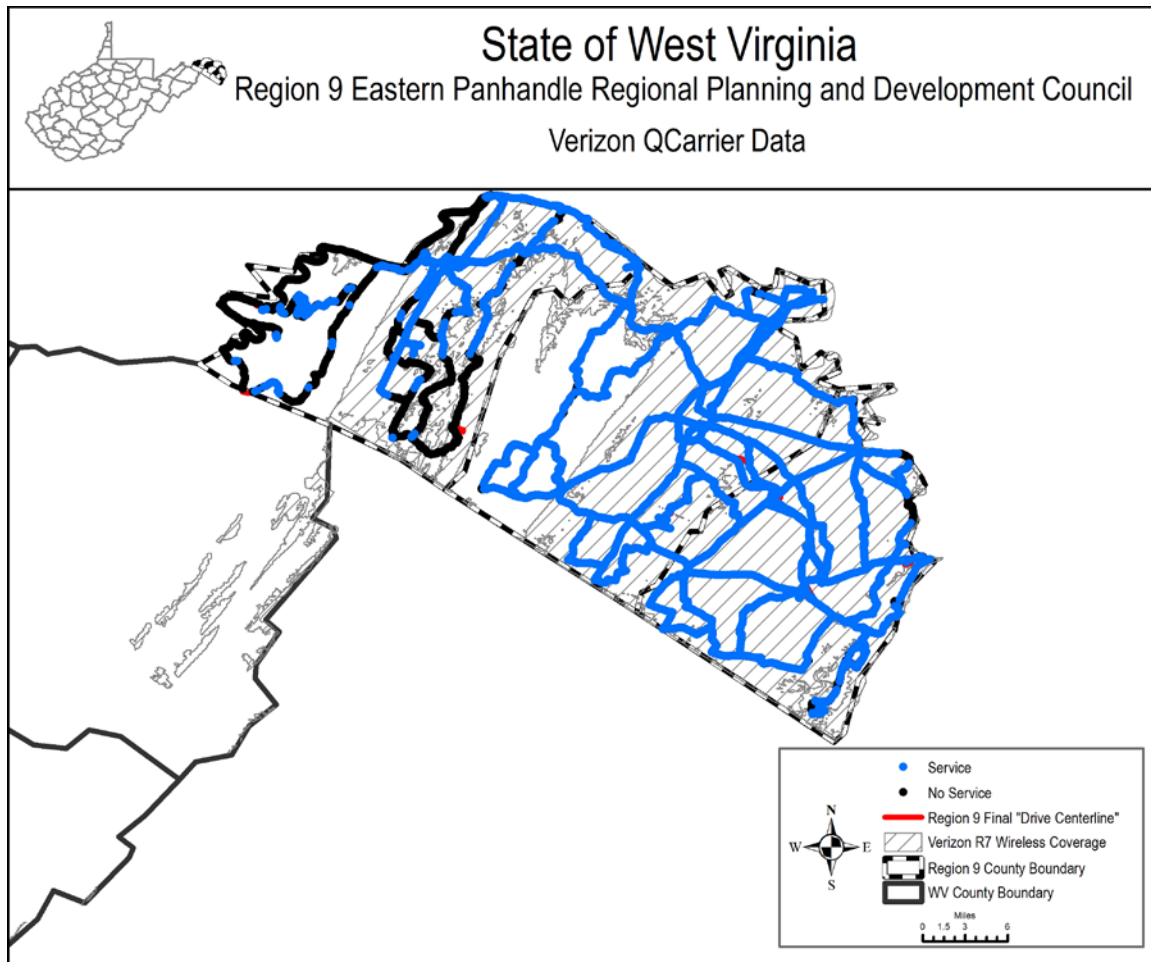


Figure 17—Verizon QCarrier Results, Based on EC/IO

## 2.3 West Virginia Broadband Mapping Survey Results

As requested by the Region, LR Kimball is providing a summary of participation results for the West Virginia Broadband Mapping Program's Broadband Survey program. Residents of West Virginia have been asked to provide feedback to the State regarding their broadband access. There are two surveys available. One is for broadband feedback, and one is to measure broadband speed at a specific location. The surveys are located at <http://gis2.kimballdata.com/westvirginiaonline/WVBroadbandSurvey> and <http://gis2.kimballdata.com/westvirginiaonline/wvspeedtest>. As of June 1, 2013, 272 residents participated in the survey by taking the broadband survey, 283 residents participated by taking the speed test and 142 residents provided user feedback through the broadband survey website. These results are on a statewide basis.



Region 9 had a total of 215 participants: 30 provided user feedback, 77 took the broadband survey and 108 took the speed test. Of the 30 residents providing user feedback, 22 indicated that the map shows that broadband is available, but in reality it is not available at their residence. The remaining eight participants indicated "other." Providers listed for the broadband survey and speed test include AT&T, Comcast, Frontier, Hughesnet, Lumos, Sprint, Verizon, Virgin Mobile, Wildblue, Winchester Wireless and WVNet. The majority of residents indicated that they had poor broadband service at their residence/business. Comments include the following:

- According to your map, my area has three providers of broadband. While I am 1 mile from a main road, comcast does not service me or my neighbors. The map also says that Sprint or AT&T are options, that is only 3G and the signal is so weak that we cannot connect.
- Comcast, Verizon or Frontier does not offer broadband service in this area. These companies say we live in a dead zone. We do have access to private companies but the costs are very high. I do not feel as though we should be penalized for where we live.
- First, I do not consider wireless access (aircards) to be "broadband" access. The services for these cards can be up to \$60 a month and only one device can use them at a time. I am forced into satellite usage that only hits advertised speeds in the wee hours.
- Frontier's customer service stinks and even though I have DSL, watching videos, etc., is extremely frustrating because they're choppy. Their service is very hit and miss.
- Frontier has been a pretty good provider of DSL internet--the only problem I see is all copper wire and the distance from the downtown terminal. Sometimes in the evening your videos will temporarily stop.
- Frontier is HORRIBLE. I barely get better than dial-up speeds 80% of the time. I have been complaining for months, since October 2011 actually and they will not fix it. The network is congested. It is difficult to do online classes.
- Frontier is one of the worst possible DSL carriers. My DSL speed had decreased over the past year and the service disconnects several times per day. Frontier staff is rude and lack the technical ability and motivation to solve the numerous issues I've had.
- High speed internet is not available at my home. Comcast has stated that my road was not worth their time to run cable down. I work in IT, and would like high speed internet to telework. Cellular internet (mobile broadband) is too slow for the type of work I do.
- I'm being charged \$50 per month for service speed that I'm not getting. Frontier is the only service available and they know it.
- I am glad to see someone is looking in to the state of our broadband service in WV. I live in Berkeley County and use Frontier as my internet service provider and am far less than satisfied.
- I am very satisfied with Comcast, they offer several internet options and they also are very responsive to problem resolution.
- I currently use a neighbors wi-fi....Internet access is SO IMPORTANT these days.....I WISH THAT I DID NOT HAVE TO RELY ON MY NEIGHBORS WI-FI! (But I MUST, for I am out of work and the only way, these days, is to apply ON-LINE, for work.)
- I had dial up for several years and took high speed DSL from Verizon when it was offered. After Frontier took over, I opted out of what they offered, except for their service. I had Verizon-AOL, so nothing has changed, except that Frontier is too expensive.
- I have recently acquired broadband access when Frontier began servicing my area. Prior to that, I had a Hughes Net satellite dish, which performed very badly. I then went to a Sprint air card, which was also bad. For 6 years, I suffered with slow speeds.

- I use the internet for all financial aspects of our family as well as helping to educate our children, plan trips, read the news, download movies, social media, etc. My wife uses it for the same purposes plus Citrix connectivity to work.
- More choices would be great, DSL and dial-up are my only options at this address. Sat. internet is not possible due to trees, Sprint coverage is spotty at best. Comcast cable internet would be wonderful or a higher speed dsl.
- Our DSL is slow but at least it's faster than satellite and costs less. It's not particularly reliable and outages happen fairly often. We have 3G as a back up. Overall, Frontier needs to continue to upgrade their DSL service. There's no cable service.
- Service is erratic due to poor infrastructure - when it rains, DSL service becomes off and on - or very slow. Several times a week service goes down for several hours. Comcast has cable within 2000 ft but wants \$7800 for hookup.
- The accuracy of your available high-speed Internet providers seems to be incorrect. We are quite limited in the availability of that service.
- The only internet connection I can get does not allow me to get videostreams and no phone service over internet.
- The only option where I am is Frontier DSL. It doesn't work. I am too far from the DSLAM to get a stable connection. It is frustrating. I hope this project can in some way help get reliable/affordable broadband service to the area. Such a shame!
- Too slow and always down. Use for everything, banking, games, social, knowledge etc.
- Too slow for streaming video.
- We don't even have cable in our area it would be nice to have a fast connection and fast surfing the web for a change. We have been living at this address since 1998 and cable has been 1 mile away and still is 1 mile away. I am sick of dial up!
- We have a small business and need high speed internet. We also have six kids that would enjoy using the internet for school and other social activities.
- We use the internet for all reasons listed including telecommuting from work, on-line college, purchases and entertainment. Frontier is very unreliable and customer service is not informed properly in order to assist. This is the worst service.
- We would LOVE to get cable but they do not service our development. Go a few streets over they do. So we are stuck with DSL.
- When we were switched from Verizon to Frontier, I signed up with Frontier for broadband. I was only able to access the internet about 10% of the time. Frontier came to my home several times but were never able to fix the problem or locate a problem.
- Wow I thought my speed was great until I took the test!
- Yes, it is a lot slower than advertised. I could buy bandwidth, but I don't think it is worth the price to upgrade to business class for home use.
- Your coverage map indicates (5 or more) providers @ my physical location; but when I request the svc, from Frontier, for example, they state the svc is not available @ this location???? Seems to me, the (PROVIDERS), should be made to do just that...
- Advertised speed was 3mbps. Usual speed 1.2 download, .72 upload. NEVER been 3mbps.
- Average speed is a little over 2.0 mbps. Two days of the week it is always around 0.5 mbps which is unusable for streaming video.

- Frontier calls this service "High Speed Internet Lite". However, most of the time it reminds me of dial-up. There is no way that they can justify the price for this service. When I first got the service it was \$19.99, but quickly (within weeks) went up.
- Frontier has been responsive when I complain about the service: they refunded monies I paid for high speed when I wasn't being provided with it. But they said higher speeds are not available in my location. Videos are irritating to watch streaming.
- In general not as fast as advertised. Streaming movies will always lead to buffering.
- Good tech support, when bundled with phone makes it expensive.
- I feel that the cost of internet accessibility is too high. If I want to access higher speeds, it would cost me more than double my current cost.(from \$30 to \$64 per month). They should charge for bandwidth, not speed.
- I use my DSL for business, on-line training, etc. Frontier's connection has been very unreliable. Sometimes it drops out or is very slow. I have spoken with Frontier people but they say there is nothing they can do.
- I was told by Verizon many years ago that the lines we have in this area are bad and they could not, even at that time, guarantee dial up service. I had several months of problems with dial up until Verizon set me up with DSL. I have had no problems since.
- I would not even have broadband if I would not have begged Verizon to at least give it a try. Verizon and Frontier have both told me that I am outside of the loop. I knew my neighbor had it, so about 3 years ago, I finally convinced someone at Verizon.
- It's better than dial-up but certainly could be much faster. I compare it to free Wi-Fi at various businesses and we have much slower service. After any power outage, the router must be "fussed" with to regain the connection.
- It continually goes down and is very slowwwwwwwww!!!
- It is very slow, barely better then dialup. No Broadband provider will run cable or DSL down my road, as they say we are not worth it.
- It's very spotty, at times it works great and other times it does not work well or at all.
- Most of the time, I cannot watch video material without incessant stopping to load. This has just recently improved and instead of never streaming smoothly, I can occasionally stream a video and actually have it play smoothly.
- My speeds: 2.55 in the morning, 2.09 by 5 pm, 1.22 by 6 pm, 0.09 by 9 pm....Obviously insufficient Frontier bandwidth. Worse in past week, although very slow past month or two.
- No high speed available from Frontier, even though I live only 4 miles from downtown Martinsburg. This is horrible service from Frontier!
- Not knowing if the quantity of users affects the quality or speed of the service, but it seems slower than when I was using Verizon as my provider.
- Not much signal strength here. Hard to maintain connection. Cannot move to better location with-in home. Signal strength same throughout.
- Not much to select from. It is better than dial up but frequent interruptions in service.
- Numerous timeouts and shut downs for unexplained reasons.
- OVERPRICED, SLUGGISH, LAGS, LOCKS UP, FREEZES. My PC is almost new and well maintained. I believe the problem is Comcast. Monthly bill always rising.....performance, quality and speed on a downward spiral.

- Presently. I am on my fourth Internet System, a Broadband on the Run. It is slower than my previous system but more reliable. In the past 7 years, I have used dial-up, Satellite, SKYWEB and now, a mobile hotspot.
- Service for broadband could be a lot better in this area.
- Service goes out frequently and speeds are nowhere near as fast as they should be. I have called several times about breaks in connection and get short-term fixes. Have been told by a Frontier representative that they can't support high-speed connections.
- Service is so-so; I have more trouble with the modem. When it is changed it takes too long to get all computers to benefit.
- Service reliability is also rather poor even during light showers.
- Slow & unreliable.
- Slow and becomes very slow when schools are closed and kids are on the computer.
- Sometimes it's not too bad - Other times it times out because it seems to lock up... I'm not sure of the advertised speed.
- Speed is "spotty", that is, not constant.
- Speed seems to fluctuate a lot. Over all seems to be getting slower and slower.
- The connection is good and the speed is good but the price is a bit high in my opinion.
- The service is too slow most of the time; websites take too long to download. There is basically no customer service, when my contract is done with Frontier I will be going to Comcast.
- The speed that we are paying for is not the same as what we actually have, it is much slower.
- Uploading is the real problem, we have a website and we can't even load images to it reliably.
- Verizon provided good service. When Frontier took over the internet has slowed considerably. We have frequent outages. Overall the internet speed has declined greatly.
- Very slow and unreliable. Sometimes it moves pretty good...other times it's very slow. We'd have preferred cable, but there is no phone service through the cable provider at this location at this time. They basically force you to take the bundled package.
- Very slow service, always says host is busy. Verizon did not have service here but when Frontier came in and brought Verizon we could all of a sudden get service. Was told by the serviceman that I was last one to get service here because lines were full.
- We are unable to get cable in our housing development so we are stuck with crappy DSL that NEVER has 6mbps downloads. We're lucky if we get 1mbps.
- We have fiber optic cables that were laid by Verizon in our neighborhood. Why isn't fiber optic service being made available by the new owner, Frontier??
- When multiple devices are connected the speed slows down.
- Worse than terrible. All this fluff about upgrading the entire state is really a joke.

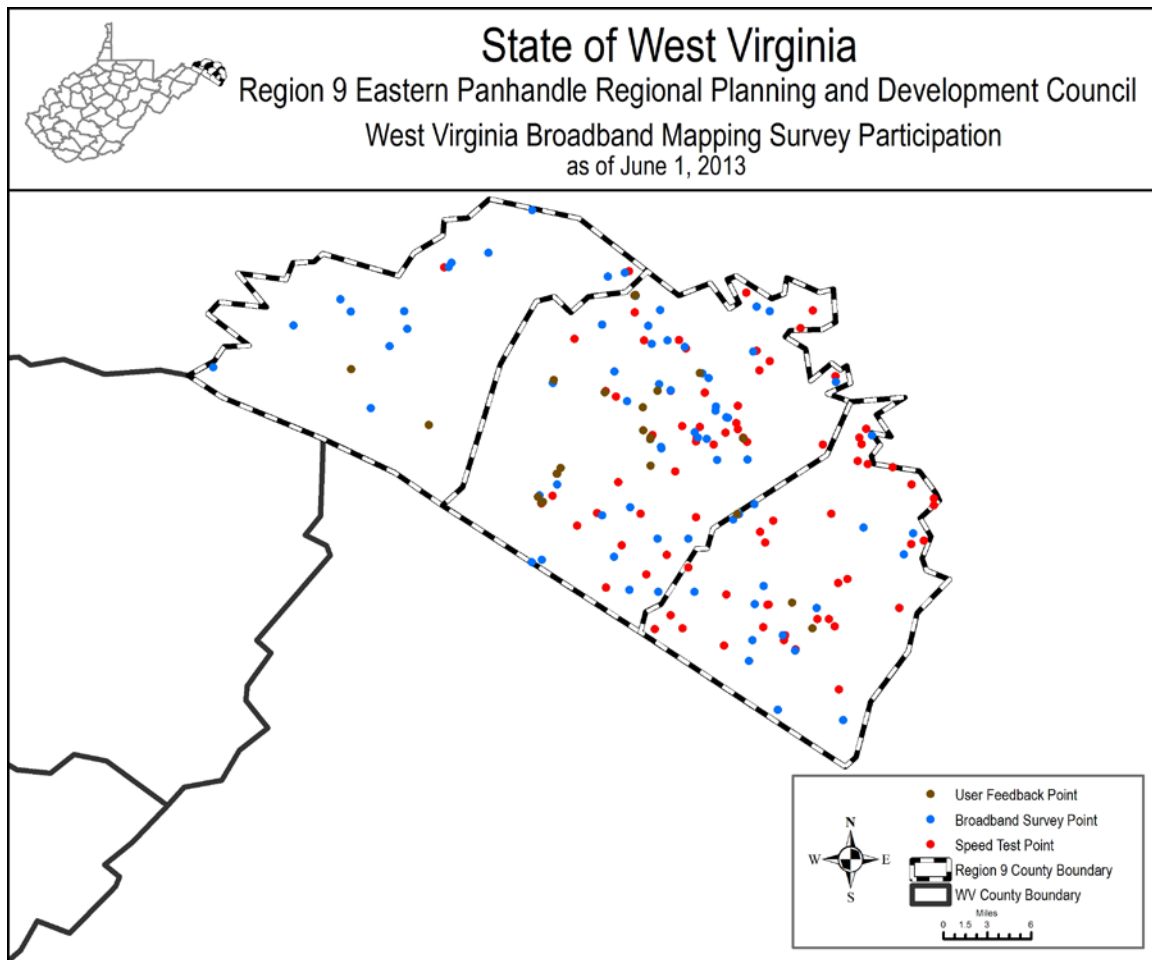


Figure 18—Broadband Survey Participant Locations



## 3. CONCLUSION

### 3.1 Carrier Connectivity

Carrier connectivity for the AT&T, US Cellular and Verizon networks proved to exist as anticipated with good coverage in the urban areas and poor to non-existent coverage in the rural areas of Region 9. Those carriers submitted acceptable designations of their coverage areas to the NTIA. Carrier connectivity for the nTelos network proved to be better than expected and showed discrepancies in reported coverage boundaries for both the urban and rural areas of Region 9.

### 3.2 Recommendations

There are several areas within Region 9 having very limited cell carrier connectivity. Unfortunately, the topography and demographics of this area of West Virginia is not conducive to the efficient construction of additional cell towers, as it would be difficult to reach a large number of potential customers with one tower. However, it is recommended that the region continue to look at other possible broadband technologies to build out last mile capabilities for residents within the region. Broadband technologies are described in more detail in the following section.

One of the most noted comments by L.R. Kimball field technicians throughout their drive-testing within the State is the lack of appropriate road name signage. It is highly recommended that the regional councils encourage their participating counties to erect street signs at each intersection according to addressing standards once county SAMB addressing data has been verified and approved by the United States Postal Service. The "West Virginia E9-1-1 Addressing Reference Guide, Version 2.1" contains guidelines regarding road signage, and should be used for reference.<sup>4</sup>

It should also be noted that several of the roads traveled during the drive-testing were found to not be suitable for non-four-wheel-drive vehicle use. Some SAMB road classification may need to be reviewed in some areas over time to assure road classifications meet the road types for dispatching vehicles as it may be difficult for emergency vehicles to travel some of these rural roads. Travelers unfamiliar with some of these areas following GPS-given directions could find themselves in a challenging, potentially dangerous road situation if assuming a road is a certain road classification.

### 3.3 Broadband Technologies

This section will give a high level overview of the different types of bandwidth transport mediums and types of service providers available in the industry today.

#### 3.3.1 Cable

The Cable TV providers throughout the country have migrated and grown to be much more than simply video programming providers. The cable providers are now providing cable internet speeds much faster than DSL, satellite

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<sup>4</sup> <http://www.dhsem.wv.gov/gis/Documents/reference%20guide.pdf>

and dial-up. Another advantage is in discounts that can be realized by the end user through bundled service offerings. These bundled services usually offer TV, high speed internet access and phone services.

The transport method to the end user is typically using fiber optic cables from the head end office at the cable company to a common fiber node in the field which is then converted to coaxial cable to the end user's location. This technology, in conjunction with other elements in the network, allows for high speed internet access to be a reality. With this technology the bandwidth speeds realized can be up to 50 Mbps.

The cable providers are improving as time goes by but consumers are more likely to lose cable service before traditional telephone service. One reason for this may be due to the standards followed by cable providers when installing the outside plant facilities. Poor weather conditions can cause outages.

In areas such as West Virginia, high amounts of rock and granite tend to make the installation of such outside plant facilities expensive to construct, making the offering non cost-effective for the provider.

### 3.3.2 Fiber Optics

Fiber Optic technology is used by nearly all providers to deliver the voice, video, and data included with high speed internet access. A very high level description of fiber optic technology is an electronic signal (traditional) that is converted to an optical signal through an optical transmitter. This optical signal will transmit through the optical fiber to an end point. In some areas of the country, a few of the local exchange carriers such as Verizon and AT&T have optical service to their residents. Optical gear is expensive to purchase for large networks and the cost of construction, like all outside plants, tends to be expensive to deploy.

The following table and scenario is provided by <http://www.lageman.com/bandwidth.htm>.<sup>5</sup> Using a file size of 1,000,000,000.00 bytes (1,000.00 Megabytes) the following download speeds are projected using standard calculations and demonstrating bandwidth use with a T1 (1.5Mbps) as the standard. Notice the faster OC speeds are ideal for voice, video, applications mirroring, and disaster recovery hot sites because the speeds of mirroring systems are relatively instantaneous.

|          |              |          |                 |
|----------|--------------|----------|-----------------|
| 128 K    | 128,000 bps  | 17:21:40 | 91% slower      |
| 256 K    | 256,000 bps  | 8:40:50  | 83% slower      |
| 512K     | 512,000 bps  | 4:20:25  | 66% slower      |
| 768 K    | 768,000 bps  | 2:53:37  | 50% slower      |
| T1, DS-1 | 1.544 Mbps   | 1:26:21  | BASELINE        |
| T3, DS-3 | 44.736 Mbps  | 2:59     | 2,748% faster   |
| OC-3     | 115.520 Mbps | 51       | 9,973% faster   |
| OC-12    | 622.080 Mbps | 13       | 40,191% faster  |
| OC-48    | 2.488 Gbps   | 3        | 161,040% faster |
| OC-192   | 10 Gbps      | 1        | 647,569% faster |

Figure 19—Typical Download Speeds Using Standard Mediums

<sup>5</sup> <http://www.lageman.com/bandwidth.htm>

### 3.3.3 Digital Subscriber Line

Where typically delivered by the Local Exchange Carriers (LEC), which provide very reliable services, there is normally very little downtime using Digital Subscriber Line (DSL). The DSL services provided by the LECs are competitive in price to other service providers in the same market segment. DSL can be purchased at different speeds up to a maximum speed. DSL can use a medium transport for data over the existing twisted pair cabling.

Advertised bandwidth speeds for DSL are good and much better than dial-up services. DSL is typically delivered by the LECs over twisted pair facilities which may limit the through-put speeds desired. Extremely fast speed may require other types of services such as Asymmetrical Digital Subscriber Line (ADSL) and Symmetrical Digital Subscriber Line (SDSL), T-1, T-3 etc.

### 3.3.4 Wireless

Wireless technology uses radio waves as a medium of communication.

With consideration to the remote locations attempting to be serviced <http://www.broadband.gov> describes wireless broadband in the following five bullets:<sup>6</sup>

- Wireless broadband connects a home or business to the Internet using a radio link between the customer's location and the service provider's facility. Wireless broadband can be mobile or fixed.
- Wireless technologies using longer-range directional equipment provide broadband service in remote or sparsely populated areas where DSL or cable modem service would be costly to provide. Speeds are generally comparable to DSL and cable modem. An external antenna is usually required.
- Wireless broadband Internet access services offered over fixed networks allow consumers to access the Internet from a fixed point while stationary and often require a direct line-of-sight between the wireless transmitter and receiver. These services have been offered using both licensed spectrum and unlicensed devices. For example, thousands of small Wireless Internet Services Providers (WISPs) provide such wireless broadband at speeds of around one Mbps using unlicensed devices, often in rural areas not served by cable or wireline broadband networks.
- Wireless Local Area Networks (WLANs) provide wireless broadband access over shorter distances and are often used to extend the reach of a "last-mile" wireline or fixed wireless broadband connection within a home, building, or campus environment. Wi-Fi networks use unlicensed devices and can be designed for private access within a home or business, or be used for public Internet access at "hot spots" such as restaurants, coffee shops, hotels, airports, convention centers, and city parks.
- Mobile wireless broadband services are also becoming available from mobile telephone service providers and others. These services are generally appropriate for highly-mobile customers and require a special PC

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<sup>6</sup> [http://www.broadband.gov/broadband\\_types.html#wireless](http://www.broadband.gov/broadband_types.html#wireless)

card with a built in antenna that plugs into a user's laptop computer. Generally, they provide lower speeds, in the range of several hundred Kbps.

#### **3.3.4.1 Cellular**

Cellular Internet service is based on a cellular architecture that consists of a backbone network with fixed base stations interconnected through the wired public switched telephone network (PSTN).

#### **3.3.4.2 Satellite**

Satellite access is another type of wireless transport.

One should consider that satellite communications can be highly affected by atmospheric conditions as well as severe weather. Intermittent and sporadic interruptions are very possible.

Lower orbiting satellites are used today to provide many services to our population such as (but not limited to) communications and video transmission. Satellite broadband is also a key element in providing necessary links for delivering access to the end user. Although faster than dial-up one could realize speeds of 500 Kbps downstream and 80 to 100 Kbps upstream.

#### **3.3.4.3 WiMAX**

The network WiMAX is known as Worldwide Interoperability for Microwave Access and known to the technical community as IEEE, 802.16 (WiMAX). WiMAX is thought by many to be the technology that will deliver access to the majority of the population in the near future. WiMAX is an option when considering the last mile connection to the end user.

The data rates are 30 to 70 Mbps. A 30 mile radius for access is possible. WiMAX provides qua broadband access and has a very high penetrability, in that the microwaves it emits can be accessed by nearly every point in its coverage area. Access is from fixed or mobile devices, desktops at home or work, smart phones etc. VoIP is possible as well.

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## **APPENDIX A—QOS SOLUTIONS ANDROID APPLICATIONS**

The QoS Solutions Android Applications can be found on the following pages.

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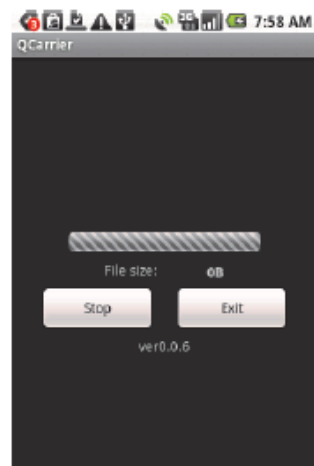
## Instructions for Running QoS Solutions Android Applications

The applications will be sent to you as attachments in an email from qos-solutions.com or from your account administrator.

**Please review the Download and Installations Document for further information.**

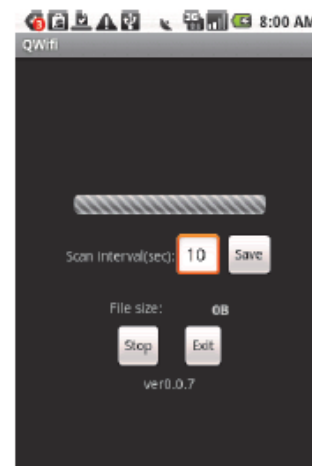
### QCarrier

QCarrier will automatically create a file each time it starts on the SD Card of your phone. The app will automatically create records every 10 seconds or whenever the signal changes. The file size will not show up until the file exceeds 1MB.



### QWiFi

QWiFi is designed for locating and recording WiFi services. It also creates a file on the SD card each time it starts.



### QPerf

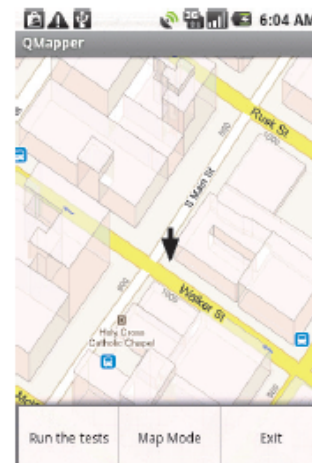
QPerf is designed to measure the carrier's connectivity. It is recommended that you hit the Menu Button and turn off WiFi so that you measure the carrier's performance and not WiFi. You should remain in the same location until it completes.



QPerf will run every 5 minutes until you stop or exit the program. QPerf does not record any data locally. All data is sent to the QoS website for downloading.

### QMapper

QMapper is designed for those locations such as downtown locations where GPS is unreliable. The application will download a map so that you can pinpoint your exact location and run any or all of the tests such as QCarrier, QWiFi and QPerf.



| Q Carrier            |  |
|----------------------|--|
| Field                | Description  |
| accuracy             | accuracy of the fix in meters  |
| carrier_cid          | cell id in GSM, UNKNOWN_CID if in UMTS or CDMA   |
| carrier_lac          | Location Area Code in GSM, UNKNOWN_CID if in UMTS or CMDA  |
| date_stamp_date      | The calendar day of the measurement..  |
| date_stamp_hours     | The hour of the measurement.   |
| date_stamp_minutes   | The minutes into the hour of the measurement.  |
| date_stamp_month     | The numeric month of the measurement.  |
| date_stamp_seconds   | The seconds into the minute of the measurement.  |
| date_stamp_time_zone | The time zone (hours +/- GMT) of the measurement.  |
| date_stamp_year      | The year of the measurement.   |
| latitude             | Phone latitude   |
| longitude            | Phone longitude  |
| newtnetwork_type     | The carrier type of network  |
| phone_type           | CDMA or GSM  |
| remote_id            | The IMEI of the phone  |
| signal_level         | The strength of the signal, measured in either RSSI (for GSM phones) or dbm (for CDMA and EVDO) phones |
| sim_operator_name    | Provider name  |
| Phone_Name           | MBI Calculated field   |

|       |                      |
|-------|----------------------|
| Route | MBI Calculated field |
|-------|----------------------|

|                            |  |
|----------------------------|--|
| Q Perf                     |  |
| Field                      | Description  |
| Timestamp                  | Date and Time from QPerf.  |
| _Location                  | The phone that data was gathered from.   |
| _Internal_IP               | In a NAT environment, this is the IP address of the device which would be different from the External IP   |
| _External_IP               | This is the IP address of the device as seen from the internet   |
| _Latitude                  | Phone Latitude   |
| _Longitude                 | Phone Longitude  |
| _Inbound_Jitter__msecs     | This is a measure of the variance in interarrival packet delays calculated according to RFC 1889   |
| _Inbound_Dropped____       | Packets dropped from server to phone.  |
| _Inbound_Out_of_Order____  | Packets which arrived at phone not in the order sent from server   |
| _Outbound_Latency__msecs   | This is calculated as the average round trip time of a set of UDP packets sent to the server and returned to the device.                                       |
| _Outbound_Jitter_msecs     | This is a measure of the variance in interarrival packet delays calculated according to RFC 1889   |
| _Outbound_Dropped____      | Packets dropped from phone to server.  |
| _Outbound_Out_of_Order____ | Packets which arrived at server in not in the order sent from phone  |
| _Inbound_Bandwidth_kbps_   | This is calculated using the total number of data bytes received * 8 / time to completion  |
| _Outbound_Bandwidth_kbps_  | See above  |
| _Target                    | Qperf.net  |
| _UDP_TOS_                  | These settings are available in the NetQuality Analyzer to enable testing based on TOS Values typically used in carrier MPLS networks for prioritizing traffic |
| _TCP_TOS                   | See above  |
| Provider                   | MBI Calculated field   |

|                    |  |
|--------------------|--|
| Route              | MBI Calculated field   |
| YEAR               | MBI Calculated field   |
| MONTH              | MBI Calculated field   |
| DAY                | MBI Calculated field   |
| MINUTES            | MBI Calculated field   |
| HOURL              | MBI Calculated field   |
| Upstream_Req_Met   | MBI Calculated field. Value is 1 if the [_Outbound_Bandwidth_kbps_] value greater than 200 |
| Downstream_Req_Met | MBI Calculated field. Value is 1 if the [_Inbound_Bandwidth_kbps_] value greater than 786  |

|                   |                                  |
|-------------------|----------------------------------|
| Q Wifi            |                                  |
| Field             | Description                      |
| hours             | Timestamp Hours                  |
| minutes           | Timestamp Minutes                |
| Seconds           | Timestamp Seconds                |
| time_zone         | Time Zone of Phone               |
| Remote_iD         | Phone IMEI                       |
| latitude          | Latitude in Degrees              |
| longitude         | Longitude in Degrees             |
| accuracy          | Accuracy of GPS fix in meters    |
| ssid_name         | SSID Name                        |
| ssid_id           | Numeric ID of SSID               |
| ssid_capabilities | SSID Capabilities                |
| ssid_frequency    | SSID Frequency                   |
| ssid_level        | The detected signal level in dBm |