

Madison County Board of Supervisors and

Madison Gigabit Internet, Inc.

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Madison, Virginia, 22727 703-862-4056

Madison County Rural Broadband Expansion Technical Proposal

VATI Grant 2019

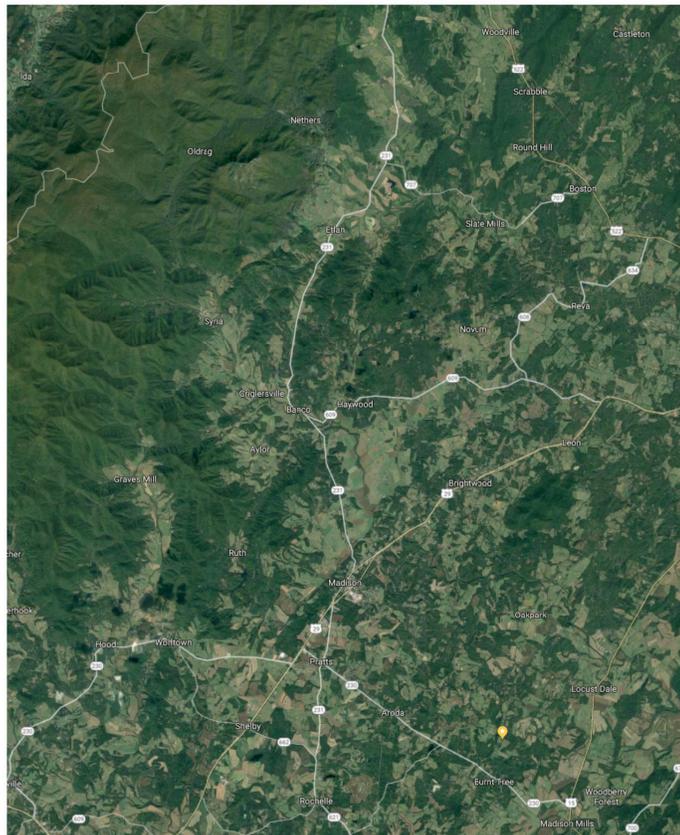


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Madison County Background and Demographics.

Madison County, Virginia, is a low-population county, with 13,300 residents. Average density is 40 people per square mile; a misleading number because the northwest quarter of the county is essentially empty, partially occupied by Shenandoah National Park. Madison has a median household income of \$51,000, as reported in the 2010 census.

There are no large private employers in Madison (anchor businesses); the school system is the largest public employer. Farming is the largest business activity. There are a number of small businesses in the county; the exact count is unknown as there is no formal registration required. Our estimate is 500; a large majority are entrepreneurial.

Madison is surrounded by mountains to the northwest, Charlottesville to the south, Orange to the southeast, and Culpeper is northeast. Madison has one town, also called Madison, population 220.

Madison County's geography is challenging, with plenty of hills and trees, virtually no flat areas at all, cell-phone dead zones on Route 29, hills and trees that block all kinds of radio/TV signals.

Madison County, and Madison Gigabit Internet (MGI), are partnering in this proposal. MGI is the only locally-based ISP in the County.

National Background

In 1998, we WERE all using 50 KILOBits of dialup. Amazon only sold books. Google was a research project. Facebook creator was in junior high school. Social media was AOL.

In 2018, we CAN use 50 MEGAbits of cable. Amazon sells everything. Google dominates the internet enough to have had its name become a verb. Facebook dominates social media.

In 2038, we will WANT to use 50 GIGAbits of fiber. What new thing we haven't thought of yet will be dominant?

County and Corporate History

Broadband Committee

Madison County formed a committee several years ago to understand and explore options and possibilities. The committee's primary outcome was getting the County to fund a formal survey that was very informative.

Survey

In May 2017, Virginia Center for Innovative Technology (CIT) performed a residents survey for Madison County, asking questions about internet access and performance. There were 1000 responses for approximately 5400 households and businesses, more than enough for a valid statistical result.

The essential results were that 65% of the responses were residents who were not happy with their service and wanted something better. 17% of the responses were from residents who have no service at all. Two percent of the residents are still using dial-up; no businesses are. These numbers are consistent with other recent surveys, like RUOnline. Satellite and cellular are the most common access channels.

It was also possible to add write-in comments for each of the questions. There were 350 comments; about half were of the nature of “so glad someone is working on this!”. Others, while still anecdotal and not more than individually representative, were very specific about details.

The clear reading outcome from the comments and the statistics is that there is significant demand for better service in Madison County. The survey is here:
https://www.madisonco.virginia.gov/sites/default/files/fileattachments/economic_development/page/2797/broadband_-_madison_survey_analysis_27june2017_by_cit.pdf

The survey's conclusions were that Madison County should do what we are now doing.

Madison Gigabit Internet

The statistical results of the survey, and the comments, led Mr Hyde to conclude it was time to get the project going. Discussions and presentations began in August 2017. Madison County Planning Commission added a new line-item to the new Five-Year Comprehensive Plan, in advance of the new 2018 State of Virginia legislation requiring it (HB. Other presentations in 2017 were to the Board of Supervisors, the Madison Town Council and the Town Planning Commission.

In early 2018, following a newspaper interview and a television interview, Mr Hyde formally incorporated Madison Gigabit Internet, to tackle the problem of how to achieve true high-speed internet service in Madison County.

The long-term solution will be done in two stages, where the first, high-speed wireless, has lower cost, and necessarily lower speed, to bootstrap a revenue stream to support the second stage, fiber to the home. Madison Gigabit began serving customers in its immediate vicinity in Spring 2018.

Census Tract Eligibility Research Method

Madison Gigabit, and all Internet Service Providers, are required to file the “FCC 477” report to the FCC (Federal Communications Commission) every six months. This information is then matched with the US Census Bureau’s data to determine eligibility for broadband expansion grants and other government funds. To determine which census blocks are Served, Unserved, or Underserved, MGI used the following methodology:

There are two Census Tracts in Madison:

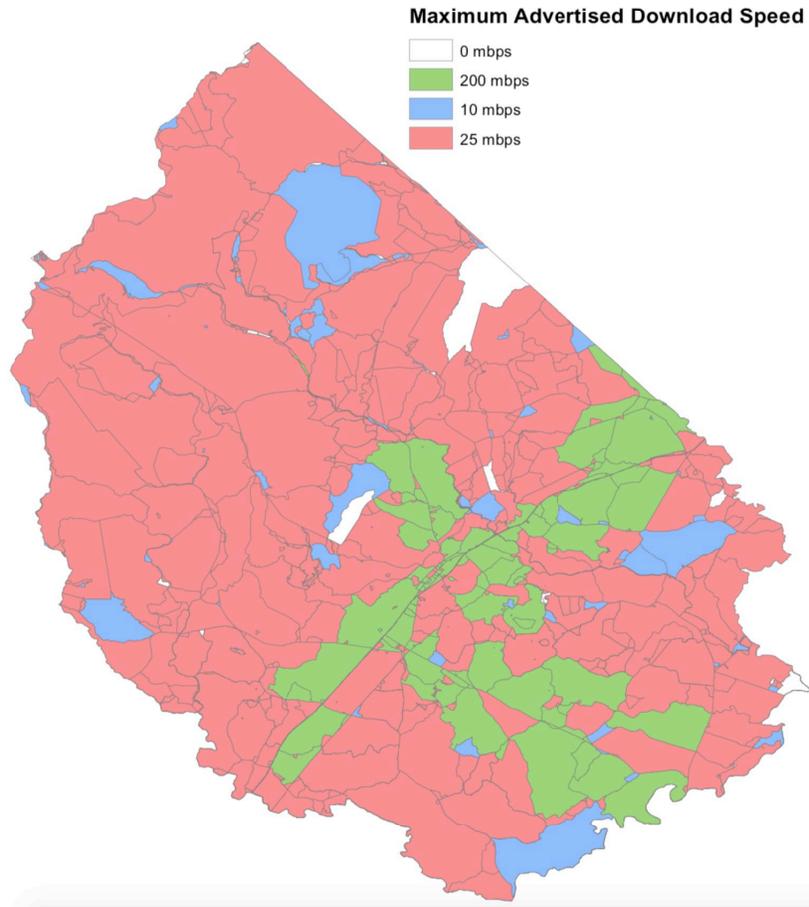


7 census block groups, and 1000 census blocks (some of which are quite tiny, as small as a single house).

This is a GIS image of the Madison County census blocks. There is no correlation between the block size and the population present.



The FCC 477 data shows that most of the county is “covered” by one provider or another, but these numbers are misleading. There are two sets of numbers, actual customers, and potential customers. For a WISP (Wireless Internet Service Provider), the fact that a radio signal reaches into/over a census block allows that block to be called “covered” at a particular speed, when there may in fact be no actual customers being served. That set of assumptions allows for a map like this:



It includes all download speeds 10 megabits and above. Providers under 10 megabits are not real players in this business.

A different flavor variation of this map is online at: <https://broadbandmap.fcc.gov/#/location-summary?version=jun2017&lat=38.362909&lon=-78.287923>, and shows the count of providers in census blocks, not service speeds (although those are related).

Each of the “polygon” outlines is a census “block”. The size varies crazily, so there isn't any real meaning to that aspect.

The several white blocks can't possibly be “unserved” when they are surrounded by blocks that are at least served by satellite, so this suggests omissions/flaws in the FCC data.

The green blocks are where Comcast reports service, although Comcast does not fill those green blocks. This includes their coax service and fiber presence.

The blue are the lesser services, with the caveat about flawed data. They should probably be red.

The red blocks are those served best by satellite; this reaches nearly the entire county (and probably reaches the blue blocks, too, but the FCC data says not). It is our measured experience that although the FCC data says 25/3 megabits for satellite, 8/1 megabits is the reality, which means that most of the county falls in the FCC “unserved” category. Because satellite does cover the county there is already substantial service overlap.

The FCC provider coverage data from the Form 477 shows the following providers of home service across the county:

Skycasters
HighSpeedLink.net
ViaSat (Exede)
Verizon
DishNet (Hughes)
Virginia Broadband
Comcast

Madison Gigabit is new enough to not be present in the dataset yet. MGI filed its first FCC 477 at the end of summer; this data is from the end of June.

Of these providers, only these claim to offer service better than 10 megabits:

12	HighSpeedLink.net
12	ViaSat Inc
15	Verizon Virginia LLC
25	HughesNet
25	Virginia Broadband, LLC
95	Madison Gigabit
200	Comcast

Interestingly, AT&T is not listed in this FCC data, but their hotspot-cell-based service can be very good where it is available.

We know that ViaSat offers 25 megabit service, but 12 megabits is all that shows in the FCC data.

Skycasters appears to have no customer base in Madison; a casual survey of in-county Facebook Friends suggested no one has ever heard that name here. The FCC data for Skycasters is 2 megabits, so they are not a serious player as an ISP.

HighSpeedLink.net claims 12 megabits in the FCC data, but the same casual Facebook survey suggests no customers in Madison.

HighSpeedLink.net offers this coverage map over Madison and surrounding areas south



We imagine there is some kind of radio tower southwest of Madison County, that has some signal reach into Madison, but there appear to be zero actual customers in Madison. The coverage does seem to follow roads closer than a radio map typically would, making this picture suspect.

This is the Comcast Madison coverage map:
(Comcast is buried coax cable, so not broad areas)



The correspondence to the green census blocks on page four is obvious, but nowhere does Comcast cover all the space the census blocks and FCC data would suggest. (The pink “line” is wide for visibility, not as geographic coverage.)

Comcast is the real competition, and we will avoid those areas for now.

The Virginia Tech Broadband-availability map (<https://broadband.cgis.vt.edu/IntegratedToolbox/>) shows that Madison has very little unserved or underserved area (because satellite covers it all), but the “not available” and “needs improvement” responses cover pretty much the entire county.

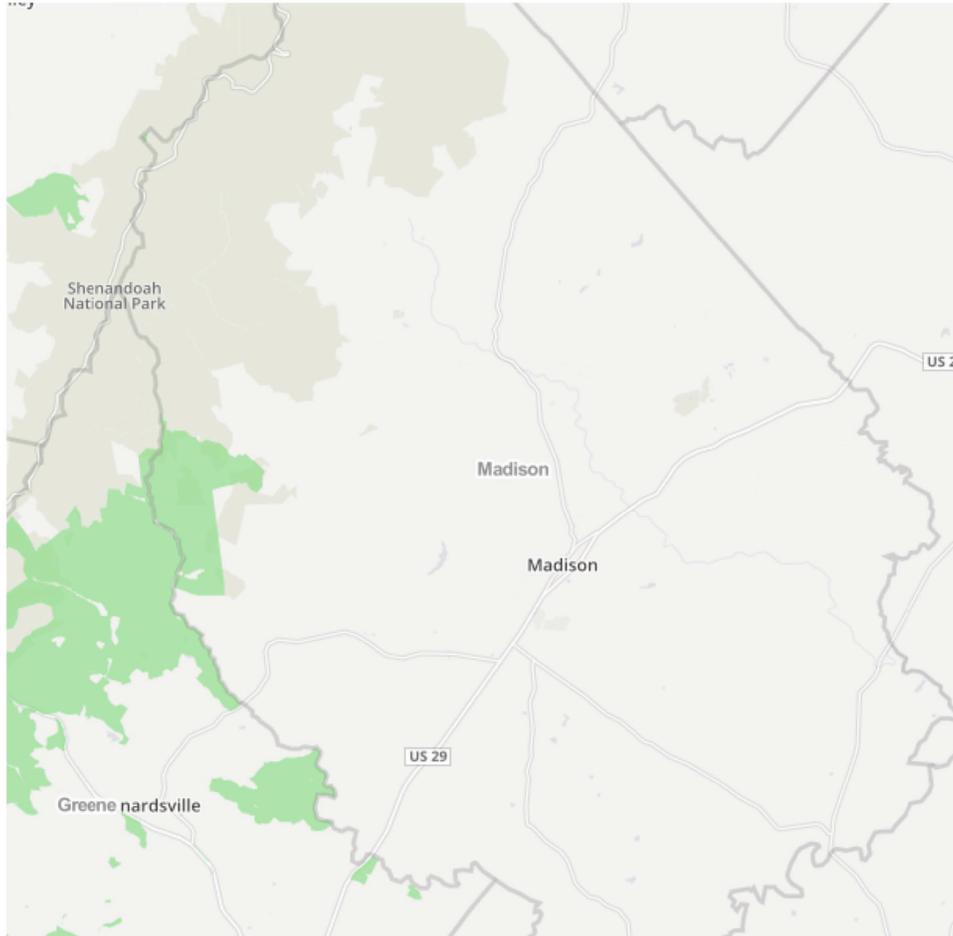
We will be providing service speed greater than 25 megabits because we believe that is barely sufficient for today's needs, and inadequate for future needs. MGI's current wireless service speed is 100/25 and will jump to 100/100 for this new system.

Another thing we have found regarding satellite service is that the terrain shadowing caused by Madison's geography makes for two homes being a short distance apart north/south can be unserved and served by satellite because of hills.

We also have the CIT survey raw data, and can plot specific kinds of service across the dataset. It does not distinguish between providers of the same kind of service, but there are only two satellite providers.

Connect America Fund II

This is the FCC CAF II map (<https://www.fcc.gov/reports-research/maps/caf-2-accepted-map/>). This is telco action and accepted funds for expansion. It covers nearly nothing of Madison County.

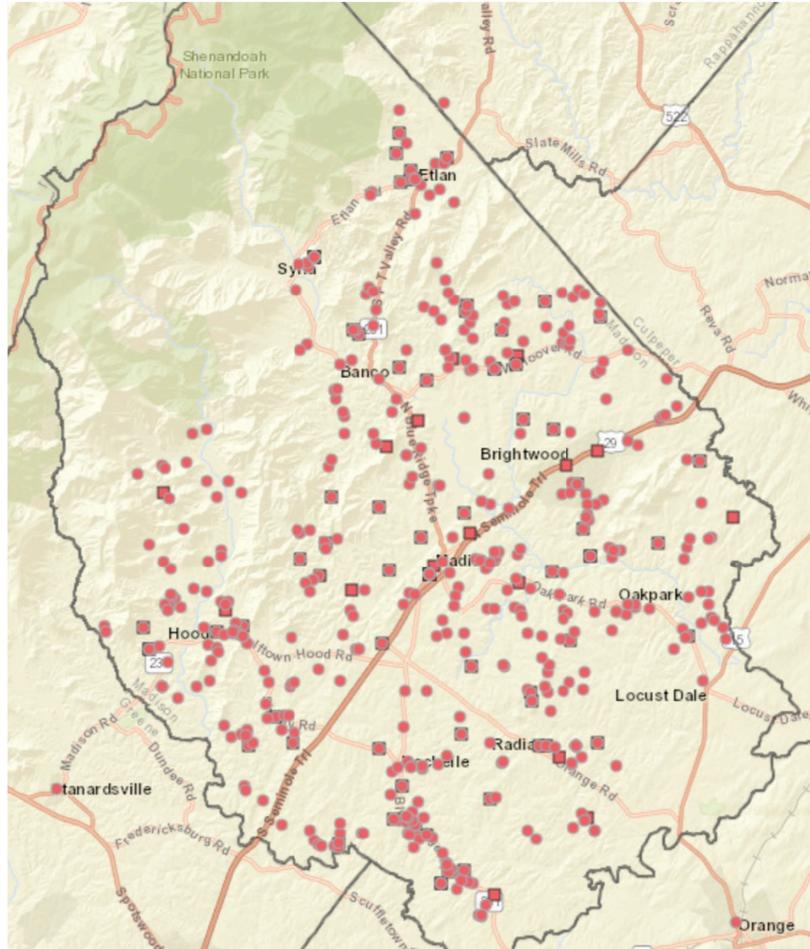


So there is no CAF II action in Madison at this time. Co-applicant Madison Gigabit was ineligible to apply because of being too new in the business category.

Any work done with this grant will not be in that small area at the west-center edge of Madison.

Demonstrate Need:

From the 2017 CIT survey results: The survey results strongly indicate that there is widespread need. The number of responses and comments saying so were substantial, well above 50%.



The above map, from the CIT survey, is the plot of georeferenced. Each red dot indicates responses where “inadequate service” was reported. There is a concentration in several areas that will address this need.

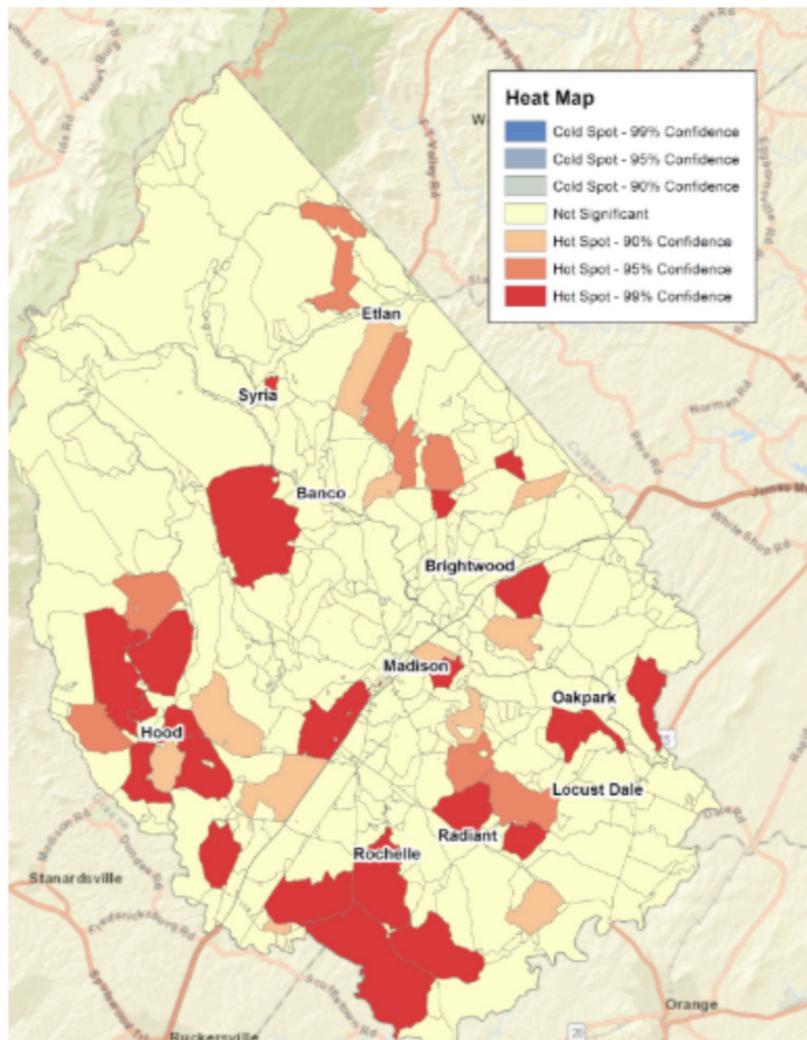
In 2009 there had been a previous survey conducted by CIT in Madison, on a far smaller basis, receiving only 100 responses. Reading that final report you notice two things: half the responses came from people who were still using dialup, and the same %s of responses said “we want better”. In addition, the written comments were nearly identical: “expand my business”, “sell my house”, “schoolwork”, etc.

The RUOnlineVA survey data says the same things within the statistical confidence variation.

<https://www.cit.org/assets/1/17/Release-RUOnlineVAreport.pdf>

<https://www.wired.virginia.gov/sites/default/files/RUOnline%20Virginia%202016%20Report.pdf>

This map from the CIT survey results shows a heat map of reported inadequate service over census blocks:



It correlates to Wolfstown (Hood), Rochelle, Brightwood, and near Criglersville (Banco), which are the locations we are targeting with this proposal.

From the 2017 survey, 65% of the responses said “I want better service”. 7% of the responses said “I do not have service of any kind” and 10% said “no service is available at all.” That is more than 80% of the county.

The top three reasons given for being dissatisfied with the existing service were “too slow”, “too expensive”, and “service unreliable”. All those issues will be addressed by the Madison Gigabit Internet solution. Other surveys say essentially that same thing.

The comments included such things as “I could expand my home-based business if I had better service” and “I could sell my house for more money if I had better service”. MGI has a customer now that is renting a house in town vacated by the homeowner because the available service was poor (or perhaps too expensive; in town, Comcast coax is available, can perform quite well, but is not cheap). An anecdote reported in Fauquier County's own survey: a resident was forced to reduce the asking price to sell his house by \$50,000 because high-speed service was not available there.

Business in America, in general, needs or demands good internet access itself. A county with poor internet service options cannot attract new businesses when neighboring counties have better; this is no different than the quality of local roads or local schools.

In schools, online access is a requirement now, yet the service in Madison doesn't meet the needs of children. An unknown number of them (estimated to be 500 per week) use the library regularly, including the library's free (but limited) WiFi after the library closes at night, or use the free WiFi at McDonalds. Good schools are a driver of economic success.

Anecdotal evidence, from many conversations with local citizens, indicates that if we could deliver better service county-wide today, we could sign up most residents immediately.

Internet access is like roads and electricity—more is better, all the time. And it will lead to things we cannot even imagine yet.

Statistics from the CIT survey analysis:

[?] Residential

- 67% state their home Internet is inadequate
- 64% of those depend on cellular, satellite or dial-up services
- 17% state they have NO access at all
- 30% of residents would telecommute if they had better access.
- 30% of respondents have K12 students, 12% are homeschooled
- 45% of respondents use the Internet for school and work purposes
- 26% of respondents report home based businesses

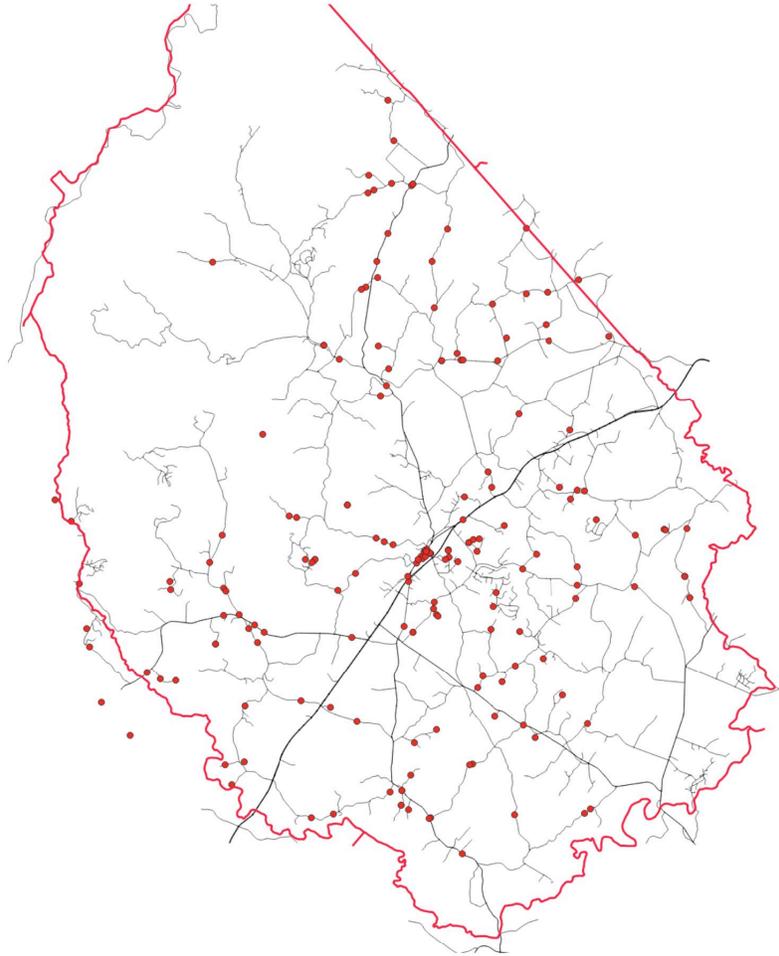
[?] Businesses

- 25% of respondents own a business
- 62% of businesses state they need better access than they have today
- 87% of business owners say the Internet is important/critical to their businesses
- 67% of businesses depend on inadequate services; cellular, satellite and DSL
- 26% (of all respondents) have home based businesses

From these statistics, and conversations with county residents, it is clear that everyone here wants more than what they have, and it is also clear that in a few years we will all want more than that.

Amazon's announcement of building a new corporate headquarters in Northern Virginia really necessitates improving infrastructure at least 100 miles out all around, and boosting educational capabilities. We need to move forward quickly on this, because the spill-over from the economic expansion that causes will reach this far within 10 years.

This simple map contains georeferenced locations for people in Madison who have expressed interest in better service directly to MGI through its website registration:



Interestingly, other than the concentration in town, associated with early, experimental users, the interest is relatively evenly distributed around the county (it extends outside the border also, into Greene, Orange, and Culpeper counties, although not all are shown here). The CIT map reflects this same distribution, on a larger scale.

Because the locations are so evenly spread, there's no clear winner for where to begin. Therefore, this proposal includes several sites around the county.

Competition:

Satellite service is the most widely available across the county (38% uptake), but cable service has the most satisfied users. The speed different is the most likely cause.

Satellite speeds cannot be very great (in order to achieve great distances like that from satellite to ground, the radio frequencies are lower, which translates into lower data speed). Weather has an impact, clouds and rain interfere with radio signals, and heavier storms can completely block internet service. Personal experience with satellite service is more “click-n-wait” than speedily getting things done, and there are certain uses of internet access that simply don't work via satellite because of high transmit/receive latency (VPN in particular). Satellite and wireless services reported numbers reflect theoretical capabilities, or service speeds that are deliberately restricted to conserve bandwidth. Our casually measured service speeds, using speedtest.net, for existing satellite are under 10/1, nowhere near the FCC-reported speeds.

Comcast is available in the Town of Madison, along Route 29, and along a few select roads that extend away from Route 29. This service can be as fast as listed by the FCC.

Virginia BroadBand (VABB), another WISP, has some service in Madison, and is, in a way, a direct competitor. Their actual service area installation is small, however; their FCC data shows wide coverage, like satellite. Here, too, speeds are limited.

DSL is not competitive, seldom reaching past 2 megabits, and very distance-from-the-hub limited.

The other players are too small to have impact, or not even present in the county.

Madison Gigabit is already offering service speed of 100 megabits and will continue to; the eventual target of fiber and gigabit service will eclipse them all.

Other location examples:

South of Madison, CVEC power co-op has begun to run data fiber with its power distribution. Their service will be speed and price comparable to what MGI is doing. In other counties there are additional fiber-based services being worked on (BARC, another power coop, has begun doing likewise in their area, as is Roanoke County). Ting, in Charlottesville, offers gigabit service over fiber now.

Verizon FIOS is gigabit service capable where it exists.

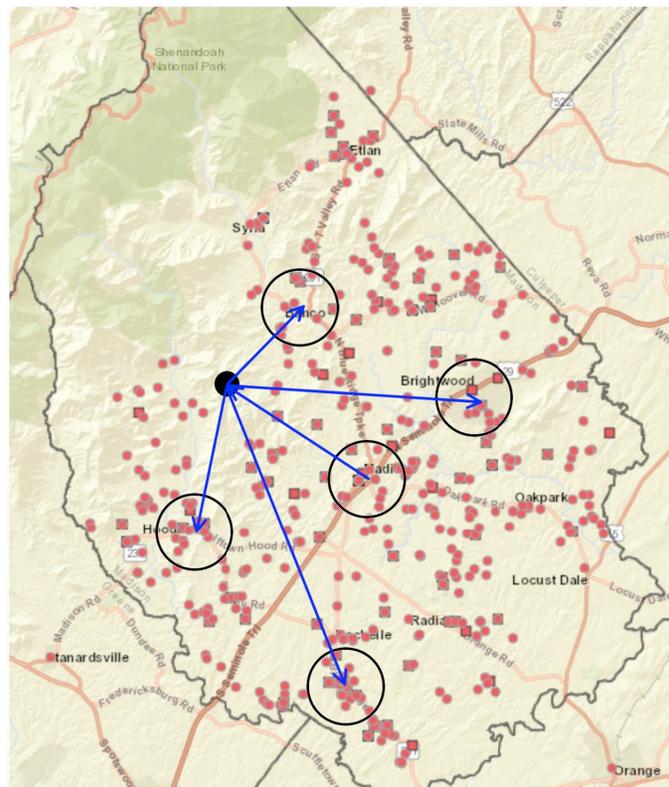
Project Description:

Madison Gigabit's long-term plan for improved internet service and access in Madison begins with high-speed wireless service and backfill with fiber-to-the-home. The wireless service is less expensive to install, and can reach farther sooner, but has hardware speed and geographic limitations.

There are multiple parts to the creation of wireless service. There must be a fiber trunk within reach. Madison has at least five lines through the county (LUMOS, Comcast, Fiberlight, Verizon, AT&T). The most readily available source is LUMOS. Both Madison County and Madison Gigabit have existing service and relationships with LUMOS.

(There will eventually need to be several Point-of-Presence (fiber taps) in the county. With a transmission tower at each one, it will be possible to reach further-away locations that serve as repeaters.)

This map is the CIT map with 2-mile diameter circles drawn for the tower deployment locations, and a black dot for the REC “Blakey” tower; Blakey is the critical repeater point, because it has greater elevation above sea-level (2000 feet) than anywhere else usable in the county (generally around 500 feet). The other green circles would be receiver end-points for local distribution. The circle in the center (in town) would be the ground station, where there will be a direct fiber tap.



This map shows the signal coverage area for antennas on the REC Blakey Tower:



Also in this picture are two points in town that can easily send/receive to that tower. Using Blakey tower as an antenna location then covers nearly the entire county; the small areas not covered have other hills that do some signal blockage.

The backhaul radios we will use between the locations in this image are 24GHz full-duplex devices capable of reaching 20 kilometers (12+ miles). The distance there is 9 kilometers (5.6 miles).

In reality, of course, overall service delivery won't be as good as the image implies—there can be trouble about trees, but Blakey is the best intermediate point to use. MGI is currently negotiating with REC to do so.

From Blakey, we will use the same 24 GHz radios to reach the end-points. That said, you do not want to daisy-chain very many hops—there is performance loss each time. The point-to-point from in-town out to Blakey is a special antenna for middle-mile delivery. Rochelle is near that distance from Blakey, and if the 24GHz radios can't reach there we will use something smaller instead, with greater distance but somewhat less data capacity. These backhaul radios will have one hop from the ground station to Blakey tower. A second pair will extend from Blakey to each of the desired end points. The last-mile radios are 5 GHz devices. They only need to go out to a mile or so.

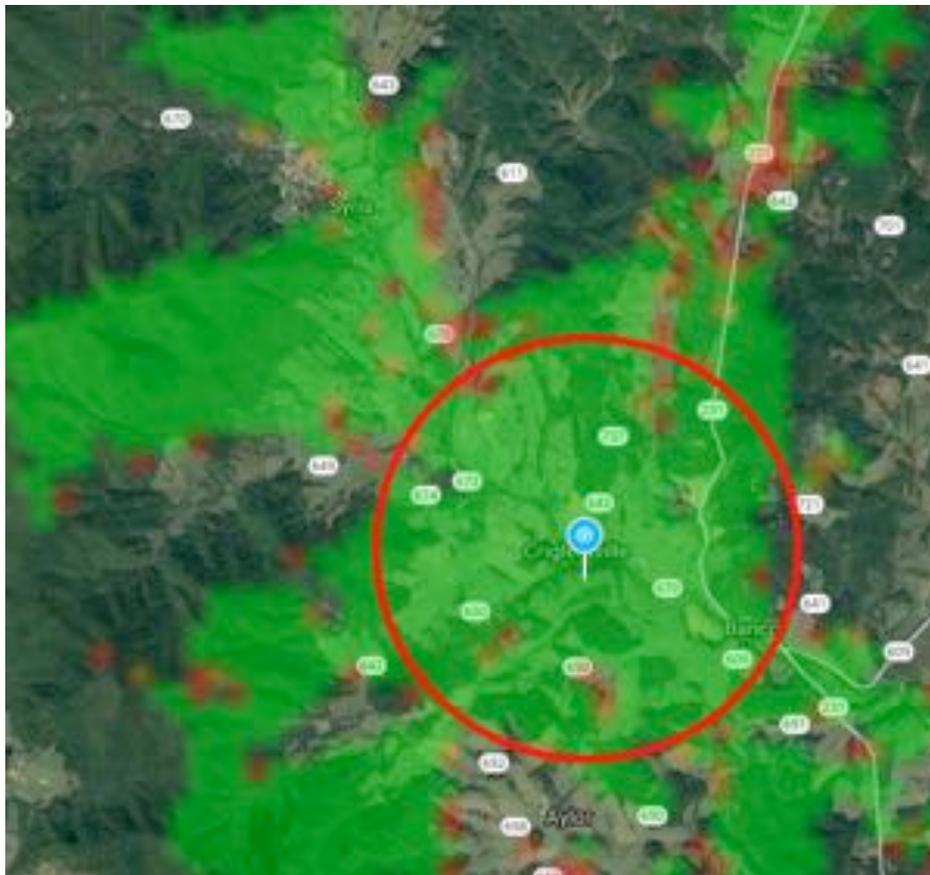
The next step is to place last-mile repeater antennas in the right locations, with the best projected available customer base. These towers will have matching 24 GHz back-haul antenna to reach Blakey, and local last-mile pie-wedge directional antennas to reach individual houses. These omni antennas have a reach over a mile in all directions, so distance will not be the limiting factor.

We anticipate that the last-mile antennas have a functional limit of how many individual homes they can handle, in the range of 40-50, so there will be four to six for each tower. We anticipate the total cost for each one of these “nodes” is \$12K for a pole, and \$25K for a metal tower, including all the antennas and radios.

A pole can be planted by drilling a hole and placing the pole in it. A metal tower requires a 10-foot deep hole for a concrete pad that the bottom metal piece is embedded into.

The following images are radio-signal coverage projections based on line-of-sight calculations using terrain elevation data.

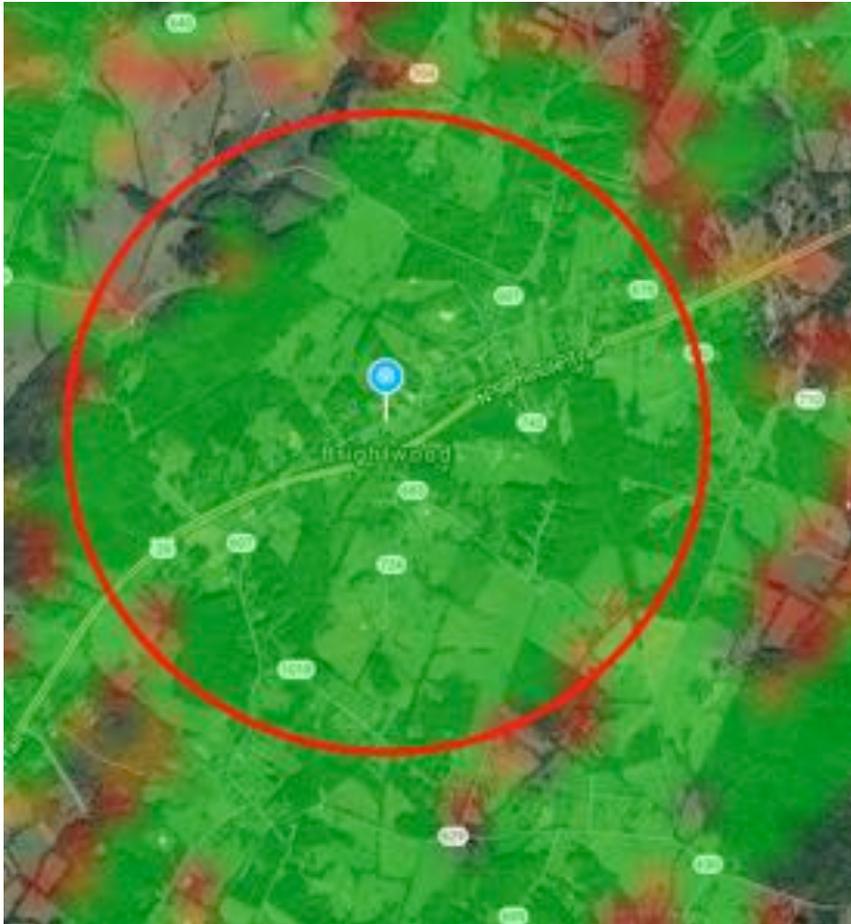
Criglersville, shown here, is 5 kilometers (3 miles) from Blakey. The red circle is expected radio/antenna reach from the tower. Homes and businesses inside that circle are the potential customers at this tower location.



The location marked by the blue circle is a reasonably good location for a pole or tower. Criglersville is a less-populous area, and hillier than locations further east in the county, but we believe that this phase

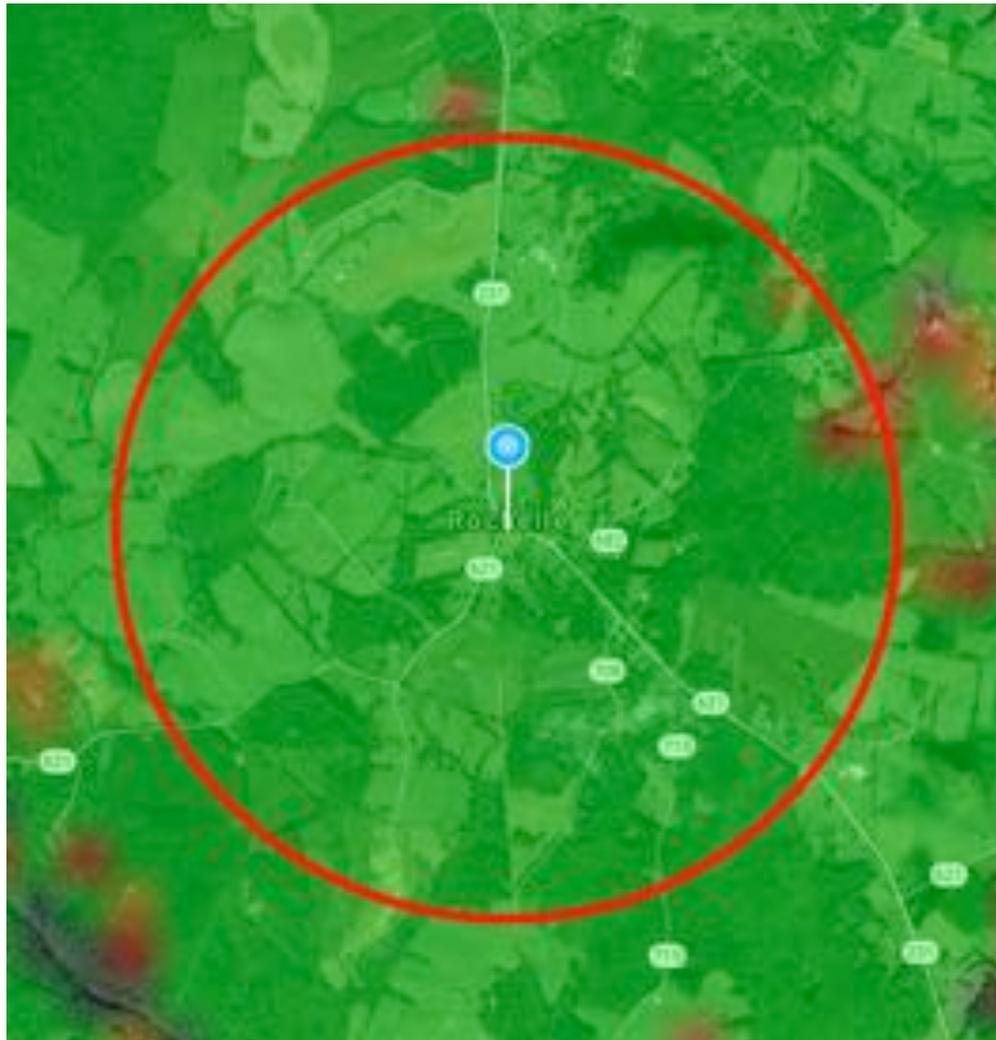
of construction and service delivery should include a location in the northwest of Madison County.

Brightwood, shown here, is 12 kilometers (7.5 miles) from Blakey. The red circle is expected radio/antenna reach from the tower. Homes and businesses inside that circle are the potential customers at this tower location.



Brightwood is a high-point in its vicinity. Just southeast off Rt 29 there is a small defunct tower already. Where the blue circle is in the image is a high point that would be an ideal location for a 75 foot tower. There is reasonable population density in this area; some of it is served by Comcast but away from Rt 29 is not.

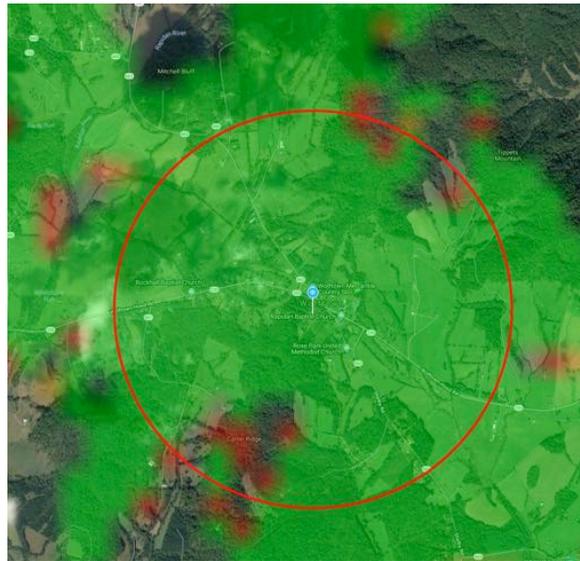
Rochelle, shown here, is 16 kilometers (10 miles) from Blakey. The red circle is expected radio/antenna reach from the tower. Homes and businesses inside that circle are the potential customers at this tower location.



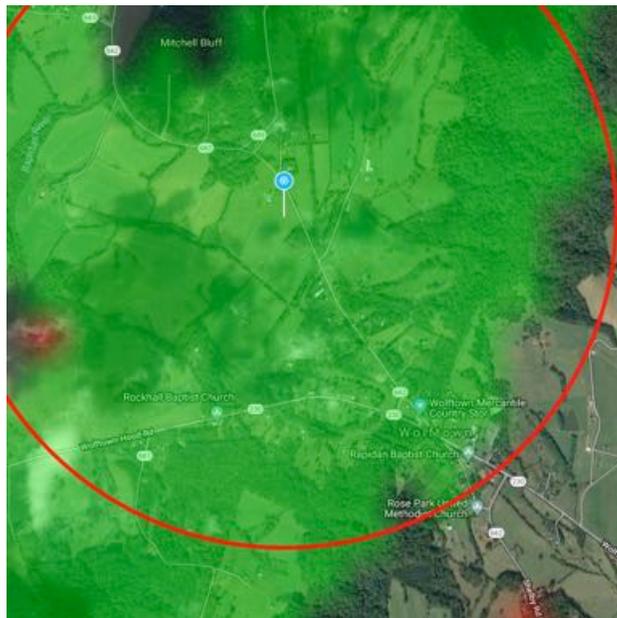
Rochelle is at a high point in the vicinity. The signal reach from here is good in all directions. In addition, as can be seen in the light-vs-dark green differences, there is very little tree cover at that peak, affording good reach for a mile or more.

Other than satellite there isn't any good service in this area.

Wolftown, shown here, is 8 kilometers (5 miles) from Blakey. The red circle is expected radio/antenna reach from the tower. Homes and businesses inside that circle are the potential customers at this tower location.



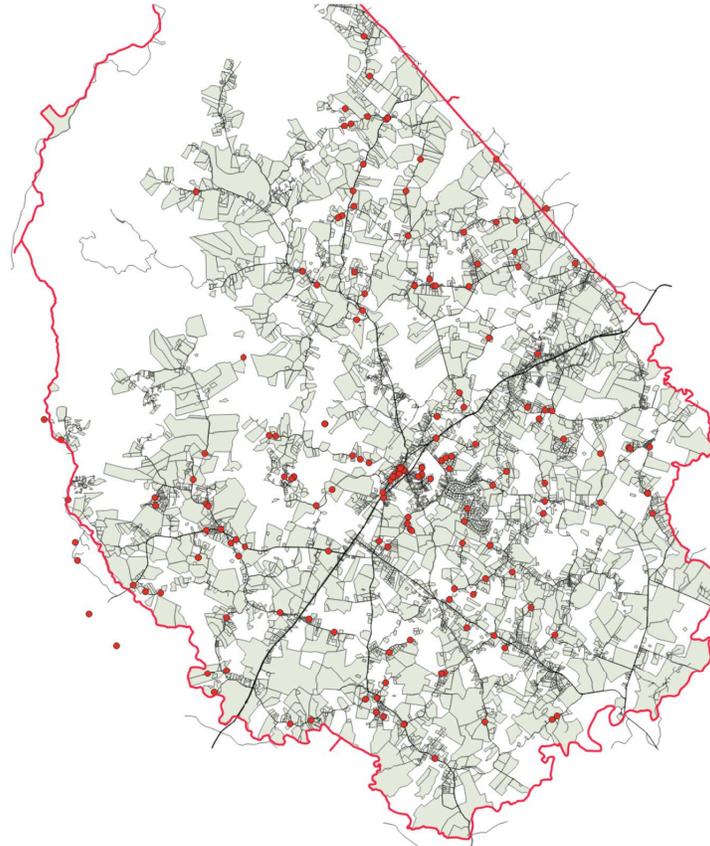
Wolftown center is in a pass through a small elevation ridge. While the location of the small blue circle is more or less center for the location, the antenna at Blakey may not reach there.



We expect the signal from Blakey to reach here more effectively, but this limits coverage east of the ridge.

Other than satellite there isn't any good service in this area.

Map of interested people and all occupied real estate parcels. (Interested people are ones who have signed up with MGI via a form on the website.)



The significance of this is that there are some serious areas in Madison where there are no houses, businesses, etc., shown here as white gaps between colored parcels. We will avoid those regions.

The concentration of interest, between our own gathered information and that from the 2017 survey shows that Wolftown, Rochelle, Brightwood and the Criglersville/Banco area are the best targets.

There are several interesting vertical assets in Madison other than Blakey. Two are at the edge of the Town of Madison, and will be considered as the ground-station locations for reaching to Blakey. Both are on Main Street, and the LUMOS fiber trunk runs along that street end-to-end, making for an easy tap. In addition, local service can be provided by placing other end-point service antennas on those vertical assets.

Overall the project includes backhaul between the ground station and Blakey tower, middle mile from Blakey to the four endpoints, and last mile from those endpoints to actual customers. MGI will be the owner and maintainer of the towers and attached electronics. Blakey tower spaced will be leased from REC.

Proposed Construction Costs

Erecting a tower is a medium-priced effort. The price is \$15000 for a 50-foot tower, \$17000 for a 75-foot tower, and \$20000 for a 100-foot tower. The tower itself is \$1500-2000, the remainder is contractor labor, for a concrete base and complete assembly. Each point-to-point antenna associated with backhaul will cost \$3000, and the end-point multi-point antenna solution will cost \$2000.

It is also possible to plant a “telephone-pole” as a “tower”. This is a less expensive option overall, \$10-12000 combined cost for Rappahannock Electric Co-op to plant the pole, and for us to mount antennas. REC owns and plants thousands of poles. We will determine during site surveys at the beginning of project execution if pole is actually the feasible solution. Preliminary estimates suggest it can be, but planning is not that detailed yet. Poles are height-limited to 50-60 feet

It is our intention that any such tower be “short-term” (which probably means several years), and in use only until such time as the service area gets converted to fiber-to-the-home.

costs	grant	M G I	county
ground stn	\$3,000.00	\$2,000.00	5000
Blakey	\$4,000.00	\$14,000.00	
Wolftown	\$17,000.00	\$6,000.00	500
Rochelle	\$17,000.00	\$6,000.00	500
Brightwood	\$17,000.00	\$6,000.00	500
Criglersville	\$17,000.00	\$6,000.00	500
admin	5000	\$4,000.00	
totals	\$80,000.00	\$44,000.00	7000
grant	\$80,000.00		
Applicants		\$51,000.00	

Example of tower cost:

<https://www.rowewireless.com/tbx-self-supporting-tower-available-from-24-to-64/>

Antenna costs:

<https://www.ubnt.com/airfiber/airfiber24-hd/>

<https://store.ubnt.com/collections/wireless/products/rocket-5ac-prism-gen2> (backhaul)

<https://store.ubnt.com/collections/wireless/products/prismap-5-90> (middle)

<https://store.ubnt.com/collections/wireless/products/nanobeam-5ac-gen2> (CPE)

CPE is not listed in the table because that is per-customer cost, dependent on take rate.

Customer Take Rate

It is a question of when, not if or who, it will eventually be 100%. Of current residents, there will be some who do not ever have a computer, a smart phone/tv. While that may last some years, it will not last forever.

No one lives without the internet any more, whether they know it or not. All banking uses the internet somehow. Schooling requires the internet. Most shopping/commerce uses the internet.

The internet has enabled the creation many new things, ones not conceivable 30 years ago. The future of the internet will do even more of that.

All progress will need expanded internet service and access. If we are not moving forward we are falling behind.

Our experience is that everyone wants it. The residents in a given vicinity of someone who has said they want it probably also want it and just haven't said so yet.

Microspots, where a pole serves a handful of homes, are one approach on a small scale; microspot approaches are often multiple-hop daisy-chains of repeater nodes where the customer ends up with unhappily low service speed. Our approach, while similar, but larger scale, is a better starting point because the service capability is greater. And in the end the target is gigabit service over fiber, because the future will require it and we should plan towards it now.

Our current estimate of potential customer base at the four sites is:

Wolftown: 75 homes, approximately 200 people

Rochelle: 150 homes, approximately 300 people

Brightwood: 75 to 100 homes, approximately 250 people

Criglersville: 75 homes, approximately 200 people

These number come from a distance estimate using the radio-coverage images and counting the real estate parcels with actual homes in them, and comparing against Google Maps satellite images of the same areas. We did not make a distinction between business and residential locations in those numbers.

100% uptake is over 300 customer sites, more than enough to be paying for itself very quickly, with an ROI recovery near the end of the calendar year.

Return On Investment:

The payback period is of course based on the take rate.

For approaches that do not require building a tower, the payback period is going to be fairly short. It will take 20 residential customers at \$75 per month to pay the fee for fiber access (\$1400).

There is a fixed capital cost of approximately \$3000 for backhaul antennas, \$2000 for local service antennas, and then \$200 per residence for service; this is approximately \$30000 up front capital cost for electronics. Reaching 100 homes produces \$7500 per month income. That is roughly a 120-day payback.

Maintenance cost is minimal, our experience so far with the devices we use has been that they either fail right away or not at all.

If the take rate is only 50 homes the ROI payback timeframe is longer, of course.

The following tables are about income and payback for the capital investments. The end-point locations we will use have the potential to reach as many as 125 homes (customers), which is a faster ROI.

This is a basic table of revenue per month.

Customer count	20	25	30	35	40	45	50
income/month	1500	1875	2250	2625	3000	3375	3750
months							
1	1500	1875	2250	2625	3000	3375	3750
2	3000	3750	4500	5250	6000	6750	7500
3	4500	5625	6750	7875	9000	10125	11250
4	6000	7500	9000	10500	12000	13500	15000
5	7500	9375	11250	13125	15000	16875	18750
6	9000	11250	13500	15750	18000	20250	22500
7	10500	13125	15750	18375	21000	23625	26250
8	12000	15000	18000	21000	24000	27000	30000
9	13500	16875	20250	23625	27000	30375	33750
10	15000	18750	22500	26250	30000	33750	37500
11	16500	20625	24750	28875	33000	37125	41250
12	18000	22500	27000	31500	36000	40500	45000

The next two tables are about the break-even point for using a 50-ft “telephone pole” versus a 100-ft metal tower. The payback time-frame will not be the decision criteria for pole versus tower; that decision is based on which one yields greater reach to customers.

This is the ROI timeframe for using a Pole as the end-point. A pole install estimate is \$13000.

Pole end point Customer count Months	13000						
	20	25	30	35	40	45	50
1	-11500	-11125	-10750	-10375	-10000	-9625	-9250
2	-10000	-9250	-8500	-7750	-7000	-6250	-5500
3	-8500	-7375	-6250	-5125	-4000	-2875	-1750
4	-7000	-5500	-4000	-2500	-1000	500	2000
5	-5500	-3625	-1750	125	2000	3875	5750
6	-4000	-1750	500	2750	5000	7250	9500
7	-2500	125	2750	5375	8000	10625	13250
8	-1000	2000	5000	8000	11000	14000	17000
9	500	3875	7250	10625	14000	17375	20750
10	2000	5750	9500	13250	17000	20750	24500
11	3500	7625	11750	15875	20000	24125	28250
12	5000	9500	14000	18500	23000	27500	32000

Where a 50-ft pole plus associated electronics are expected to cost \$13000 plus antennas. The ROI time-frame is not bad, less than a year even with only 20 customers.

This is the ROI timeframe for erecting a metal tower as the end-point. A tower install costs \$20000.

Tower end point Customer count Months	20000						
	20	25	30	35	40	45	50
1	-18500	-18125	-17750	-17375	-17000	-16625	-16250
2	-17000	-16250	-15500	-14750	-14000	-13250	-12500
3	-15500	-14375	-13250	-12125	-11000	-9875	-8750
4	-14000	-12500	-11000	-9500	-8000	-6500	-5000
5	-12500	-10625	-8750	-6875	-5000	-3125	-1250
6	-11000	-8750	-6500	-4250	-2000	250	2500
7	-9500	-6875	-4250	-1625	1000	3625	6250
8	-8000	-5000	-2000	1000	4000	7000	10000
9	-6500	-3125	250	3625	7000	10375	13750
10	-5000	-1250	2500	6250	10000	13750	17500
11	-3500	625	4750	8875	13000	17125	21250
12	-2000	2500	7000	11500	16000	20500	25000
13	-500	4375	9250	14125	19000	23875	28750
14	1000	6250	11500	16750	22000	27250	32500
15	2500	8125	13750	19375	25000	30625	36250
16	4000	10000	16000	22000	28000	34000	40000

A metal tower is of course more robust, but is also more expensive, thus a longer ROI. Where the potential count is greater than 50, the payback period is even faster.

All of which then affords other expansion work.

BENEFITS

Despite being located near northern Virginia, Madison County does not have adequate and reliable internet access for its citizens. **Broadband impacts all areas of community life including local government, healthcare, education, economic development, and public safety. Madison County’s ability to attract and retain economic development and its overall quality of life is dependent on infrastructure.**

Investment in infrastructure is a responsibility Madison County takes seriously. As demonstrated throughout this application, Madison County broadband needs include the need for expanded, lower cost, more reliable services. These needs have been expressed by users including residential customers, public safety officials, small businesses, telecommuters and industries. Education, healthcare and economic development needs are all abundantly clear.

Telecommunication planning and investment is fully supported by the Madison County 2017/18 Comprehensive Plan. The plan states:

“Promote County-wide availability of affordable and accessible high-speed internet service...Actively pursue becoming a leader in providing, through private providers, affordable and accessible internet service to homes and businesses throughout Madison County and achieving gigabit performance levels within no more than five years.”

We believe the Amazon decision to locate a new headquarters facility in Arlington heralds accelerated growth at least as far out as Madison, directly or indirectly. It could also be an inflection point of change that causes other businesses to select Virginia as a siting choice. The construction of boxy data centers in Northern Virginia will begin to reach this far, to be on cheaper land, producing job growth and residential growth. That sort of growth will come, and better internet access will be necessary to deal with it, lest such growth go elsewhere and leave Madison behind.

Economic Development

Madison County recognizes the importance of being competitive to attract new business development and improve what is already present.

In 2015, the Virginia Center for Innovative Technology in Herndon published a report titled “Improving Broadband Access and Utilization in Virginia-Recommendations for Locality-Led Broadband Initiatives in Virginia”. The report says that:

“Broadband not only benefits a locality’s economic development but has become essential to attracting and growing businesses. Broadband facilitates development of a skilled labor force and allows a locality to compete for and retain these skilled workers. Additionally, it allows businesses to deploy telework strategies which assist in employee retention, improved quality of life and reduced traffic congestion.”

The Madison economy is working at a moderate, steady pace, but lags behind other wealthier counties, in part due to lack of widespread internet. The need for infrastructure, including high speed internet has become vitally important in recruiting new industries to our County.

Population growth in Madison is anticipated to be flat through 2030, but that is projected without

Internet service growth/improvement, or the Amazon impact.

Broadband is critical infrastructure for counties and communities. Daily activities by residents and businesses now often require internet access. All banking uses the internet in the background. Schools continue to expand the use of internet-enabled learning resources, and children in households with inadequate internet service are at a severe disadvantage. As is mentioned other places, some are reliant on the WiFi service at the one McDonalds in Madison County, or the Library. The large number of people trying to use the internet for educational activities and job-related work indicates that the internet access in the area has become critical to community and economic development. The availability of affordable and adequate broadband has already begun to influence both business location decisions and home-buying decisions.

Businesses

Advances in technology have elevated the importance of the Internet in economic development and site selection. The availability, quality, and competitiveness of broadband service have become and will continue to be key issues many places. As the population in Madison County has increased, residents have expressed an interest in moving their small businesses to the County in order to work from home, or closer to home.

Virtual Private Network (VPN) is a technique that allows secure access to non-local corporate employer internal networks, allowing someone to telecommute with direct access to internal services and capabilities, like secure email and file servers. VPN is not possible on satellite services or others that are even slower—it just doesn't work adequately or properly.

The Madison County Chamber of Commerce fully supports our application to expand broadband availability and access in Madison County. The Chamber of Commerce is a private, non-profit, membership-driven organization comprised of over 225 business enterprises, civic organizations, educational institutions and individuals. The chamber's mission is to be the voice of the business community working to promote, build, and support the most effective climate for economic development.

Madison's economy is multifaceted and growing with the times. The County and Town governments, along with various agencies and local representatives, are working hard to bring and retain business in Madison and nurture long-term relationships with local businesses and industries.

Health Care

An aging population in Madison will need expanded healthcare options. As the data volume associated with health care has grown, costs have grown. As the need for in-home care grows, telemedicine will need to expand everywhere, including Madison. People's quality of life will be improved by not having to spend extra time in a hospital if they can interact with health-care providers via the internet instead of in person.

It could, literally, be a matter of life and death not to have to wait for EMS to arrive.

Internet-enabled healthcare will help reduce cost and medical errors and extend aid to people who might otherwise be unable to receive it in person. As the "universal health-care" problem gets solved, there will be more consumption. Online patient portals will make it easier for patients to stay up to date on their health, thereby assisting in critical health decisions. Health IT is quickly pushing demands for

greater bandwidth and as in-home monitoring and assessment applications are deployed that demand for bandwidth is going to push into residential areas.

Nearby hospitals are currently utilizing “TeleStroke” technology to ensure that stroke patients have been properly cared for while being airlifted to UVA hospital in Charlottesville. The recently expanded emergency room with feature “E-ICU” allowing physicians and specialists to provide remote access and real time care to patients in Madison.

The expected growth in population that will arise from improved internet service is going to need more health-care options. Very high-speed service will allow live video-conferencing.

Telework

Telework and telecommuting allow businesses to use telework methods that help with employee retention, improve quality of life and reduce traffic congestion. Telecommuting offers many benefits for employees, including improved work-life balance. Being able to spend more time with the family or having greater flexibility is the major reason many choose to telecommute. Telecommuting reduces the need for relocation for "career moves" and other job changes. An important benefit for many rurally based workers is being available to participate in community activities at a time when traditional commuters are still driving. Work opportunities are not confined to jobs within reasonable commuting distance. By telecommuting, the employee can work from almost anywhere and it opens up the opportunity to work for companies that might not be considered without it.

Madison County’s location near Culpeper, Charlottesville, Warrenton, and Northern Virginia, makes teleworking and telecommuting an attractive option, but does require dependable access—access that mostly is not available (satellite is not good enough, for speed and latency reasons). Telecommuting could reduce the number of residents leaving the County every day if Internet services allowed employees to perform their job duties remotely, reducing time wasted, traffic congestion, air pollution; lunch money would stay in Madison, etc.

Additionally, in today’s economy there are numerous home-based businesses that would not be possible without reliable Internet services. Madison has a number of them; remarks from such entrepreneurs have been that improved internet service would allow them to grow.

Telework keeps employee income in the county where they live, as opposed to where they work. In Madison, that would be extra valuable. Anecdotes from residents indicate that they want to telework, but cannot. The most widely available service, satellite, cannot do VPN, a software technique for secure login access for telecommuting.

The decision of Amazon.com to locate a new headquarters in Northern Virginia is going to have an extended ripple effect outwards. Some of this will manifest as need to telecommute from out near Madison; some of it will be for local businesses who support new residents who don't live near work. Part of the agreement with Amazon includes having more STEM graduates available.

Transportation

Shopping in Madison is limited. The very small “business district” is along Route 29, a mile south and north of the town of Madison. Many residents live in the county but work outside Madison. Nearly all shopping requires a trip to Orange, Culpeper, or Charlottesville. According to 2015 Census data, approximately 61% of the County’s labor force works outside Madison County.

The top places residents commute to include Charlottesville and Fairfax/NoVA.

A flexible telework approach will give many Madison County residents the flexibility to work from home, which would ease the burden on roadways leaving the County. Madison County is committed to improving all modes of transportation.

Education

Every level of education benefits from broadband utilization including digital textbooks in the classroom to digital learning at home. Students without access to broadband after school hours are often unable to complete homework assignments and schools that are unable to use broadband-dependent technologies are unable to keep up with those that can. Adults who wish to further their education but are confined to the home for medical reasons, family, or otherwise can utilize online courses.

A recent inquiry about school age students estimated that up to 70% do not have proper access to the internet at home. The survey doesn't have enough detail to break this down further. The Madison County School Board fully supports our application to expand broadband availability and access in Madison County. Student access to broadband at home is a primary concern for Madison County Public Schools.

The Joseph R. Daniel Technology Center at Germanna Community College in Culpeper is about 10 miles outside Madison County. This facility is designed primarily for workforce development instruction and technology training. A wide variety of credit classes are also offered. Distance learning opportunities have been identified as a primary goal of the Community College, and Madison residents are students there.

Carver Piedmont Technical Center is at the edge of Madison County and is re-opening for new classes.

All of Madison County's educational opportunities will benefit from the expansion of broadband services. Universal internet access will allow us to focus our resources and partner with schools and others centers for higher learning in order to expand opportunities for our residents. Affordable, reliable internet will also make education attainable beyond the facilities within our border.

Madison has students attending or telecommuting to the Blue Ridge Virtual Governor's School, which needs good internet access to participate.

LIBRARY

Madison County has one public library. The 80-year-old library has hundreds of guests per week. The library has free computer use by students and residents, including that of making its WiFi service available after hours for someone who can sit outside in a chair or a car. The library usage data says there are about 1000 WiFi sessions per month, both inside and outside use, and at least 15 users of desktop computers every day.

E-Commerce

There are businesses in Madison now that need expanded service to support their own e-commerce. Although in general those capabilities are hosted elsewhere, the businesses here need access to those servers for regular maintenance work such as product and pricing changes, promotional specials, etc.

E-GOVERNMENT

In order to do business efficiently, and to provide the best possible service to Madison County citizens, our technology must remain current. Discussions have begun regarding what and how to improve IT infrastructure in order to insure that the County can continue to operate efficiently. The Madison County Board of Supervisors fully supports our application to expand broadband availability and access in Madison County.

Tourism

According to the Virginia Tourism Corporation, Traveler's Spending in Madison County for 2017 topped \$35 million. Americans have grown used to, and expect, good internet service where they travel. Generally they are using their phones for this, but final destinations need to offer WiFi to support visitors including during the local festivals. Travelers need to be able to access the internet for the same reasons residents do when it comes to convenience, and planning their itinerary.

The money spent by tourists and visitors of all kinds in Madison is significant compared with our neighbors:

County	Population	Visitor \$	per capita
Madison	13000	35000000	2692
Greene	19000	20000000	1053
Culpeper	51000	43000000	843

2017 number from the Virginia Tourism Corporation

Research shows that many new businesses and residents choose to live in a destination after visiting, so first impressions, including internet access, matter.

Americans have grown used to, and expect, good internet service where they travel. Generally they are using their phones for this, but final destinations need to offer WiFi to support visitors, including during the local festivals.

A growing number of acclaimed locally owned restaurants can also be found in Madison. The farm to table movement, which encourages the use of locally sources products is thriving in our area. The Town of Madison Tourism and Economic Development Department fully supports our application to expand broadband availability and access in Madison County.

Entertainment

In addition to offering economic development incentives, Madison County knows that businesses place a priority on the quality of life in the community. In addition to the natural resources which are beneficial here, Madison also provides parks and recreation programs and many other events which provide a sense of community. These events are a source of pride in the community, and bring visitors to the County and provide ample opportunity for business exposure. Taste of the Mountains and Graves

Mountain Apple Festival are the prime examples here.

Public Safety

The Public Safety radio service is beginning to undertake system upgrades in Madison County. These upgrades will be “IP radios” that are internet-enabled. If and where there is room for collaboration we will do so.

Madison Gigabit will, in the future, be providing service access to county emergency services everywhere possible, as a courtesy.

Project Timeline

Contract award: Month 0

Execution begins: Month 1

Month	Location	MGI Lead: Clint Hyde	Madison Lead: Jack Hobbs, Tracey Gardner
1	All	Tower location site surveys. Antenna acquisition and testing. Basic advertising including newspaper ads and site-specific local temporary signage. Obtain rights/easements from landowners.	Process invoicing and payments.
2	Ground station, Blakey.	Setup; antenna install. Marketing. County permits.	Process invoicing and payments.
3	Wolftown	Tower build. Antenna install. Customer marketing, installs begin.	Process invoicing and payments.
4	Rochelle	Tower build. Antenna install. Customer marketing, installs begin.	Process invoicing and payments.
5	Brightwood	Tower build. Antenna install. Customer marketing, installs begin.	Process invoicing and payments.
6	Criglersville	Tower build. Antenna install. Customer marketing, installs begin.	Process invoicing and payments.
7	All	Customer installs.	Process invoicing and payments.
8	Project conclusion	Final report.	Process invoicing and payments. Final report.

Advertising/marketing will begin immediately after a win announcement, via all local communication channels including Facebook. The county government will talk it up as well. We already have specific local contacts waiting to help spread the word.

We expect to start in March, and finish in November.

Key Personnel

Clint Hyde, Owner/President, Madison Gigabit Internet. BSEE Virginia Tech, 1981. More than 40 years in computing, designing and building distributed systems and networks.

Jack Hobbs, Madison County Administrator.

Tracey Gardner, Executive Director Madison Chamber of Commerce, Madison County Economic Development and Tourism Director. County project lead.

Patrick Mauney, Executive Director, Rappahannock-Rapidan Regional Commission, Culpeper. Will provide administrative oversight, reporting coordination, and project management activities in support of the grant.

Clarke Security Services, Brightwood. Tower construction. Has installed hundreds of miles of networking cable in the general Washington DC area, built other towers, security systems for various clients including US Government.

David Hutchins, MGI Chief Technical Officer. University of Virginia UVACollab Infrastructure Architect, previously Director of Enterprise Information Systems at Norfolk State University. General Class Amateur Radio Licensee.

Mitch Dickey, MGI. Certified Wireless Network Expert #250. Cisco Certified Network Associate Router/Switch/Wireless. Senior Network Engineer, Loudoun County Public Schools. Amateur Radio, W4LAN.

Name	Title	Description
Clint Hyde	President, Madison Gigabit	BSEE, 1981. 40 years computing experience
Jack Hobbs	Madison County Administrator	Senior admin oversight.
Tracey Gardner	Chamber of Commerce, ED and Tourism Director	County project lead.
Patrick Mauney	Executive Director, RRRC	Administrative advisor
David Hutchins	MGI Chief Technical Officer	Years computing center experience
Mitch Dickey	Wireless Networking Specialist	Years large-scale wireless experience
Clarke Security	Sub-contractor	Tower construction.

Statement of Experience

In May 2017, CIT executed a survey for Madison County. There were over 1000 responses, with street addresses. The essence of the results were that most of the people in Madison want better service than whatever they may have, if indeed they have service at all.

Excerpts from the final report are used in this proposal. This report is available on the Madison County website at:

https://www.madisonco.virginia.gov/sites/default/files/fileattachments/economic_development/page/2797/broadband_-_madison_survey_analysis_27june2017_by_cit.pdf

In 2009, there had been a previous survey conducted by CIT in Madison, on a far smaller basis, receiving only 100 responses. Reading that final report you notice two things: half the responses came from where people were still using dialup, and the same %s of responses said “we want better”. In addition, the written comments were nearly identical: “expand my business”, “sell my house”, “schoolwork”, etc.

No further action arose out of the 2009 survey.

The Rappahannock-Rapidan Regional Commission (RRRC) is one of 21 Planning District Commissions in Virginia. RRRC has provided grant management for both local and regional projects and programs for more than 40 years, including federal and state grants administered by the Department of Housing and Community Development and other Virginia state government agencies. Staff that will be assigned to this project have more than 30 years' combined experience at RRRC in project administration, grant financial management and reporting.

Following the 2017 survey report from CIT, Mr Clint Hyde realized that the need and desire in Madison was greater than had been previously understand, and that it was time to move forward. He immediately began the project, and incorporated Madison Gigabit Internet early in 2018 to tackle the project.

Mr Hyde has been in the computing world since 1976. He has designed, coded, and built various medium-sized distributed software systems over the years, primarily for DARPA and US military services.

Madison Gigabit Internet current is providing 100 megabit service in the Town of Madison, since May 2018. This is experimental phase, so customer count is limited. There are currently 10, with two additional pending and others being scouted. Our Facebook “friends” list and website registration is hundreds more who are waiting.

Service Offering

There are two possible pricing models:

- 1) Price by byte. This is a consumption-based model, the version for “data plans”, where you are paying \$X per month for Y gigabytes of data. This model is often used by ISPs that have their own data limitations. People generally despise this model, fearing the cost of accidentally/unexpectedly going “over the cap”, or getting “throttled” down to dialup speed.
 1. The “overage” outcome is one of two things: (a) pay more, which is often quite expensive, or (b) speed throttled down to nearly useless. Anecdotal evidence is that both are hated.
- 2) Flat rate. This is an access-based model, which is like taxes that pay for roads—you pay the amount, and you drive as much as you need (the traffic model that is consumption-based is toll roads; no one likes toll roads). Typically it is also associated with a speed: \$50 per month for 50 megabit service.

MGI uses the second model, a flat rate. MGI's incoming service has no data limit, and is gigabit-capable immediately. **MGI's service price is \$75 per month, flat rate.**

Our experience is that the wireless hardware we use today (Ubiquiti, <http://www.ubnt.com/>) is capable of symmetric 100-megabit speed, which makes for a very fast and pleasant experience online. We do not expect more than that from the wireless approach; the incoming service line can provide gigabit speed, and the eventual fiber installations will handle far more than that.

RFP Question/Answer page matrix.

RFP Questions

1. Provide maps. Explain areas. (Proposal pages 17-23)

1. Ground station in/near Town of Madison. Site chosen based on ease of availability getting fiber tap.
2. Blakey tower site. This is a high-elevation point in western Madison County. Towers already exist here. The tallest is owned by Rappahannock Electric Coop. MGI is in negotiation with REC for approval to mount radios/antennas on this tower, at 110 feet off the ground.
3. Wolfstown. A location in Madison with a hotspot in the CIT survey response map.
4. Rochelle. A location in Madison with a hotspot in the CIT survey response map.
5. Brightwood. A location in Madison with a hotspot in the CIT survey response map. Comcast covers a portion of this, but only near Rt 29.
6. Criglersville. A location in Madison with a hotspot in the CIT survey response map. Alternative: Etlan make have a greater interest. No cost difference.

2. Outreach to identify existing providers. (Proposal pages 5-7)

We used the FCC 477 reporting data to expand beyond the basic knowledge of who are the service providers that advertise in the county.

3. Unserved areas.

The entire county is “covered” by satellite service availability. Our measurements of their performance are that satellite service is typically about 8/0.6, making nearly all the county “unserved”. All other services do overlap with satellite, because of its broad coverage.

4. Population.

Total county population is 13,000. Population density averages 40 per mile. We counted houses in the Google Maps satellite imagery based on within one mile of specific sites for end-point antennas.

5. Businesses, anchor institutions.

Large businesses in Madison are all near Rt 29, and all served by fiber (LUMOS) already.

6. Take rate.

We expect the take rate to be at least 50% everywhere. Eventually everyone will demand better service, and so far the common response is “when are you coming to MY neighborhood?”

7. Backhaul/middle/last-mile.

The project will be all three dimensions. There will be Backhaul from the fiber tap in town to Blakey site, middle-mile from Blakey to the proposed end-point locations, and last mile service to homes from

the end-point locations. Map on page 17 shows these pieces.

8. Ownership.

Madison Gigabit Internet will be the owner and maintainer of all the components built under this contract. Existing facilities will continue their current ownership, with some usage/rental fee involved.

9. Service Description.

Service will be a shared 100 megabits fiber trunk incoming, split among the receivers at the highest speed possible with the selected hardware. The radio systems at the customer end currently operate 120-200 megabits (there is a distance from the tower aspect, with a sweet spot). Once the customer count passes 125, the fiber trunk will be boosted to 300 megabits incoming. At 250 customers, the fiber speed will be boosted to 500 megabits. Higher trunk speed will reduce congestion at that bottleneck, but will not also boost speed at the customer.

10. Network design.

The ground-station will have an incoming fiber trunk. This trunk will be capable of 10-gigabit or better service, at our choice/cost. It will start at 100 megabits. This service will be backhaul broadcast to an intermediate node on an existing “radio tower” at a site called “Blakey Ridge”; this site has three towers, with the tallest being owned by REC. The backhaul speed will be on a 20 kilometer full-duplex antenna capable of approaching 500 megabits. The Blakey intermediate node will have multiple repeater antennas, with the same antennas aimed at the end-points. The endpoint antennas will be short-range (2 kilometer) half-duplex capable of 100-200 megabit service to approx 40-50 customers per radio with 4-6 radios per end-point. The drawing is roughly a spiderweb-of-spiderwebs.

11. Current state of project development.

Sites have been studied for the various “towers”. We have preliminary offers from landowners to install something. We have an existing smaller system in town using some of the same electronics hardware; we have verified that this exact arrangement can and does work for this spiderweb layout. We are exploring the locations for the ground station.

12. Matching funds.

Madison County will provide in-kind contribution in terms of administration and financials. Madison Gigabit Internet will provide all cash contributions for all remaining expenses, with the minimum estimated at \$44000; MGI will be responsible for all costs beyond that as well. This is 40% or more of the total project cost.

13. Applicant and co-applicant.

Madison County will serve as project oversight and financial conduit. Madison County may provide access to an existing county-owned radio tower as the ground station site. The county will waive fees for permits and expedite any needed permitting.

14. Key personnel. See page 35.

15. Detailed budget. See page 24.

There are capital costs for tower construction, \$17,000 each, for four towers in select locations. There are associated electronics at each tower location: power, cooling (maybe), cable, routers, antennas and radios. Each tower will need \$5000 of radios and antennas, plus an additional \$1000 of other electronics. The ground station will require a different set of electronics, use an existing vertical asset, and have the same \$6000 worth of radios and antennas. The Blakey tower will need the most radios and antennas, and thus has the highest total cost for that aspect; using an existing tower means no capital cost.

16. Cost benefit index.

Grant/state share of the total cost is \$80000. Applicant share is \$51000 for known costs, and whatever incidentals occur during execution, plus the cost of CPE, estimated at \$200 per customer.

17. History and experience. See page 35.

18. Service offering. See page 36.