ctc technology & energy

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Broadband Strategic Plan

Prepared for Somerset County, Maryland
July 2020

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1 Executive Summary

Over the past several years, Somerset County has undertaken an ongoing effort to ensure that all County residents and businesses have access to high-speed, affordable broadband services—but service gaps persist.

Unserved portions of Somerset County face the same challenges as other rural communities in attracting broadband infrastructure investment. Nationwide, even in the most affluent rural and semi-rural areas—from the horse farms around Lexington, Kentucky, to the ski communities outside of Aspen and Telluride, Colorado, to the resort areas on the Chesapeake Bay—the economics simply do not exist for rural broadband deployment absent substantial government funding. The private sector will not build costly infrastructure to reach all homes and businesses in low-density areas simply because the potential return on investment is insufficient to justify the investment.

The same dynamics apply to virtually all areas of rural infrastructure development. In the case of broadband, the issues are starker because broadband is traditionally thought of as an area of private investment, rather than public investment. The challenging economics result from the lack of density of homes—and, in many cases, the fact that homes are located on large parcels of land; long driveways or setbacks from the road greatly increase the cost to deploy wired infrastructure to those homes.

1.1 Project Background

The County hired CTC Technology & Energy (CTC) in 2019 to develop a strategic plan to address the needs for broadband in unserved parts of the County. CTC performed the following tasks at the County's direction:

- Identified, at a high level, the areas of the County that are served and unserved by wireline broadband infrastructure, based on public data sets and desk surveys
- Conducted field surveys of wireless signal strength
- Met with key public and private stakeholders to identify broadband needs
- Met with representatives of internet service providers (ISP) operating in the County (or with potential interest to operate in the County) to learn what market forces or County support might lead them to invest in the County
- Prepared a high-level design and cost estimate for a fiber optic network deployment to fill the identified broadband gaps in the County

- Prepared a high-level design and cost estimate for a fixed wireless network deployment that might help fill broadband gaps in the County
- Analyzed a range of federal and state funding opportunities to identify potential sources of grants or loans (to the County or to ISPs) that might support the expansion of broadband services in unserved areas
- Developed a series of potential strategies the County could pursue to leverage federal and state funding to meet its broadband goals

1.2 Project Findings

Most residents of Somerset County have access to a variety of internet services, but many locations do not have robust wireline *broadband*[1] services. For example, while Comcast and Charter provide residential wired broadband service in the County's denser neighborhoods, neither provides service that meets the definition of broadband in sparsely populated areas. We also know there is a substantial number of unserved households based on complaints the County has received over time from citizens and employees.

Because of the challenging economics of broadband deployment in rural areas, private ISPs likely will not invest in ubiquitous wireline broadband infrastructure in currently unserved parts of the County absent some sort of financial support. State and federal funding programs may present the County and its potential partners with opportunities to fill some broadband gaps—so long as the presence of federally funded wireless service providers in the area do not render the County ineligible for new funding.

1.2.1 The County has homes and businesses unserved by wireline infrastructure in contiguous areas and scattered locations

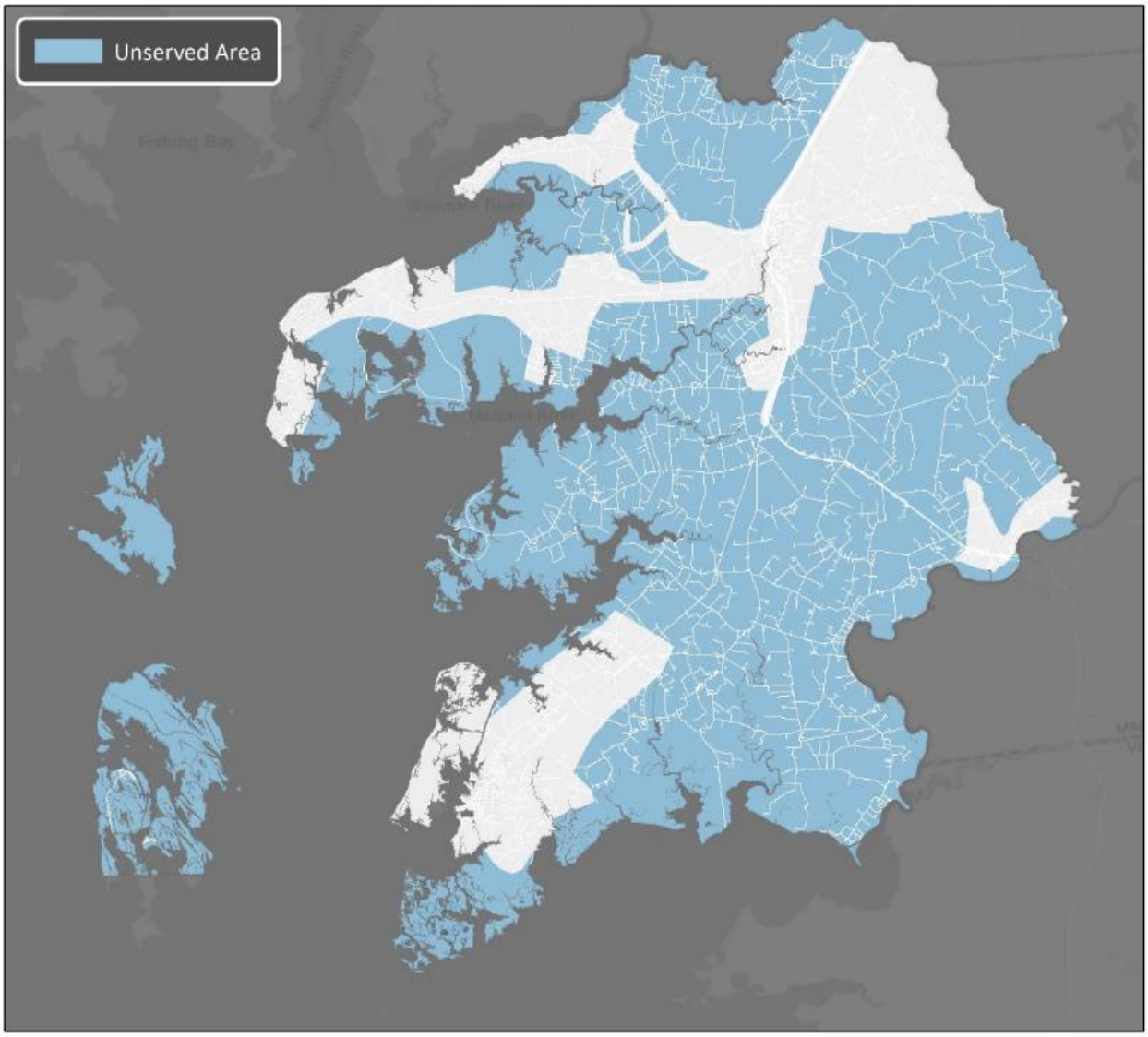
We began our analysis by identifying unserved areas where no wireline infrastructure capable of delivering services that meets the federal and state definitions of broadband "passes" homes and businesses—meaning there is no infrastructure (such as optical fiber or coaxial cable) running along the road where the property can be accessed.[2]

[1] Defined by the Federal Communications Commission as an internet service delivering speeds of 25 Mbps download/3 Mbps upload. ("2018 Broadband Deployment Report," FCC, Feb. 2, 2018, https://www.fcc.gov/reports-research/reports/broadband-progress-reports/2018-broadband-deployment-report.) This is also the definition adopted by the state of Maryland.

[2] A "passing" is the infrastructure that literally "passes" a home or business along the road but it does not include the "service drop"—the portion of the network that connects from the road to the home or business itself. The availability of a passing to a home or business is the universally understood definition of what is served, both within the industry and among the state and federal government entities that fund broadband expansion and regulate communications services.

Based on our review of existing data sets, supplemented by a desk survey conducted by a CTC outside plant engineer, we believe the great bulk of the County is not served with wireline at broadband speeds. We estimate the County has approximately 6,000 unserved premises located in contiguous unserved areas (referred to herein as "Category 1") (Figure 1).

Figure 1: Category 1 Unserved Areas



A second category of unserved locations ("Category 2") comprises pockets of unserved premises located on isolated, low-density roads that fall within areas that are otherwise served. In other words, while the larger areas around these homes are generally served, these locations are on roads that do not have broadband infrastructure, usually because the density of homes is so low that the incumbent providers are not obligated to pass those locations with their infrastructure.

The Category 2 unserved locations typically are on roads that are long relative to the total number of potential broadband customers on the road. Neither Comcast nor Charter has business reasons to build infrastructure on those roads; their potential return on investment is not great enough to prompt an investment in reaching the potential customers who live there. Given the low density of houses, too, neither Comcast nor Charter is obligated to build infrastructure on those roads under the terms of their cable franchise agreements with the County.

Other Category 2 locations include pockets of multiple unserved homes surrounded by served areas. For the residents on these roads, which exist in locations in many parts of the County (as opposed to being clustered in contiguous geographic areas like the unserved homes in Category 1), this situation is particularly challenging; the cost of Charter or Comcast's line extension down their road—which the residents would be required to pay in order to get service from those companies—can be high.

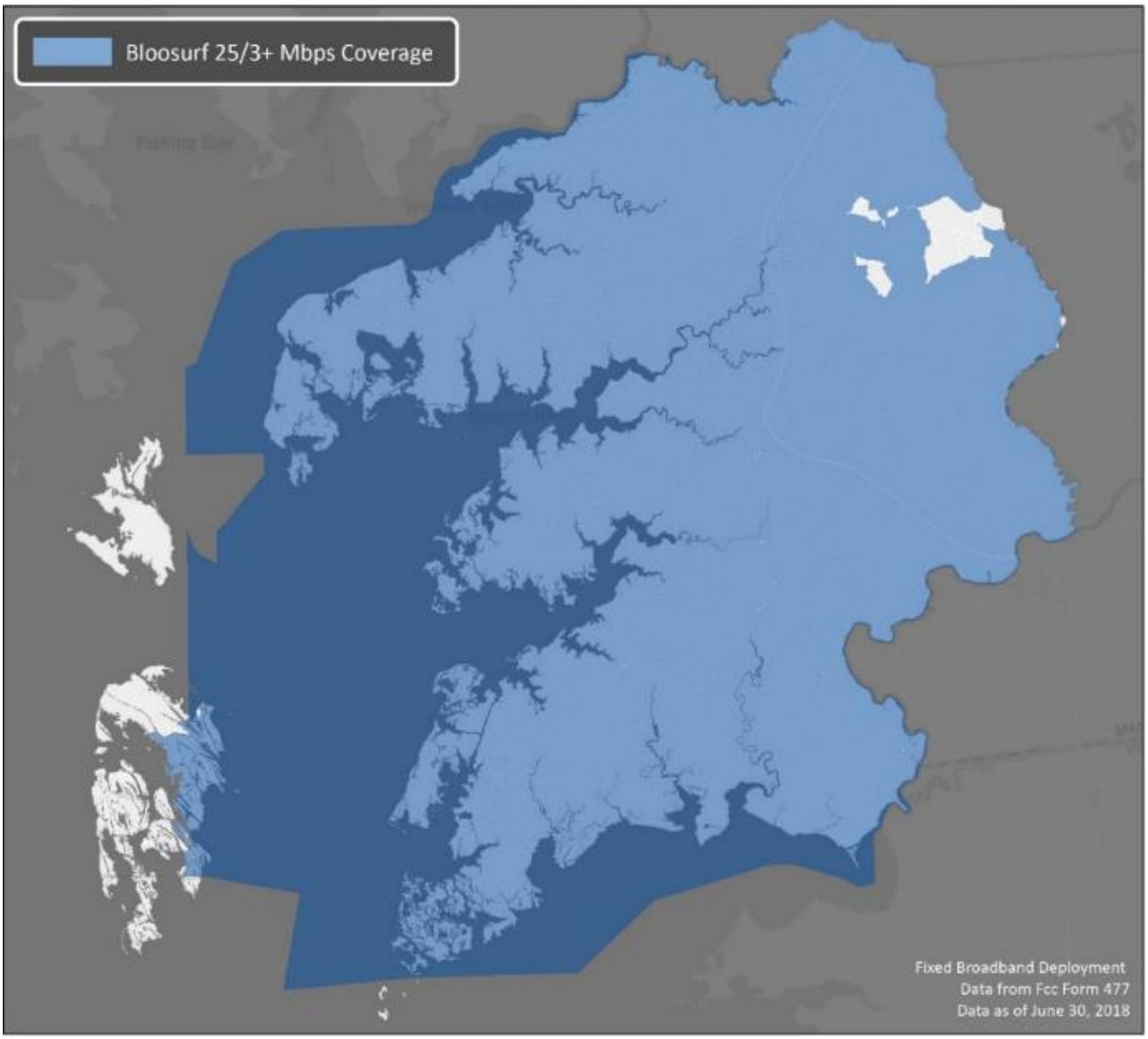
There also exists a third category of locations within the County where homeowners struggle to get service, despite the presence of broadband infrastructure passing the home: premises set so far back from the road that the ISP has no obligation, under County franchise requirements, to build the service drop from the road to the user's premises (i.e., along the driveway) at no cost to the customer (referred to herein as "Category 3"). Although these homes are effectively unserved because many homeowners find the drop construction cost unaffordable, the homes are not considered "unserved" under federal and state definitions or with respect to eligibility for federal or state broadband grant funding.

We note that the category numbers do not indicate prioritization or emphasis in terms of the County's approach to filling its broadband gaps; the numbers are merely a convenient way to refer to the categories.

1.2.2 The wireless internet service provider Bloosurf claims to serve most of the County—and has previously received federal grant funds for that service

Bloosurf is a wireless internet service provider that claims in its FCC Form 477 filings to provide fixed wireless coverage to almost all of Somerset County at speeds meeting the federal definition of broadband: 25 Mbps download and 3 Mbps upload (25/3) (Figure 2). Such claims are not realistic (given the company's wireless technology) and do not reflect the feedback the County has received from citizens who say they cannot receive Bloosurf service. However, **if Bloosurf is indeed capable of providing these speeds to residents across the County, then the County would be considered "served" in regard to broadband coverage and thus ineligible for state and federal grant programs.**

Figure 2: Bloosurf's Self-Reported Coverage from Form 477



Further complicating the County's situation, Bloosurf has previously received federal grants for delivering these claimed broadband services; those grants—from the USDA's Broadband Initiatives Program (BIP) and the FCC's Connect America Fund (CAF)—make Bloosurf's service area ineligible for consideration by other federal grant programs such as the USDA's ReConnect program. Bloosurf's previous funding thus presents an obstacle to the County or a new partner applying for federal broadband grants (though not state grants).

To verify Bloosurf's coverage claims, CTC requested that Bloosurf provide technical details regarding the company's current network map, actual propagations, tower placements and heights, and other details that could enable an analysis of Bloosurf's actual service; the company

declined to make that information available. Bloosurf also declined to conduct joint testing with a CTC engineer at random customer home locations (which would demonstrate actual customer service speeds).

Even without the company's cooperation, however, it is possible to determine whether Bloosurf could *potentially* deliver 25/3 speeds in the County. Because Bloosurf uses licensed spectrum to deliver its service, its frequencies are uniquely allocated to Bloosurf in the County—and can be independently evaluated.

Using a spectrum analyzer, a CTC engineer tested the signal strength of Bloosurf's licensed spectrum at 25 representative locations across the County. (See Appendix A for a description of the testing methodology.) All 25 tested locations had signal levels greater than the receiver threshold theoretically needed to achieve 25/3 data speeds. In other words, these **test results indicate that Bloosurf is theoretically capable of delivering 25/3 speeds at the test locations provided they have the proper network equipment and there are no capacity limitations or immediate obstructions (such as trees, foliage, terrain, and built structures).**

Demonstrating which addresses would be considered served therefore requires network-specific wireless testing at premises (or simulating premises-based testing). Such tests would ideally be conducted with Bloosurf's own endpoint electronic equipment and measure both actual signal strength at premises/locations and network speeds through Bloosurf's network from the tested locations.

The signal tests distributed across the County—paired with Bloosurf's coverage claims—together establish that there are likely locations in the County where Bloosurf is capable of providing service of acceptable quality. Since these areas overlap Comcast and Charter's service areas, there may be locations where Bloosurf can provide an alternative and competition to the cable companies. Bloosurf may also be able to provide a solution for the Category 3 addresses described above.

1.2.3 County data and experience demonstrate that Bloosurf service is not actually available everywhere—and that the company frequently declines to serve potential customers

As we note above, Bloosurf's coverage claims are not realistic (given the company's wireless technology) and do not reflect the feedback the County has received from citizens who say they cannot receive Bloosurf service. The County cited many reported examples of residents who are not served by Bloosurf, despite living in areas that Bloosurf claims to serve. In addition, the County provided anecdotal data that Bloosurf routinely declines to offer service to new customers without even coming out to their homes to evaluate the feasibility of serving them.

These data and anecdotal insights demonstrate that Bloosurf service is not ubiquitously available in the County.

1.2.4 Federal and state broadband funding could enable wireline broadband deployment—if Bloosurf's claimed coverage can be challenged

Federal and state funding sources represent an important element of large-scale broadband deployments for unserved areas. While these programs tend to have restrictions that affect their potential breadth of impact, our analysis is that a number of programs—including Maryland's rural broadband grant program and the federal ReConnect and Rural Digital Opportunity Fund programs—could assist the County's efforts to reduce the number of unserved homes and businesses.

We encourage the County to view these programs as helping to gradually address the unserved areas of the County. A comprehensive solution is likely to require multiple years, including multiple rounds of applications to these and future federal and state funding programs.

First, we note that USDA's ReConnect program represents the most significant congressional appropriation of broadband funding since the Recovery Act in 2009. The initial $550 million allocated for 2020 was expanded by an additional $100 million in the CARES Act,[3] which Congress passed in response to the coronavirus crisis); the program will likely see annual future appropriations. The program awards loans, grants, or a combination of the two for last-mile connections in rural areas; it favors applicants that demonstrate both experience in network operations and strong support from the local government in the area to be served. The current round of grant applications were scheduled to close March 16, 2020 but have been extended due to the coronavirus crisis.[4]

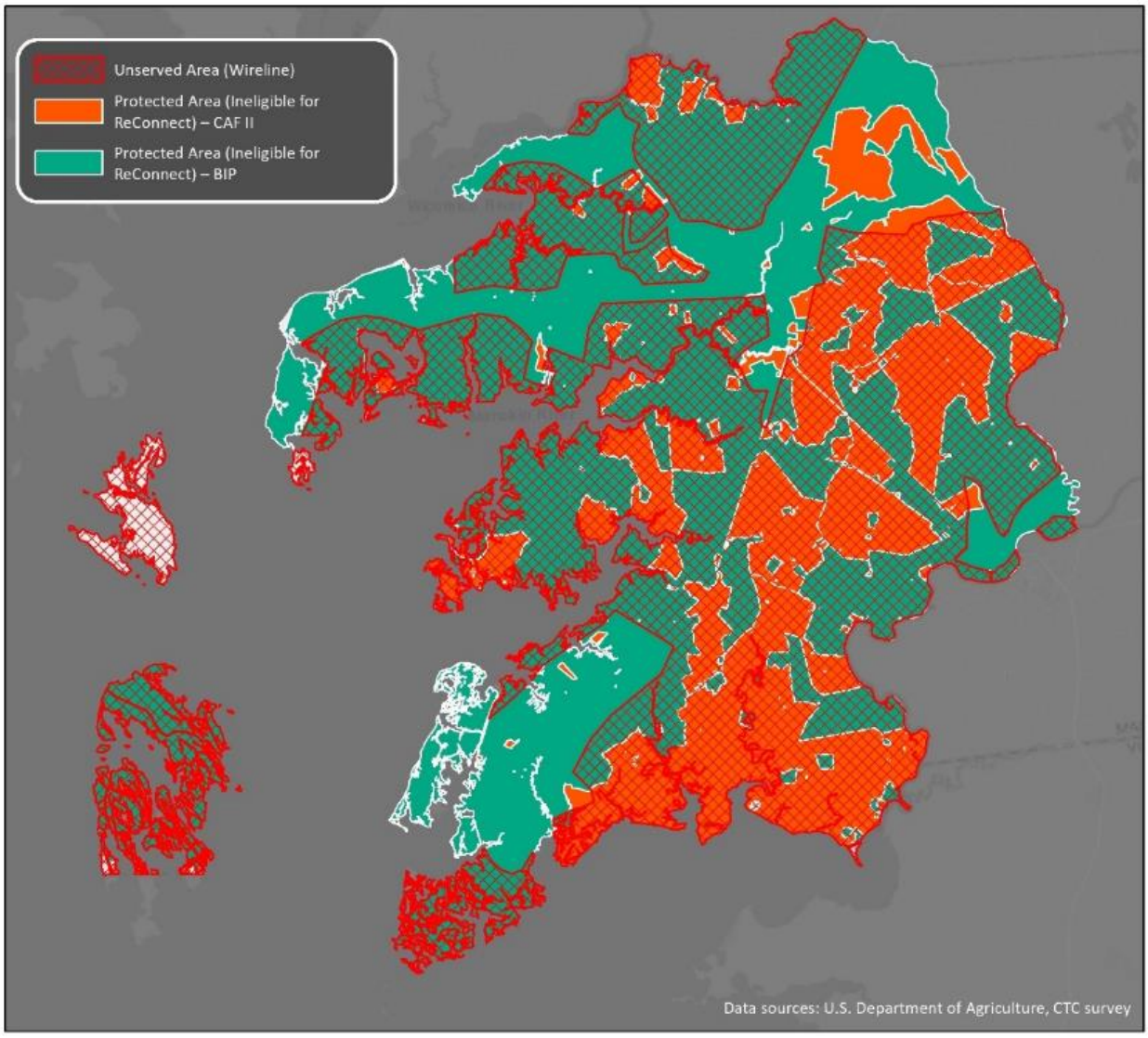
However, Congress created a significant barrier to ReConnect funding when it wrote the legislation: It made ineligible any areas for which any entity has received a previous broadband award under certain programs. This barrier unfortunately complicates the County's path forward and its options for accessing federal funds.

[3] "Coronavirus Aid, Relief, and Economic Security Act," U.S. Congress, https://www.congress.gov/116/bills/hr748/BILLS-116hr748enr.pdf (accessed March 31, 2020).
[4] "USDA to Make $550 Million in Funding Available in 2020 to Deploy High-Speed Broadband Internet Infrastructure in Rural America," U.S. Department of Agriculture, News Release, Dec. 12, 2019, https://www.usda.gov/media/press-releases/2019/12/12/usda-make-550-million-funding-available-2020-deploy-high-speed (accessed December 13, 2019). "Secretary Perdue Statement on Coronavirus Rescue Package" U.S. Department of Agriculture, News Release, Mar. 27, 2020, https://www.usda.gov/media/press-releases/2020/03/27/secretary-perdue-statement-coronavirus-rescue-package (accessed March 31, 2020).

Bloosurf was awarded $3.2 million in USDA Broadband Initiatives Program (BIP) grant and loan funding in 2010 for service across Somerset and other counties,[5] and in 2018 won the Connect America Fund II (CAF II) auction for additional portions of the County;[6] those areas (shaded in green or orange, respectively, in Figure 3 below) are technically ineligible for ReConnect funding. While there is some chance that the protected status of the areas in green (where Bloosurf received funding from the BIP program in 2011) will expire in 2021, this is not certain. Further, the protected status of the areas in orange (in which Bloosurf received CAF II funds) will continue for an undetermined time that may be as long as, or longer than, a decade.[7]

[5] "Advancing Broadband," USDA BIP Awards Report, January 2011, https://www.rd.usda.gov/files/reports/RBBreportV5ForWeb.pdf (accessed December 2019).
[6] FCC, https://ecfsapi.fcc.gov/file/10102081816708/Bloosurf%2C%20LLC%20PETITION%20FOR%20ELIGIBLE%20TELECOMMUNICATIONS%20CARRIER%20DESIGNATION%20WC%20Docket%2009-197.pdf (accessed March 2020).
[7] See Section 1.3.1 for more details regarding how the County might challenge Bloosurf's protected status in a ReConnect application.

Figure 3: Bloosurf's Grant-Funded Service Area as Compared to Wireline-Unserved Areas



Second, the FCC's Rural Digital Opportunity Fund is an auction process, scheduled to begin on October 22, 2020, that will award $20.4 billion over the next decade to support the buildout of high-speed broadband networks in unserved areas of the country.

Third, Maryland's Office of Rural Broadband recently released the application for a broadband grant initiative that explicitly seeks to complement federal and local funding sources—an approach that could enable an entity partnering with the County to use the state's funding as a match for a federal ReConnect grant application, or to enable a lower bid in the Rural Digital Opportunity Fund reverse auction (in which the lowest bidder wins). The state will award grants of $1 million to $3 million from a total funding budget of at least $9 million. Applications for the

first round of funding were due in February; we anticipate future rounds of funding to be announced by the state.

1.2.5 Building fiber-to-the-premises in the County's Category 1 contiguous unserved areas would require an estimated $54 million capital investment but relatively low operating costs

Constructing fiber infrastructure to Category 1 unserved portions of the County would require a total capital investment of approximately $54 million. Considering only the outside plant infrastructure costs—not the service drops to the premises—the network would cost approximately $7,700 per passing. These estimates are based on conceptual-level engineering for serving 100 percent of Category 1 unserved premises; this planning-level design considers a range of factors that affect deployment costs, from the availability of utility poles to the number of fiber route miles necessary to pass all unserved homes and businesses. (Actual costs will also vary from this estimate due to factors that cannot be precisely known until the detailed design is completed, or until construction commences.) Section 4 describes this cost estimate in more detail.

1.2.5.1 Fixed wireless could serve about 82 percent of Category 1 unserved premises at lower capital cost than fiber—but with higher ongoing operating costs

As an alternative to deploying fiber-to-the-premises, the County could consider a fixed-wireless network to deliver broadband services to unserved Category 1 areas. CTC's engineers developed a candidate model to assess the viability of serving unserved Category 1 addresses with a fixed wireless network using existing government and commercial towers within the County.

Our analysis found that a fixed wireless network could be used to serve a portion of the County's unserved Category 1 homes and businesses—but it would have clear technical limitations relative to a fiber optic network, would not reach all unserved premises, and would be significantly more expensive *to* operate than a fiber network.

1.2.5.2 Fiber offers a better return than wireless, given total cost of ownership and technical benefits

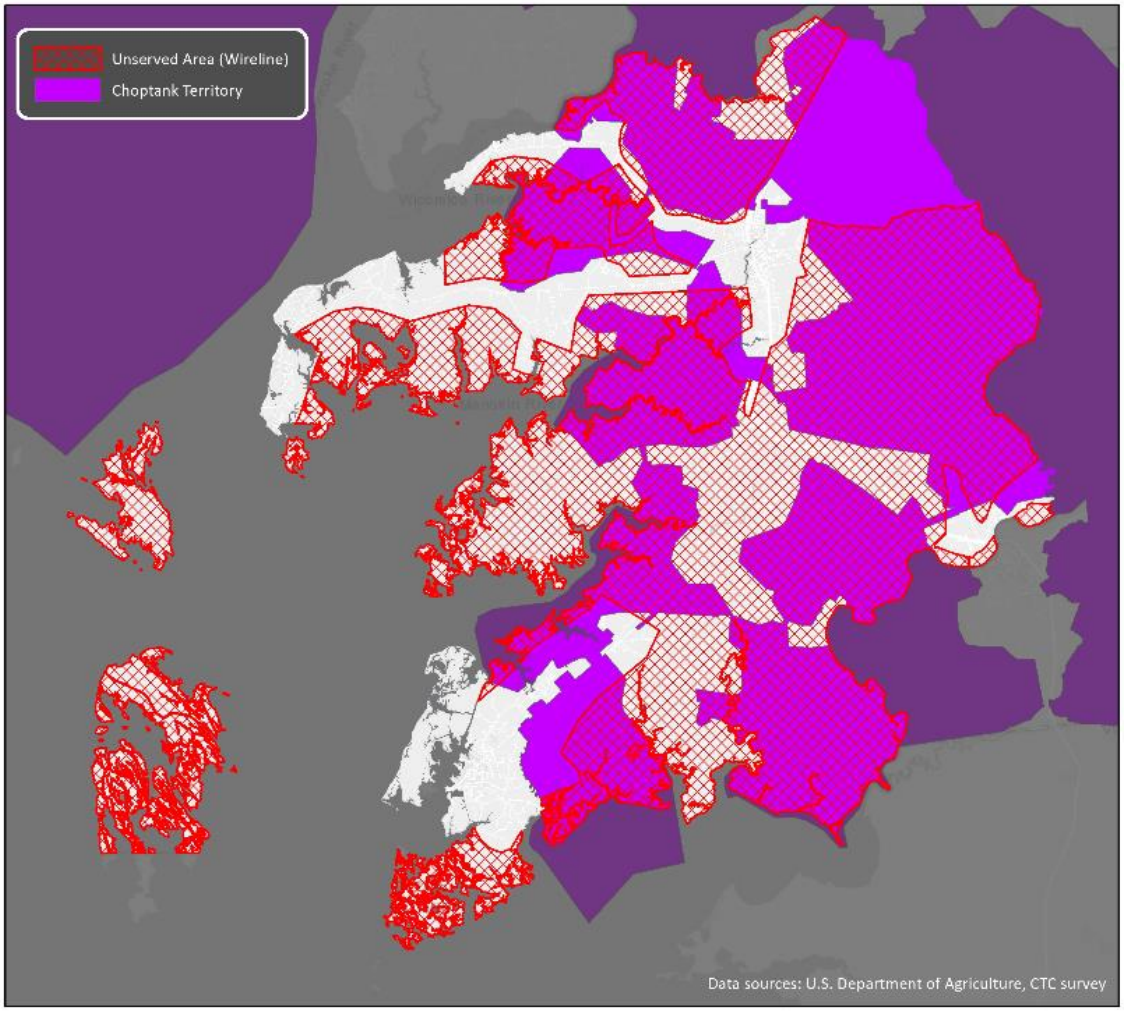
Based on engineering and cost-estimation for the fiber-to-the-premises and fixed wireless solutions for Category 1 unserved portions of Somerset County, we conclude that overall, fiber-to-the-premises represents a better broadband solution than fixed wireless for most unserved areas.

Taking into account the ongoing maintenance costs for each type of network—including tower lease fees and regular equipment replacement for the fixed wireless solution—the total long-term cost of ownership for a fiber-to-the-premises network would be lower than for a fixed wireless solution.

1.2.6 Choptank has expressed strong interest in serving large parts of the County's Category 1 and Category 2 areas

Choptank Electric Cooperative expressed strong interest in providing broadband service to its entire service area, which has a high degree of overlap with the County's Category 1 areas (Figure 4).

Figure 4: Choptank's Electric Service Area Compared to Category 1 Unserved Portions of the County[8]



Choptank would have the lowest cost to build of any entity other than Verizon because of its ownership of poles, which would be a competitive advantage if it were to bid on the FCC's planned reverse auction for the Rural Digital Opportunity Fund or apply for grant funding. Choptank communicated that its interest in providing broadband service is strategic and not dependent on grant funding, although its pace of rollout could be. Choptank, as of the writing of this report, was not yet ready to fully commit to specific plans for offering broadband in the

[8] Source: https://choptank.maps.sienatech.com/ (accessed December 15, 2019).

County (see more details in Section 1.3.3). It has, however, communicated publicly about its intent to participate in the Rural Digital Opportunity Fund auction. Unlike other potential partners, Choptank also communicated that it would not cherry-pick areas in the County, but rather would extend both to its own electric service area and potentially also in non-Choptank areas that are sandwiched between its service areas.

1.2.7 Extending Comcast or Charter's networks would be a solution to serving Category 2 addresses on isolated streets

Because both state and federal grant programs are applicable to Category 2 unserved locations, the most logical potential solution for these unserved residents is for Charter, Comcast, or both to seek public funds for line extensions—thus making it economically desirable for them to provide this service. (Installing the service drop from the road to the home could add additional cost for a homeowner located far from the road, as in Category 3.)

Unfortunately, we believe it would be far more challenging for an alternative or new competitive provider to build in these areas because the unserved pockets are not economically attractive on their own (given their low density) and the area is already generally served by either Comcast or Charter—thus reducing the economic attractiveness of building the area.

In addition, no state or federal funding is available to new providers to build communications infrastructure in areas that are already served—other than on the isolated roads, which would be a limited amount of funding relative to the total cost of building the area. As a result, Comcast or Charter, plus a combination of state or federal funding, represent the most viable path forward.

1.2.8 Constructing drops to Category 3 addresses would not be eligible for state or federal funding

With respect to the locations in Category 3, locations that are "served" but for which the cost of the service drop from the road to the home is unaffordable, the options for funding are more limited. The County could choose to subsidize the cost of drop construction for the homes and businesses with long setbacks, but this is unfortunately an area in which the County will not have a state or federal partner to solve that problem—because neither state nor federal grant funding apply to building service drops to these locations.

1.3 Project Recommendations

Our primary recommendation is that the County collaborate with private sector partners to apply for state and federal broadband grants, with the understanding that this effort may require multiple years and is unlikely to be resolved in the short-term. For example, we believe the Category 1 (contiguous unserved) areas present a potential opportunity for a partnership between the County and a private entity in which the private entity, with the County's support,

will seek state and federal grant funds to build broadband across one or both of the unserved areas.

Our recommendations lay out a strategy and timeline for this approach beginning in 2020, with the understanding that there likely will be state and federal broadband funding in 2021 and beyond—and it may take years to access sufficient grant funds to address the entirety of the two types of unserved areas. We note, however, that the Rural Digital Opportunity Fund does represent a unique opportunity because the reverse auction (which will be held starting October 29, 2020) will award a decade's worth of ongoing funding; the County and CTC have encouraged providers to participate in the auction.

The following are our recommendations for steps the County can take, in light of what we have learned in conducting this study, to begin to remedy the broadband challenges identified. We begin with Choptank. From a partnering perspective, Choptank provides the most desirable option for the County; it is less grant-dependent than other options and is not hampered by the fixed wireless coverage claims that may impede other approaches. We next provide recommendations for approaches to working with—or challenging—Bloosurf, because the protected status of the company's service area, when it comes to federal grant opportunities, is the key to developing any grant-dependent strategy.

1.3.1 Engage with Bloosurf to improve the company's service to County residents—or challenge the company's coverage claims

Choptank Electric has made clear its intention to build a fiber-to-the-premises network in its service area, which covers large parts of the County. Frankly, the Choptank fiber network (see 1.3.2 below) would be a best-case solution. However, given that Bloosurf is already purporting to serve the market and has protected status,[9] the County is in the position that engaging with Bloosurf is a necessary first step in terms of ReConnect funding. The County can either seek to work with Bloosurf to improve the company's services and fill in service gaps—or the County can challenge Bloosurf's coverage claims.

At issue is the fact that Bloosurf has received funding from the federal Broadband Initiatives Program (BIP) and CAF II program, which effectively protects it from alternative provider applications for ReConnect funds in the areas for which it was previously funded, as described above. Bloosurf's service area covers the entire County.

This obstacle does not apply to the Maryland grant programs, and does not present itself equally for all future federal grant programs. For example, the Rural Digital Opportunity Fund does not

[9] "Protected" in this context (i.e., under USDA Rural Utilities Service rules) means that Bloosurf is the only entity allowed to apply for ReConnect funds in areas originally awarded to it under previous federal broadband funding programs, such as BIP and CAF II.

exclude all of the areas excluded under the ReConnect rules; while the CAF II areas would be excluded, the original BIP areas would be available. This makes the Rural Digital Opportunity Fund a viable option for another provider, as we describe below. And, in the event Bloosurf's protected status expires or is challenged, the protected areas for ReConnect may open back up for new applications for federal support.

If the County chooses to adopt a robust approach to challenging Bloosurf's claimed service for purposes of ReConnect, it would need to do so with a willing partner—because ReConnect and other federal grant programs currently lack a delineated process for challenging a previous awardee's service claims. Such documentation would therefore need to be incorporated into a formal ReConnect grant application—which would become a record of protest with the appropriate federal entities. In other words, working with a willing wireline partner, the County would need to document the lack of Bloosurf service in the County (for the protest, but also to identify the gaps) and file a new ReConnect application. The application would likely be a marker for future, more flexible grant opportunities—because the County's partner would have little guarantee of being awarded a grant (and, thus, the burden would be largely on the County to develop the documentation and complete the work required to submit the application).

The alternate approaches we outline here will either lead to Bloosurf making good on its previous federal-grant-funded commitment to deliver broadband to County residents—or will take the County down a path toward attempting to remove (through a challenge process) Bloosurf's unfulfilled claims as an obstacle to developing a robust federal grant strategy for deploying wireline broadband infrastructure in the County.

1.3.1.1 Work with Bloosurf to improve service in low-density parts of the County and map addresses that cannot receive Bloosurf service

With regard to improving broadband availability in the County's Category 1 unserved areas, we believe the ideal outcome is for Bloosurf (with the County's encouragement) to improve its service, coverage, and responsiveness to residents who call and currently are told they cannot get service, and to document and track such addresses, either for future upgrades or to allow alternative providers to seek grant opportunities to reach them.

The data we have about Bloosurf's shortcomings are largely anecdotal, but they are enough to raise real concerns that the company's lack of service is an impediment to the County's goal that broadband be an engine for economic vitality. Bloosurf has previously received federal funding on the promise that it will deliver broadband services to the majority of the County; ideally the company would deliver on those promises.

In this scenario, which would require Bloosurf's cooperation and engagement, the County would support Bloosurf in efforts to improve and extend wireless broadband service where gaps are

jointly identified. The County might also support Bloosurf in applying for new federal grants to improve its service. Less likely, but still in the realm of the possible, the County could encourage Bloosurf to identify its unserved areas and addresses in the County. This may enable wireline operators to build out to those areas (given grant support to provide a sufficient return on investment for the operator).

1.3.1.2 If Bloosurf is not willing to fulfill its commitments to serve the County, then the County should develop data to challenge Bloosurf's coverage claims and enable alternative eligibility for federal funding

The second option is for the County to develop a robust and vigorous record of where Bloosurf is not in compliance and take that documentation to state and federal policymakers. With that proof in hand, the County could ask the state and federal grant-makers to help solve the problem in terms of ReConnect[10]—because the County is in the conundrum of having all these areas not eligible for some funding, while at the same time the broadband problem has actually not been solved in a systematic way.

If the County were to take this approach, we recommend the following data-collection methodology for testing fixed wireless broadband coverage available to residents:

1. **Conduct premises-based speed testing of Bloosurf's service.** The County should select 10 or more locations for on-premises testing. Ideally, this testing would occur at the homes of residents who are Bloosurf customers and are identified by the County as being willing to host such testing (perhaps through a request for volunteers posted on the County's website). Measuring actual service capacities would require testing using a Bloosurf subscriber box authenticated into the Bloosurf network that can measure speeds from the box to a chosen server address. Such tests would also be able to measure reliability and latency.

   Unlike the field testing conducted for this study, which measured Bloosurf's theoretically feasible speeds, this premises-based testing would measure Bloosurf's actual residential service speeds at a given premises (and would enable the County to map Bloosurf's actual coverage as it relates to the 25/3 speeds the company promised in its CAF II applications).

   This testing would require the development of a standardized approach and metrics. In this way, the County would ensure the tests measure the speeds delivered to Bloosurf's

[10] The USDA's ReConnect program rules do not currently include a process by which protected status can be contested, but developing data on Bloosurf's lack of compliance with its previous funding commitment would presumably enable the County to advocate for its eligibility when such a process is developed. Further, the data would be the basis for demonstrating Bloosurf's lack of compliance with the terms of its earlier USDA Broadband Initiatives Program funding.

on-premises endpoint equipment and are not affected by internal home routing equipment or other potential bottlenecks unrelated to Bloosurf.

2. **Conduct in-field speed testing using Bloosurf endpoint equipment.** Again expanding on the field testing conducted for this study, the County should conduct in-field speed testing utilizing Bloosurf endpoint equipment. This methodology could potentially be used to perform speed tests at any location in the network—and, because it would entail the use of Bloosurf devices, it could potentially bolster the County's measurement of actual Bloosurf service availability. (We note, however, there is a possibility that such devices are tuned to particular antennas or sectors, in which case test results for some locations will not be successful and instead would be limited to a single antenna or sector.)

   To procure the endpoint devices needed for this testing, we anticipate the County will need to sign up for Bloosurf service at one employee's home or a County building location. Once the Bloosurf end user equipment has been installed and baseline capacity testing has been completed at this premises, the County can then use that Bloosurf-provided equipment to conduct testing at dozens of locations.

This type of testing is beyond the scope of our current effort, but if the County is able to develop the data, it will have a solid record and demonstration of the lack of promised broadband service. (We note, too, that the process of developing the data may in and of itself incent Bloosurf to improve both service and, frankly, customer service.) The data will be a record the County can then use, because state and federal funds are going to be so critical to solving the County's broadband issues, given the economics of rural broadband deployment. We believe this level of attention to the fixed wireless providers that are purporting to be providing service in the County is critical.[11]

If the County is able to develop this record, it can then serve as the basis for contesting the protected status that Bloosurf has with USDA—but also as the FCC improves its mapping process in the next year, providing data to the FCC to try to get the Commission to accurately map the true availability of broadband in the County.

Those efforts would then position the County to identify one or more partners who are able and committed to solve this broadband challenge and apply for federal funds to do so. But as long as the County appears to be served or partially served, it will be challenging to identify a partner that is willing to commit time and resources given the lack of eligibility for federal funds.

[11] We recommend that the County conduct these capacity tests on a regular basis; given that fixed wireless networks have a relatively short lifespan, coverage could change over time if Bloosurf does not continuously renew its network equipment.

1.3.2 Engage with Choptank Electric Cooperative on expanding broadband service to Category 1 and Category 2 premises

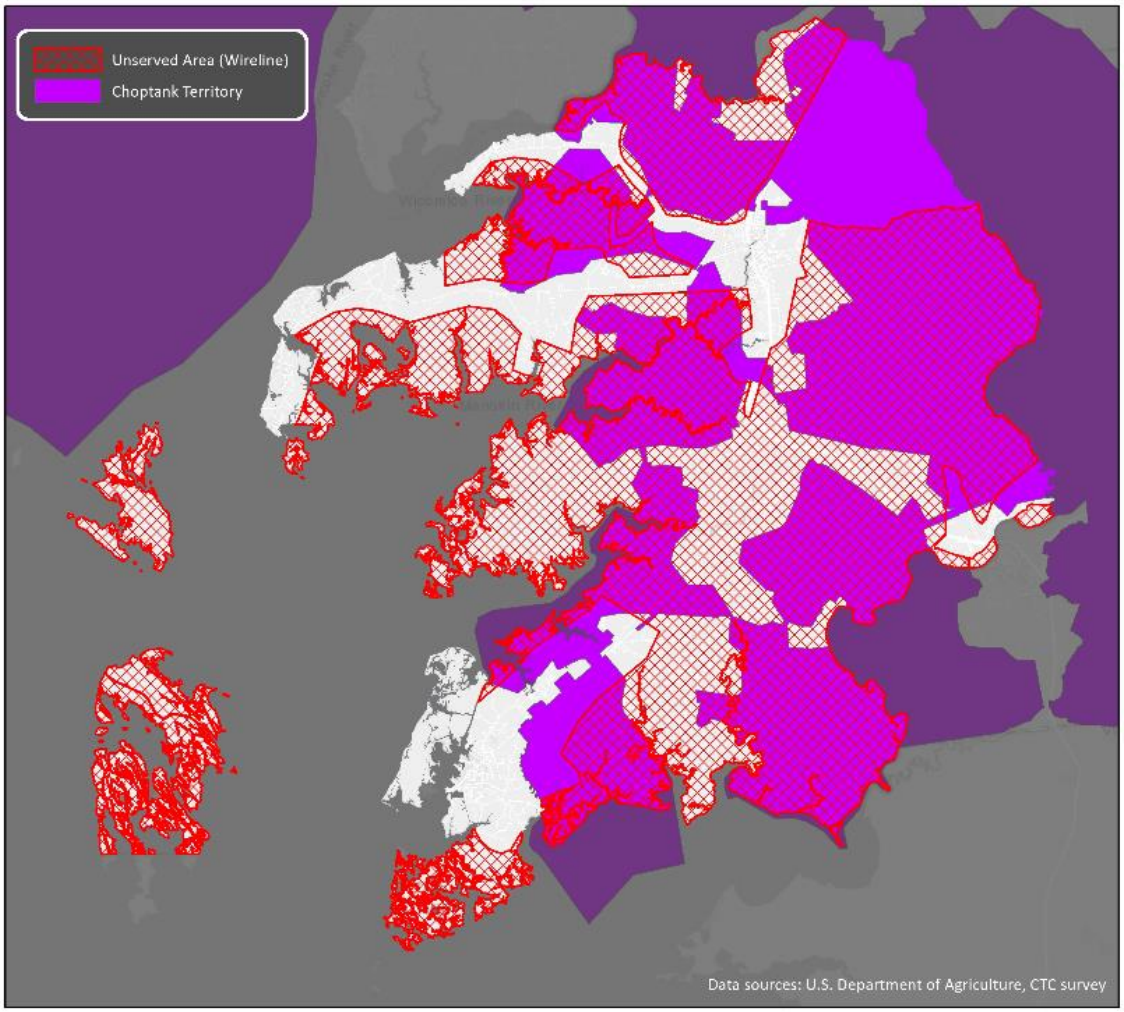
With a focus on state grant opportunities, the Rural Digital Opportunity Fund, and—if feasible—the ReConnect program, we recommend the County engage with Choptank on serving Category 1 and Category 2 unserved areas with fiber-to-the-premises. Choptank is an obvious choice for a partner in the County's broadband deployment efforts. Indeed, Choptank positioned itself for this opportunity by asking the Maryland legislature to give it the regulatory flexibility to enter the broadband market.[12] That legislation passed during the writing of this report, and Choptank is in the process of ratifying changes internally that would allow it to offer broadband service in Maryland.

Because it is member-owned, Choptank presumably would not cherry-pick only certain unserved areas; it is responsible to all members within its service footprint in the County, not just to business opportunity in the way of a for-profit ISP. Choptank also owns utility poles—the core structural asset needed for broadband deployment—throughout the County's unserved areas; those poles would be able to support fiber attachments and would dramatically lower Choptank's fiber construction costs. In addition, Choptank has the technical capability to construct aerial fiber and a proven ability to manage customer relationships.

While Choptank's current publicly published service area does not encompass all unserved areas of the County, there is substantial overlap that would enable Choptank to reach many of the unserved areas. Figure 5 (below) shows Choptank's self-reported electric coverage map and the County's Category 1 unserved broadband areas.

[12] See, for example: "Support Choptank Fiber," https://supportchoptankfiber.com/ (accessed December 2019).

Figure 5: Choptank's Electric Service Area Compared to Category 1 Unserved Portions of the County[13]



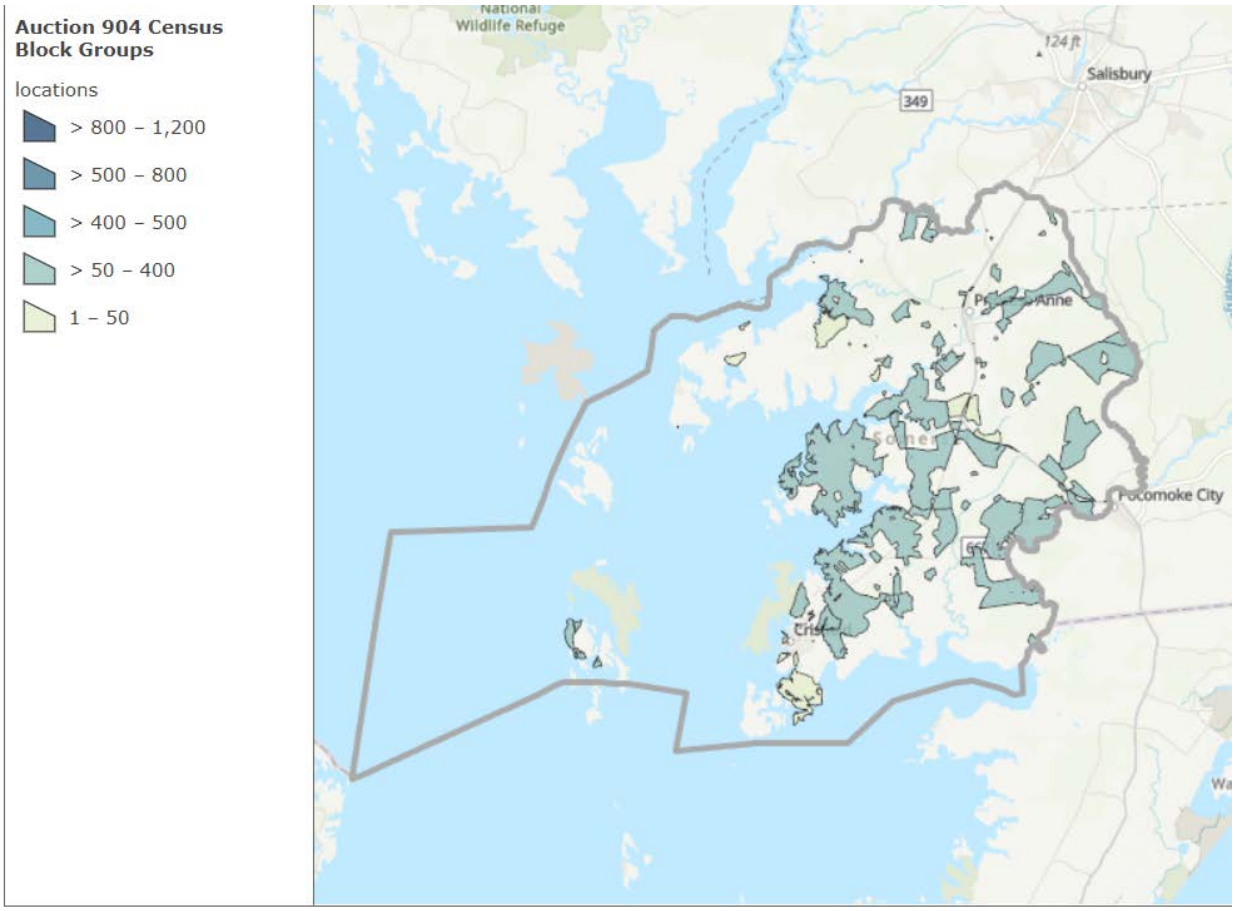
We expect electric cooperatives such as Choptank to benefit from the FCC's Rural Digital Opportunity Fund, in particular, because of its ownership of poles in unserved areas. Choptank would have the lowest cost to build of any entity other than Verizon, which would be a competitive advantage if it were to bid on the FCC's planned reverse auction for the Rural Digital Opportunity Fund (in which the lowest bidder wins).

The FCC issued maps of the areas eligible for the Rural Digital Opportunity Fund; for Somerset, those areas exclude the parts of the County where Bloosurf received CAF II funding and had claimed at least 25/3 coverage (Figure 6). Bloosurf had until April 10, 2020, to claim it had added coverage in any new parts of the County since June 2019, but the company did not contest the

[13] Areas shaded darker are service areas for Choptank. Source: https://choptank.maps.sienatech.com/ (accessed December 15, 2019).

maps. In the absence of such a challenge, Choptank will be able to participate in the Rural Digital Opportunity Fund auction and bid in those areas.

Figure 6: Census Block Groups Initially Eligible for Rural Digital Opportunity Fund[14]



In addition to Rural Digital Opportunity Fund funding, Choptank could also apply for state and ReConnect grants. The caveat in regard to ReConnect grants is that a process for challenging the previously funded BIP and CAF II areas must be developed, and a methodology for challenging those protections for Bloosurf must be implemented (see Section 1.3.1). If Choptank were to miss the Rural Digital Opportunity Fund application window, it would still be eligible to apply for later rounds of ReConnect and state funding as long as no other entity were to be awarded the relevant Rural Digital Opportunity Fund areas in the County.

[14] Initially eligible. Note that these are census block groups—not census blocks—so they appear visually larger than the actual eligible areas. These areas may change slightly prior to the scheduled auction date in late October depending on any challenge by incumbent providers that claim coverage in these areas. We note that Bloosurf did not submit a challenge and we therefore expect the final eligible area map to be close to or identical to the initially eligible map for the County.

The County should therefore encourage Choptank – to the degree feasible – to provide service in non-Choptank service areas that buffer its existing areas and discuss support and partnership arrangements for further expansion into remaining unserved areas – potentially in partnership with other ISPs.

1.3.3 Encourage Comcast and Charter to apply for state funds for Category 2 isolated unserved pockets

If the County is able to successfully contest Bloosurf's coverage, our second recommendation is that the County pursue potential partnership with Comcast and Charter to address Category 2 unserved locations (i.e., the unserved premises in the County's generally more densely populated areas). As is discussed in this report, these isolated, low-density roads within areas that are otherwise served by either Comcast or Charter (or both) do not present a compelling business case or opportunity for a new provider. In addition, the full areas are not eligible for state or federal funding because much of these areas are already served—further reducing the interest of new entrants to build in those areas.

Comcast and Charter, however, are positioned to cost-effectively expand their infrastructure to those unserved pockets within their served areas, and both state and federal funding sources are available to them for this purpose if they choose to apply. For example, the state of Maryland late last year opened a grant opportunity for these "line extensions" by incumbents such as Comcast and Charter (see Section 7.5). That particular grant opportunity has already closed, but we fully expect that the state will create new opportunities of that sort annually and potentially even more frequently, particularly if the companies show interest.

Further, the state's currently open grant opportunity, as well as the federal ReConnect opportunity, allow companies like Comcast and Charter to apply for funds to build on multiple isolated roads within a larger geographic area. The companies could file on an aggregated basis for a single grant to build on unserved roads within their existing served footprints.

We believe there is an attractive opportunity for both companies to secure public funding to serve these areas. Our understanding is that Charter has been very open to applying to the state grant program and we believe it actually submitted an application for parts of Somerset County in early 2020. We believe Comcast has applied for grants to extend their footprints in other counties and hope they will do so here, too.

We recommend the County further pursue these options with both companies for upcoming opportunities, including the Rural Digital Opportunity Fund and state grant funding.

2 The County Has Homes and Businesses Unserved by Wireline Infrastructure in Contiguous Areas and Scattered Locations

We began our analysis by evaluating unserved areas where no wireline infrastructure capable of delivering services that meets the federal and state definitions of broadband passes[15] homes and businesses—meaning there is no cable or fiber plant in the right-of-way adjacent to the property.

We identified these unserved areas through a desk survey, in which a CTC outside plant engineer analyzed Google Earth Street View maps where available—searching images of miles of County roadways for the presence (or lack thereof) of broadband infrastructure such as cable attachments on poles (for aerial construction) and handholes and pedestals (for underground construction).

Our mapping and analysis identified approximately 6,000 homes and businesses unserved by wireline broadband infrastructure in contiguous unserved areas of the County (Category 1). A second group of unserved residents live at addresses on isolated unserved roads (Category 2).[16]

There is an additional category of locations within the County (Category 3) where homeowners struggle to get wireline service, despite the presence of broadband infrastructure passing the home: premises set so far back from the road that the ISP has no obligation to build the service drop from the road to the user's premises at no cost to the customer. Although these homes are effectively unserved because many homeowners find the drop construction cost unaffordable, the homes do not fit into the category of unserved for purposes of federal or state grant funding.

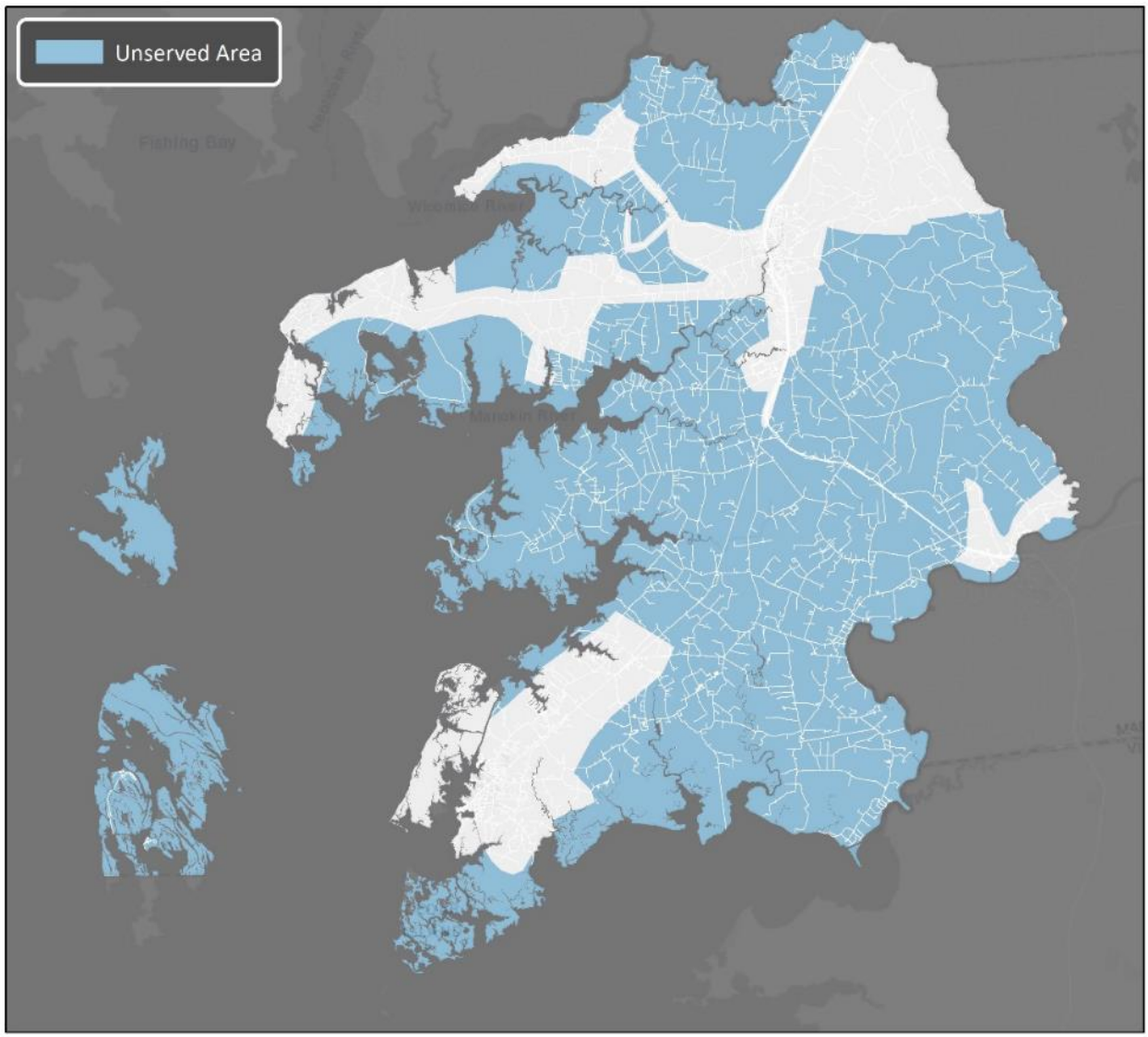
[15] A "passing" is the infrastructure that "passes" a home or business along the public rights-of-way, but it does not include the "service drop"—the portion of the network that connects from the road to the home or business itself. The availability of a passing to a home or business is the universally understood definition of what is served, both within the industry and among the state and federal government entities that fund broadband expansion[15] and regulate communications services.

[16] We note that the category numbers do not indicate prioritization or emphasis in terms of the County's approach to filling its broadband gaps; the numbers are merely a convenient way to refer to the categories.

2.1 Unserved Category 1: Contiguous geographic areas

Category 1 comprises contiguous geographic areas where there exists no wireline infrastructure capable of delivering broadband speeds. Based on CTC's analysis of available data and our desk survey, we determined that the County has approximately 6,000 unserved locations in this category (Figure 7)—and that those contiguous unserved areas comprise the bulk of the County.

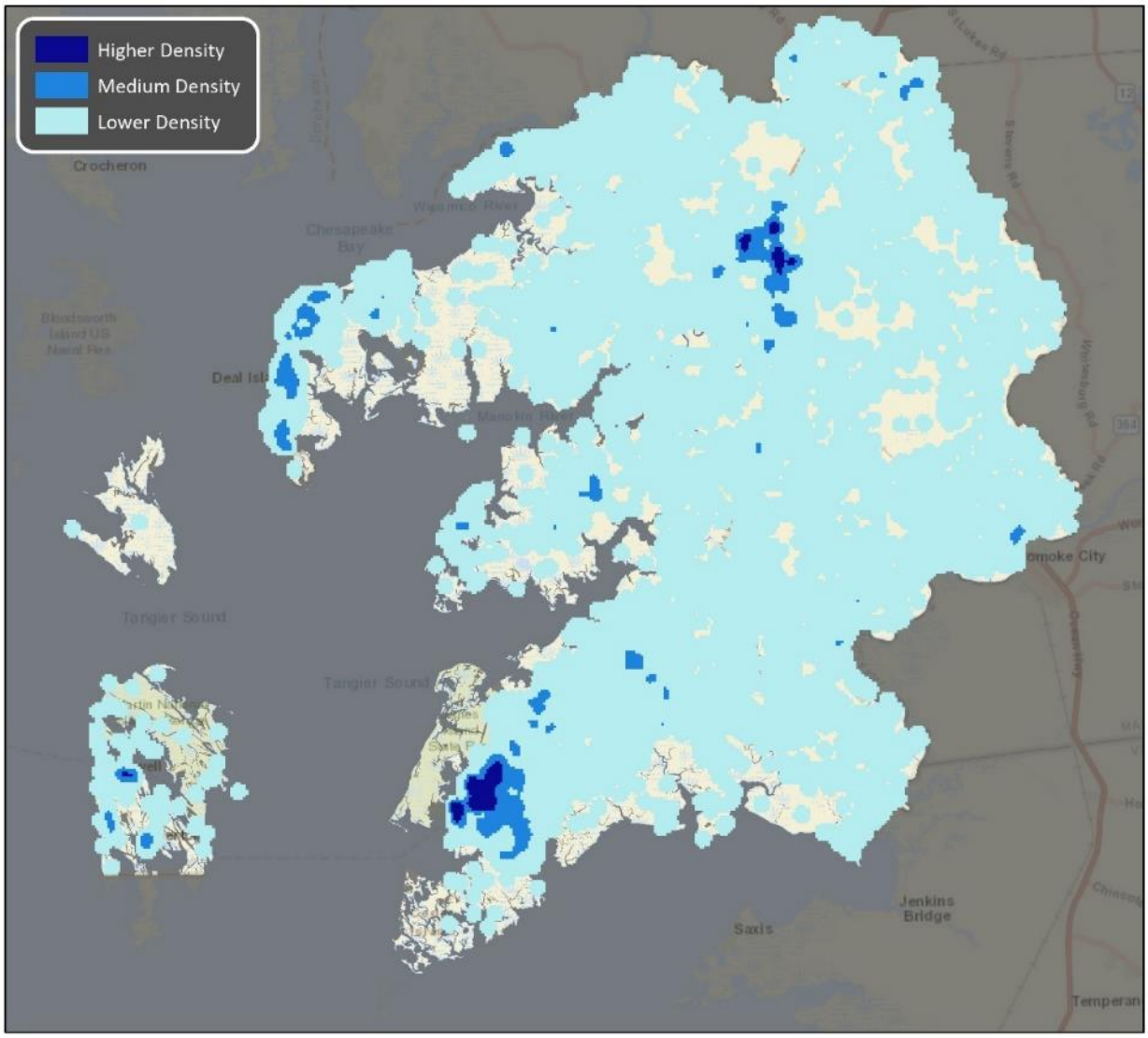
Figure 7: Category 1 Contiguous Unserved Areas



As a further step in our analysis of Category 1 unserved areas, we used the County's address data to develop a heat map of population density across the County (Figure 8). We developed the heat map of address points with a GIS mapping tool, which divided clusters of addresses into three groups relative to the County's overall density. High, medium, and low are therefore relative

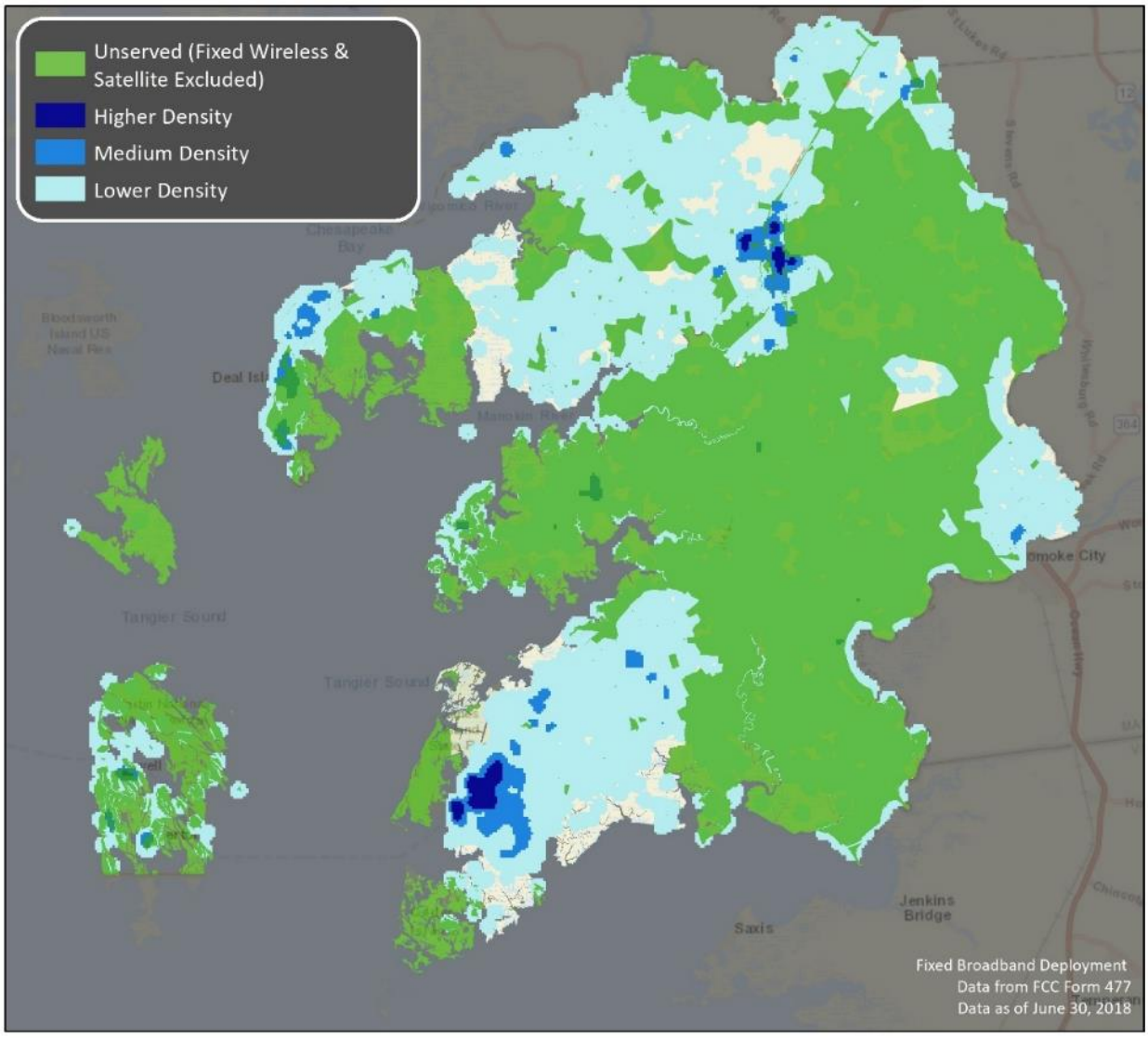
values denoting level of clustering. Most of the County has relatively low population density; the areas without a heat color are parts of the County where there are no addresses.

Figure 8: County Population Density Heat Map



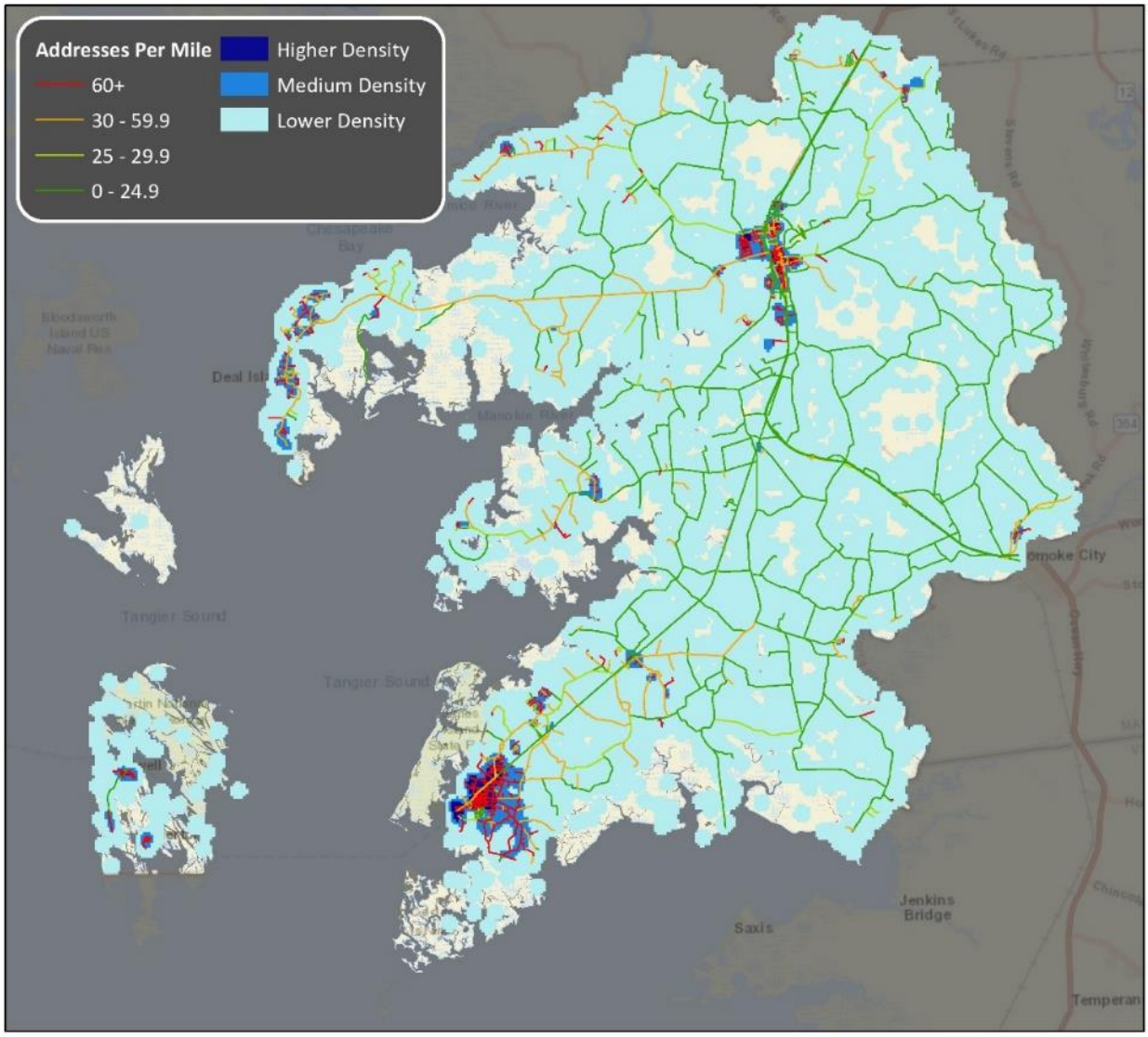
Not surprisingly, and very much in line with national broadband deployment patterns, the County's high-density areas align with the areas that our desk survey indicates as being served with wireline broadband (Figure 9). Similarly, we found that low population density is relatively homogeneous across the County's wireline-unserved areas. Very low density spaces are not included in the analysis, and thus are not shaded in the map.

Figure 9: Unserved and Served (Wireline) Portions of the County



Additionally, we calculated the passings per mile on each of the County's roads. This confirmed that when looking at address density both by area and density as it pertains to passings per street mile, the unserved areas for the most part are low-density by both metrics (Figure 10).

Figure 10: Passings per Mile, Density, and Wireline Service Availability



2.2 Unserved Category 2: Addresses on isolated roads

Category 2 comprises the unserved premises located on isolated, low-density roads that fall within areas that are otherwise served. In other words, while the larger areas around these homes are generally served, the homes are on roads that do not have infrastructure.

The isolated unserved premises are typically on roads that are particularly long relative to the number of potential broadband customers on the road; in that map, the black roads do not have broadband infrastructure, so the single homes at the end of each road are unserved. Neither Charter nor Comcast has had business reasons to build infrastructure on those roads because their potential return on investment is not great enough to prompt an investment in reaching the potential customers who live there. Given the low density of houses, too, neither Charter nor

Comcast is obligated to build infrastructure on those roads under the terms of their cable franchise agreements with the County.

Other Category 2 locations include pockets of multiple unserved homes surrounded by served areas. For the residents on roads like these, which exist in locations in many parts of the County, this situation is particularly challenging; the cost of Charter or Comcast's line extension down their road—which the residents would be required to pay in order to get service from those companies—can be high.

The County may be able to work with Comcast and/or Charter to seek grant funding to lower the cost to the providers for extending service to these isolated roads. A new broadband provider would likely not be as interested in serving these isolated roads because it would not have existing plant adjacent to the isolated roads.

2.3 Unserved Category 3: Addresses with long driveways

In addition to the two categories of unserved residents, we also identified a third category of premises that do not have broadband service. These are customers for whom the cost of installation of the service drop—the connection from the right-of-way to the user's premises—is so high as to make service infeasible. This generally refers to locations where the home or business is more than 300 feet away from the road—that distance being the typical limit for cable franchisees' obligations to install a service drop at no cost to the customer.

This is a situation that is extremely frustrating for those Somerset County residents who seek service but cannot afford to cover the cost of service drop installation, even if fiber passes their property (and thus they are considered to be "served with broadband" by the state and federal governments). Service to these homes or businesses is a matter of the affordability of drop construction, not availability of infrastructure. The County could choose to subsidize the cost of drop construction, but this is unfortunately an area in which the County will not have a state or federal partner to solve that problem—because neither state nor federal grant funding applies to building service drops to these locations.

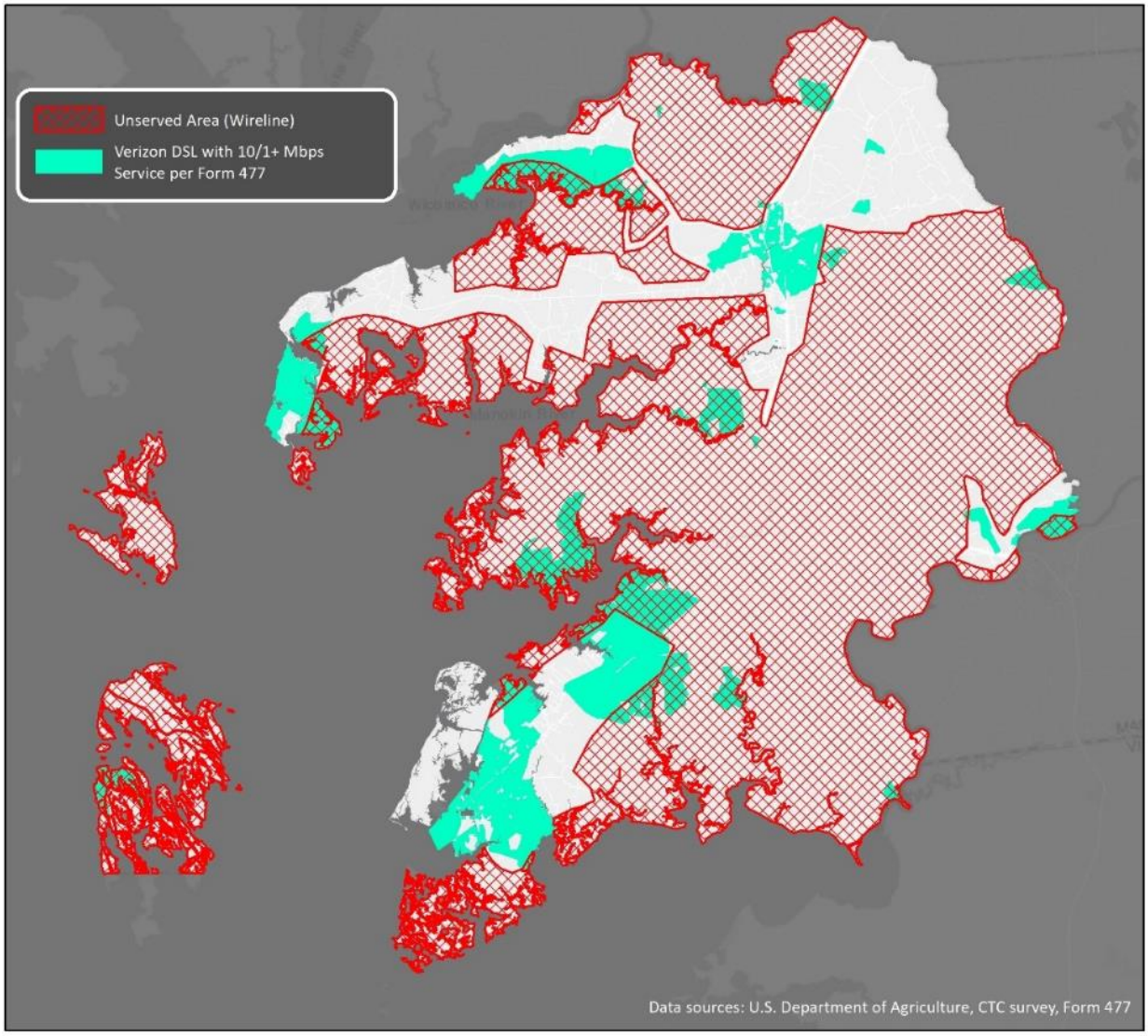
3 An Analysis of Federal Broadband Availability Data Indicates That Bloosurf—a Wireless ISP—Claims to Serve Almost All of Somerset County

With an understanding that state and federal funding may represent a viable opportunity for enabling the County's efforts to fill broadband gaps in Category 1 and Category 2 (see Section 7), we also evaluated FCC Form 477 data about broadband services available in the County—both at the 25/3 and 10/1 levels.

We note that while the County is concerned about lack of service that meets the FCC's definition of broadband (25/3)—and that 25/3 is the threshold for the State of Maryland's broadband funding—the USDA's ReConnect grant and loan program uses 10/1 service availability as its minimum definition. (Under current ReConnect rules, an applicant's proposed funded service area (PFSA) is eligible if 90 percent of the area lacks access to 10/1 service.)

Our analysis of Form 477 data determined that Verizon claims to have some DSL infrastructure capable of delivering 10/1 service in portions of the County's Category 1 unserved areas (Figure 11). This service is not considered broadband under the federal definition, but it does potentially disqualify those areas from ReConnect eligibility.

Figure 11: Verizon DSL Service Compared to Unserved Areas



It was outside the scope of this study to comprehensively map the County's DSL infrastructure, and Verizon did not provide maps of its current infrastructure to us, so we only note the census blocks that Verizon claims are served by 10/1 DSL through Form 477 reporting. (We note, too, that Verizon has seemingly shown no interest in expanding its copper-based DSL infrastructure, and is unlikely to contest grant applications in areas it currently serves.)

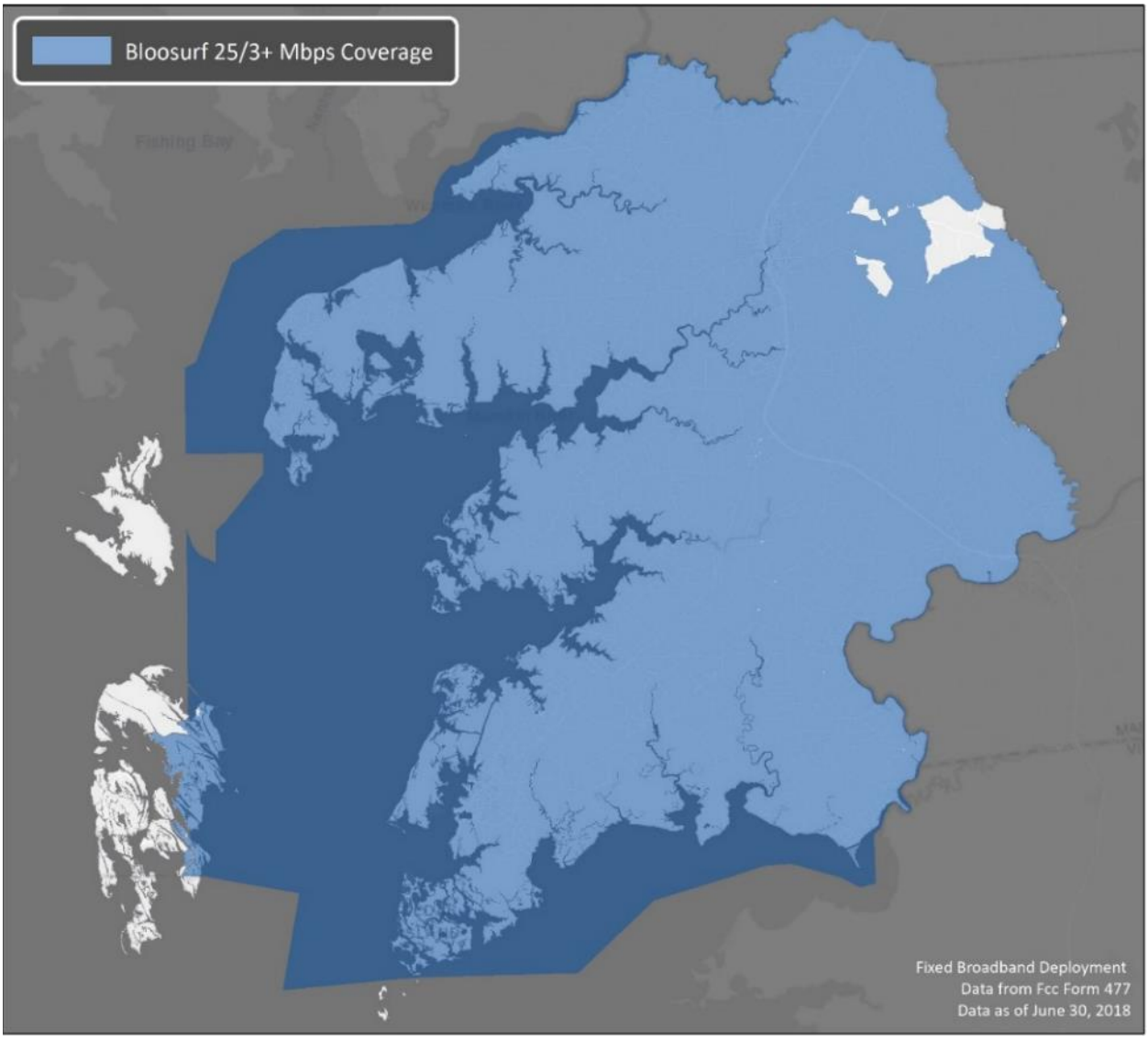
More critically, in terms of the County's strategic planning, Bloosurf claims to serve almost all of the County with speeds that would make those areas ineligible for federal grant programs.

3.1 Bloosurf claims to serve almost all of the County with 25/3 speeds

Our analysis of Form 477 data found that Bloosurf, a wireless ISP, claims to provide fixed wireless coverage to almost all of Somerset County at speeds meeting the federal definition of broadband:

25 Mbps download and 3 Mbps upload (25/3) (Figure 12). **If Bloosurf is indeed capable of providing these speeds to residents across the County, then the County would be considered "served" in regard to broadband coverage and thus ineligible for state and federal grant programs.**

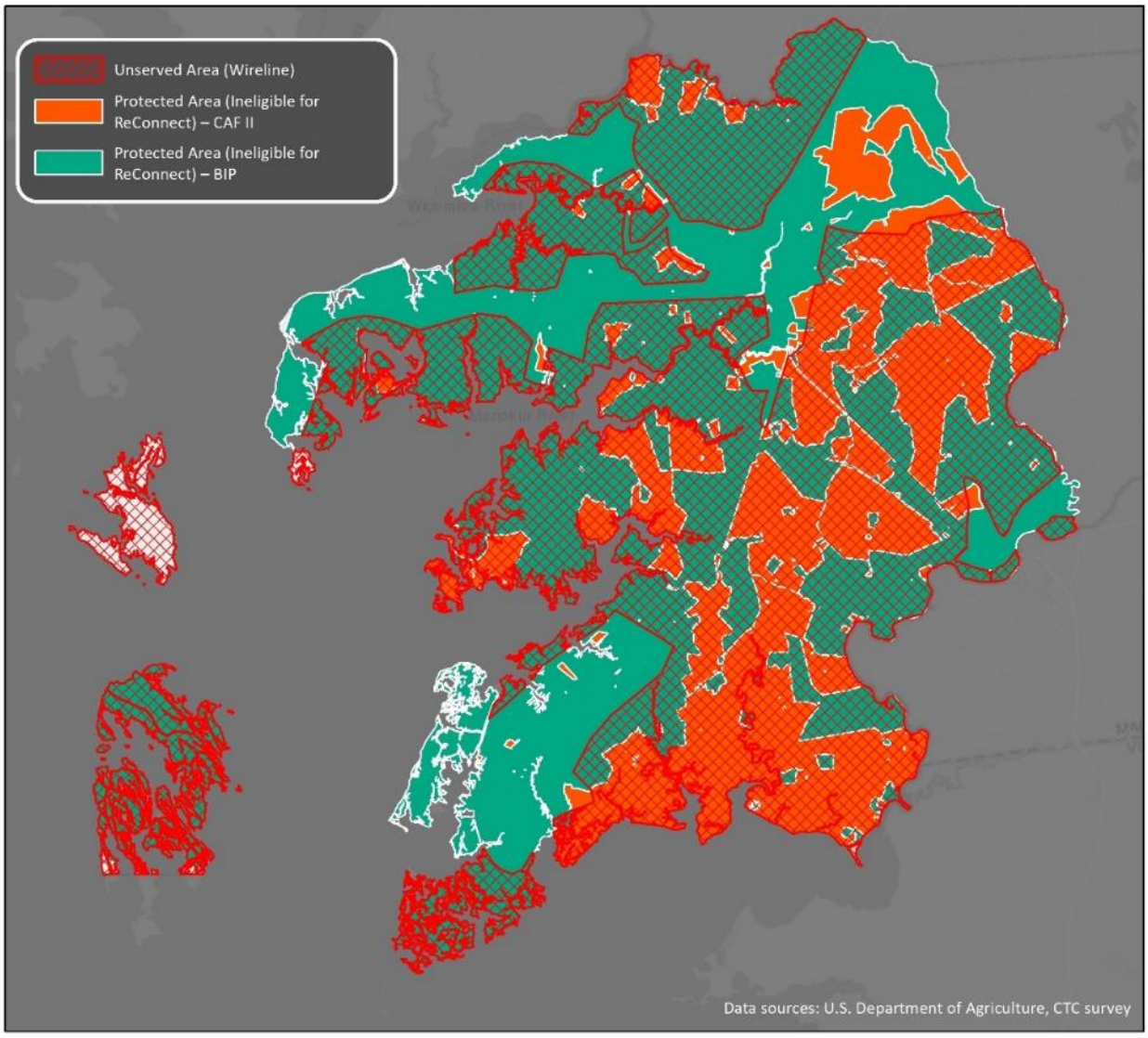
Figure 12: Bloosurf's Self-Reported Coverage from Form 477



Further complicating the County's situation, Bloosurf has previously received federal grants for delivering these claimed broadband services (see Section 1.2.4); those grants—from the USDA's Broadband Initiatives Program (BIP) and the FCC's Connect America Fund (CAF)—make Bloosurf's service area ineligible for consideration by other grant programs (see Figure 13 and Section 7).

Bloosurf's previous funding thus presents an obstacle to the County or a new partner applying for federal broadband grants (though not state grants).

Figure 13: Bloosurf's Grant-Funded Service Area as Compared to Wireline-Unserved Areas



3.2 Anecdotal reports suggest that Bloosurf's service is not available everywhere in the County

Despite the Form 477 claims, there is significant concern about the extent of Bloosurf's actual coverage in the County. Anecdotal data—including from County leadership—suggests that Bloosurf's service is not available on a widespread basis. In fact, multiple sources reported that even without line-of-sight issues (i.e., the residents do not live a long distance from the towers where Bloosurf's antennas are mounted, and they do not live within heavy tree cover) they were informed by Bloosurf that they were not eligible for service.

To verify Bloosurf's coverage claims, CTC requested that Bloosurf provide technical details regarding the company's current network map, actual propagations, tower placements and heights, and other details that could enable an analysis of Bloosurf's actual service. The company declined to make that information available. Bloosurf also declined to conduct joint testing with a CTC engineer at random customer home locations (which would demonstrate actual customer service speeds).

Even without the company's cooperation, however, it is possible to determine whether Bloosurf could deliver 25/3 speeds in the County. Because Bloosurf uses licensed spectrum to deliver its service, its frequencies are uniquely allocated to Bloosurf in the County—and can be independently evaluated.

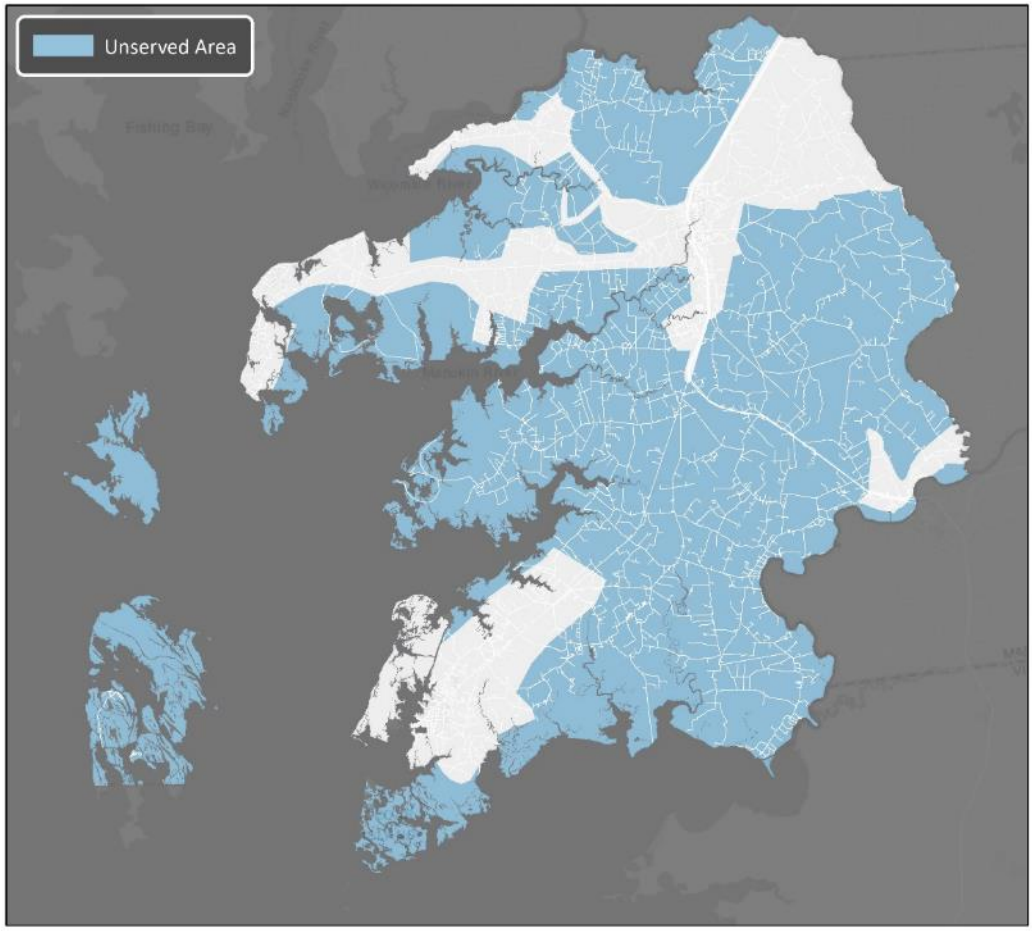
Accordingly, we conducted wireless signal strength testing to determine whether fixed wireless broadband service is feasible in the County. Using a spectrum analyzer, a CTC engineer tested the signal strength of Bloosurf's licensed spectrum at 25 representative locations across the County. (See Appendix A for a description of the testing methodology.) All 25 tested locations had signal levels greater than the receiver threshold theoretically needed to achieve 25/3 data speeds. In other words, these **test results indicate that Bloosurf is theoretically *capable* of delivering 25/3 speeds across the County.**

These signal levels indicate only that 25/3 speeds are possible in the tested locations; actual customer data speed might be lower than 25/3 in the tested locations and elsewhere in the County for a variety of reasons. For example, the results do not reflect any limitations based on the channel capacity or the actual equipment utilized by the Bloosurf network. The actual capacity available to a user depends on the line of sight between Bloosurf's antennas and the individual user, as well as the loading of the network and factors unrelated to wireless signal level, such as oversubscription within Bloosurf's internal network or the company's upstream connection to the internet. The tests also do not indicate any reliability issues in the network.

4 Fiber-to-the-Premises Infrastructure to Fill Gaps in Category 1 Unserved Areas Would Have High Capital Cost but Relatively Low Ongoing Operating Costs

As documented in Section 2, CTC's analysis of County-provided data and our extensive desk survey identified an estimated 6,000 Category 1 unserved homes and businesses (Figure 14) that could be served by a new ISP or by the incumbent providers.

Figure 14: Category 1 Unserved Areas



As a candidate solution, CTC's engineers prepared a high-level network design for the deployment of a gigabit-capable fiber-to-the-premises network to Category 1 homes and businesses. We then estimated the cost for deploying that network, including a network backbone, assuming the construction was performed by the County or a partner entity that is not the incumbent telephone, power, or cable company.

The total estimated capital cost for the County or a partner to construct a fiber-to-the-premises network to serve the two Category 1 areas is $54 million (including overhead and administrative costs); details are shown in Table 1.[17]

Table 1: Estimated Total Fiber Deployment Cost for Category 1 Unserved Areas

Cost Component	Estimated Cost
Outside Plant	$46,400,000
Central Network Electronics	$1,500,000
Fiber Service Drop Installations	$4,500,000
Customer Premises Equipment	$1,800,000
Total Estimated Cost:	*$54,200,000*

We estimated a cost per passing by dividing the outside plant cost by the number of passings. This is the cost of constructing fiber alongside the roads in front of homes and businesses, divided by the number of homes and businesses—essentially the cost of building a network independent of connections to any specific homes and businesses. We estimate the average outside plant cost per passing will be approximately $7,700 (Table 2).

Table 2: Estimated Outside Plant Cost per Passing for Category 1 Unserved Areas[18]

Cost Component	Estimated Cost
Outside Plant	$46,400,000
Passings	6,000
Outside Plant Cost per Passing[19]	*$7,700*

These cost estimates—and the estimated operating costs described below (Section 4.5)—provide data relevant to assessing the financial viability of network deployment; they enable financial modeling to determine the approximate revenue levels necessary for the County or a partner to service any debt incurred in building the network. They also provide a baseline against which to evaluate the cost of incremental and non-fiber optic approaches, as compared to the cost of full coverage of the County's unserved areas with the highest-bandwidth technology.

4.1 Capital cost estimates are derived from a customized outside plant network design

To develop and refine the range of assumptions that will have an impact on the network design and construction costs, a CTC engineer performed a desk survey of the County using Google Earth

[17] These numbers have been rounded.
[18] Unrounded numbers are used in the engineering calculations; these are then rounded in the discussion.
[19] This is the average cost to construct the outside plant portion of the fiber-to-the-premises network for each home and businesses in the unserved areas.

Street View. The engineer reviewed available green space, estimated the modifications that would be necessary to existing infrastructure on utility poles, and estimated the percentage of utility poles that would need to be replaced to accommodate the new network infrastructure. Based on this analysis, we developed customized estimates of per-mile costs for construction on utility poles and for underground construction where poles are not available.

Table 3 summarizes the conditions determined through our desk survey.

Table 3: Cost Factors Developed in Desk Survey

Cost Factor	Finding in Unserved Areas
Aerial Construction	95%
Poles per Mile	35
Average Moves Required per Pole[20]	1
Poles Requiring Make-Ready	7%
Cost Per Move	$350
Poles Requiring Replacement	3%
Average Pole Replacement Cost	$7,000
Intermediate Rock Underground	1%
Hard Rock Underground	0%

Make-ready is the work required to create space on an existing utility pole for an additional attachment. Existing attachments often have to be moved or adjusted to create the minimum clearance required by code to add an additional attachment. Each move on the pole has an associated cost (i.e., for contractors going out to perform the move). When a utility pole is not tall enough to support another attachment or the pole is not structurally capable of supporting the attachment, a pole replacement is required. The pole replacement cost is then charged to the new attacher.

Where utility poles do not exist, underground construction is required. One of the challenging variables with underground construction is the prevalence of rock. Softer stones and boulders (intermediate rock) require the use of a specialized boring missile that is more expensive than traditional boring. While this does not apply to Somerset County, where hard rock such as granite is present, specialized rock boring machinery is required to directional bore new conduit. The cost of boring through intermediate rock found in some areas of Somerset is added to the cost of traditional boring.

[20] The average moves per pole is the average number of existing attachments on the utility pole that need to be moved to create space and clearance in the communications space to support a new attachment for the fiber-to-the-premises network.

CTC's outside plant engineer noted that the quality of the poles and pole attachments in the County varied, as they do in many cities and counties—but that overall, most of the poles have space for an additional attachment.

In many parts of the County's Category 1 unserved areas, the telecommunications cables (i.e., Verizon telephone lines) are buried underground, adjacent to electric distribution cables, which are installed on utility poles. The cost estimate assumes that the County could attach to the utility poles in the communications space below the electrical cables. Based on our experience, the utility pole lines are more favorable for new pole attachment than the average utility pole—which will correspond to a lower-than-average construction cost on the aerial poles.

The figures below show samples of poles in various conditions that we identified during our field survey of the County's Category 1 unserved areas. In Figure 15, for example, make-ready is required on the pole because cables in the communications space may need to be moved to create clearance for the placement of fiber optic cable. This utility pole appears tall enough that—with make-ready—another could attach to the pole.

Figure 15: Utility Pole Requiring Make-Ready

Tree trimming is required to attach an additional attachment on the utility poles in the following picture (Figure 16). Tree trimming is also an important maintenance function necessary to keep the pole line clear of tree limbs that could break and damage the wires on a utility pole.

Figure 16: Pole Line Where Tree Trimming Will Be Required

Figure 17 shows a low (favorable) make-ready pole line that has only one existing attachment in the communications space on the power poles. Where make-ready is low, the cost of aerial construction is cheaper than in high make-ready areas.

Figure 17: Low-Make-Ready Pole Line in Unserved Area

4.2 The network architecture can support multiple subscriber models and classes of service

We developed a conceptual, high-level fiber-to-the-premises outside plant network design that is aligned with best practices in the industry and is open to a variety of electronic architecture options.[21]

Figure 18, below, shows a logical representation of the fiber-to-the-premises network architecture we recommend based on the conceptual outside plant design. The drawing illustrates the primary functional components in the fiber-to-the-premises network, their relative position to one another, and the flexibility of the architecture to support multiple subscriber models and classes of service.

The recommended architecture is a hierarchical data network that provides scalability and flexibility, both in terms of initial network deployment and its ability to accommodate the increased demands of future applications and technologies without requiring expensive new construction. The characteristics of this hierarchical fiber-to-the-premises data network are:

[21] The network's outside plant is both the most expensive and the longest-lasting portion. The architecture of the physical plant determines the network's scalability for future uses and how the plant will need to be operated and maintained; the architecture is also the main determinant of the total cost of the deployment.

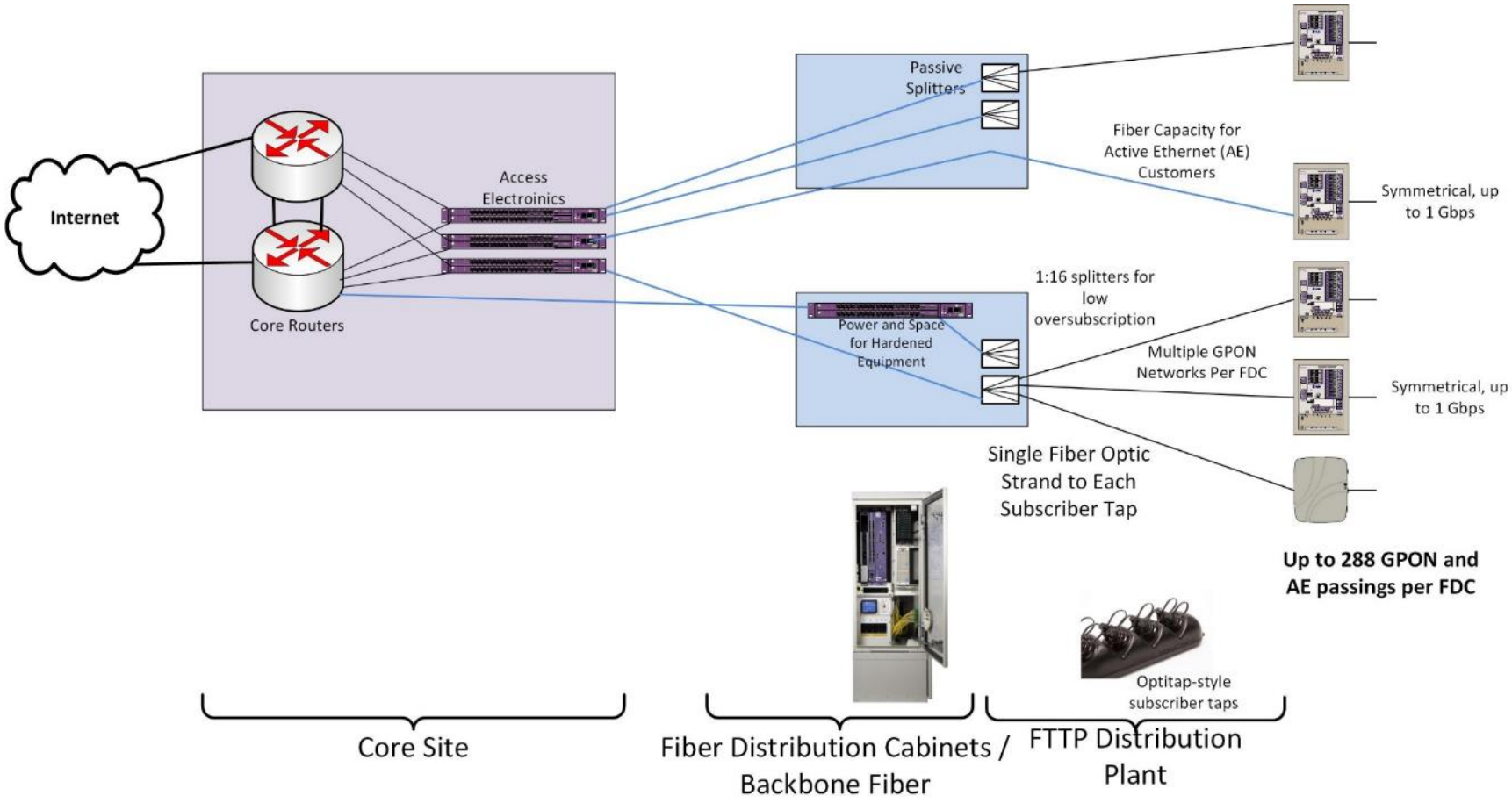
- **Capacity** – ability to provide efficient transport for subscriber data, even at peak levels
- **Availability** – high levels of redundancy, reliability, and resiliency; ability to quickly detect faults and re-route traffic
- **Failsafe operation** – physical path diversity in the network backbone to minimize operational impact resulting from fiber or equipment failure
- **Efficiency** – no traffic bottlenecks; efficient use of resources
- **Scalability** – ability to grow in terms of physical service area and increased data capacity, and to integrate newer technologies without new construction
- **Manageability** – simplified provisioning and management of subscribers and services
- **Flexibility** – ability to provide different levels and classes of service to different customer environments; can support an open access network or a single-provider network; can provide separation between service providers on the physical layer (separate fibers) or logical layer (separate Virtual Local Area Network (VLAN) or Virtual Private Network (VPN) providing networks within the network)
- **Security** – controlled physical access to all equipment and facilities, plus network access control to devices

This architecture offers scalability to meet long-term needs. It is consistent with best practices for either a standard or an open-access network model to provide customers with the option of multiple network service providers. This design would support the current industry standard gigabit passive optical network technology. It could also provide the option of direct Active Ethernet services.[22]

The design assumes placement of manufacturer-terminated fiber tap enclosures within the public right-of-way or easements, providing watertight fiber connectors for customer service drop cables, and eliminating the need for service installers to perform splices in the field. This is an industry-standard approach to reducing both customer activation times and the potential for damage to distribution cables and splices. The model also assumes that the County or a partner obtains easements or access rights to the gated communities and private drives within the communities to access the homes in those neighborhoods.

[22] The architecture enables the network to provide direct unshared Ethernet connections to 5 percent of customers, which is appropriate for a select group of high-security or high capacity commercial users (banks, wireless small cell connections). In extreme cases, the network can provide more customers with Active Ethernet with the addition of electronics at the fiber distribution cabinets on an as-needed basis.

Figure 18: High-Level Fiber-to-the-Premises Architecture



4.3 Network design assumptions include constructing 65 miles of fiber backbone

We used the following unit cost assumptions when developing our estimated fiber construction costs (Table 4). Cost estimates are based on other, similar fiber-to-the-premises projects.

Table 4: Unit Cost Estimate Assumptions

Description	Unit	Assumption
Placement of 2-inch conduit using directional boring	$/foot	$12.50
Pull-box placement, 24"x36"x36" Tier 22	each	$1,050
Aerial cable installation per foot	$/foot	$1.50
Traffic control and work area protection per foot	$/foot	$.50
Tree trimming	$/foot	$.50
Make-ready per foot	$/foot	$3.80
288-count cable	$/foot	$2.05
Aerial fiber installation materials	$/foot	$1.30

The network design and cost estimates assume the County or a partner will:

- Use existing County land to locate a core facility. The cost estimate includes the facility costs with adequate environmental and backup power generators to house network electronics, and provide backhaul to the internet.
- Construct approximately 65 miles of backbone network[23] to connect the unserved communities to the core via five fiber distribution cabinets. The fiber distribution cabinets will be located in the public right-of-way or on County-owned land that provides adequate space for the hosting and maintenance of the cabinet.
- Construct approximately 720 miles of fiber optics from the fiber distribution cabinets to approximately 6,000 homes and businesses (i.e., from termination panels in the fiber distribution cabinet to tap locations in the public right-of-way or on easements near the home or business).
- Obtain easements or access rights to private roads where public rights-of-way do not exist.

The fiber-to-the-premises network design was developed with the following criteria based on the above assumptions and required characteristics of the hierarchical fiber-to-the-premises network:

[23] The backbone construction costs are included in the cost of the fiber-to-the-premises network.

- Fiber will be installed in the communications space of the electric utility poles where poles are present, and in newly constructed underground conduit in other areas.
- Fiber will vary between 12- and 288-count based on the projected need in the area.
- Fiber will be installed in the public right-of-way or in an easement on the side of the road.
- The network will target up to 288 passings per fiber distribution cabinet.
- Fiber distribution cabinets will support hardened network electronics and provide backup power and an active heat exchange.[24]
- The network routes will minimize the need for distribution plant to cross major roadways and railways.

As with any utility, the design and associated costs for construction vary with the unique physical layout of the service area—no two streets are likely to have the exact same configuration of fiber optic cables, communications conduit, underground vaults, and utility pole attachments. Costs also vary by soil conditions; the condition of utility poles and feasibility of aerial construction involving the attachment of fiber infrastructure to utility poles; and crossings of bridges, railways, and highways.

A key point to understand is that aerial construction (i.e., attaching fiber infrastructure to existing utility poles) could offer significant savings compared to all-underground construction but increases uncertainty around cost and timeline. Under some circumstances, costs related to pole remediation and make-ready construction can make aerial construction cost-prohibitive in comparison to underground construction. However, as discussed in Section 4.1, our survey finds that the majority of poles likely have sufficient space and capacity, and that the amount of needed make ready is mostly average.

We assume that the fiber will be strand-mounted in the communications space on the existing utility poles. Splice cases, subscriber taps, and drops will also be attached to the strand, which facilitates maintenance and customer installation.

[24] These hardened fiber distribution cabinets reflect an assumption that the network's operational and business model will require the installation of provider electronics in the fiber distribution cabinets that are capable of supporting open access among multiple providers. We note that the overall fiber-to-the-premises cost estimate would decrease if the hardened fiber distribution cabinets were replaced with passive fiber distribution cabinets (which would house only optical splitters) and the providers' electronics were housed only at the hub facility.

While generally allowing for greater control over timelines and more predictable costs, underground construction is subject to uncertainty related to congestion of utilities in the PROW which cannot be fully mitigated without physical excavation and/or testing.

While anomalies and unique challenges will arise regardless of the design or construction methodology, the relatively large scale of this project is likely to provide ample opportunity for variations in construction difficulty to yield relatively predictable results on average.

We assume underground construction will be done using an industry-standard approach for this type of environment, which consists primarily of horizontal, directional drilling to minimize public right-of-way impact and to provide greater flexibility to navigate around other utilities. The design model assumes a single 2-inch, flexible, High-Density Polyethylene (HDPE) conduit over underground distribution paths, and dual 2-inch conduits over underground backbone paths to provide scalability for future network growth.

Costs for aerial and underground placement were estimated using available unit cost data for materials and estimates on the labor costs for placing, pulling, and boring fiber based on construction in comparable markets. The material costs were known, with the exception of unknown economies of scale and inflation rates and barring any shortages or supply disruptions restricting material availability and increasing costs. The labor costs associated with the placement of fiber were estimated based on comparable construction projects and data provided by the County.

4.4 Total capital costs include outside plant construction, electronics, and service drop installation

4.4.1 Outside plant cost components

The cost components for outside plant construction include the following tasks:

- ***Engineering*** – includes system level architecture planning, preliminary designs and field walk-outs to determine candidate fiber routing; development of detailed engineering prints and preparation of permit applications; and post-construction "as-built" revisions to engineering design materials.

- ***Quality Control / Quality Assurance*** – includes expert quality assurance field review of final construction for acceptance.

- ***General Outside Plant Construction*** – consists of all labor and materials related to "typical" underground or aerial outside plant construction, including conduit placement, utility pole make-ready construction, aerial strand installation, fiber installation, and

surface restoration; includes all work area protection and traffic control measures inherent to all roadway construction activities.

- ***Special Crossings*** – consists of specialized engineering, permitting, and incremental construction (material and labor) costs associated with crossings of railroads, bridges, and interstate / controlled access highways.
- ***Backbone and Distribution Plant Splicing*** – includes all labor related to fiber splicing of outdoor fiber optic cables.
- ***Backbone Hub, Termination, and Testing*** – consists of the material and labor costs of placing hub shelters and enclosures, terminating backbone fiber cables within the hubs, and testing backbone cables.
- ***Fiber-to-the-Premises Service Drop and Lateral Installations*** – consists of all costs related to fiber service drop installation, including outside plant construction on private property, building penetration, and inside plant construction to a typical backbone network service "demarcation" point; also includes all materials and labor related to the termination of fiber cables at the demarcation point. The model only includes drop costs for the estimated 60 percent of customers taking the service.

The assumptions, sample designs, and cost estimates were used to extrapolate a cost-per-mile for the outside plant infrastructure of $64,000.

The distribution plant covers approximately 720 miles, leading to a total outside plant cost of approximately $46.4 million. This leads to an average outside plant cost per passing of approximately $7,700. Table 5 provides a breakdown of the estimated outside plant costs.

Table 5: Estimated Outside Plant Costs[25]

Cost Per Plant Mile[26]	Distribution Plant Mileage	Total Cost	Estimated Passings	Cost per Passing[27]
$64,000	720	$46.4 million	6,000	$7,700

[25] Unrounded numbers are used in the engineering calculations; these are then rounded in the discussion.
[26] The cost per plant mile is the average cost of constructing a mile of outside plant for the fiber-to-the-premises network.
[27] The cost per passing is the average cost to construct the outside plant for the fiber-to-the-premises network to pass each premises within the unserved areas.

The actual cost to construct fiber-to-the-premises to every unserved Category 1 premises in the County could differ from the estimate due to changes in the assumptions underlying the model. For example, if make-ready and pole replacement costs are too high, the network would have to be constructed underground—which could significantly increase the cost of construction. A non-uniform take-rate (i.e., the percentage of passed customers that choose to purchase a service) across different areas could also influence costs. Further and more extensive analysis would be required to develop a more accurate cost estimate across the entire County.

Actual costs will also vary from this estimate due to factors that cannot be precisely known until the detailed design is completed, or until construction commences. These factors include:

- Costs of private easements;
- Utility pole replacement and make-ready costs;
- Variations in labor and material costs;
- Subsurface rock; and
- The County or its partner's operational and business model.

We have incorporated suitable assumptions to address these items based on our experience in similar markets.

4.4.2 Central network electronics costs

Central network electronics equipment to serve the unserved area will cost an estimated $1,500,000, assuming a 60 percent take-rate.[28] (These costs may increase or decrease depending on take-rate, and the costs may be phased in as subscribers are added to the network.) The network electronics consist of the core and distribution electronics to connect subscribers to the fiber-to-the-premises network at the core and the fiber-to-the-premises access electronics located at the fiber distribution cabinets. Table 6 lists the estimated costs for each segment.

Table 6: Estimated Central Network Electronics Costs

Network Segment	Subtotal
Core and Distribution Electronics	$900,000
Fiber-to-the-Premises Access Electronics	$600,000
Total	*$1,500,000*

[28] The take-rate affects the electronics and drop costs, but also may affect other parts of the network, as the County or its partner may make different design choices based on the expected take-rate. A 60 percent take-rate is possible in environments where a new provider delivers service in a previously unserved area. Market research would be required to estimate a more accurate take-rate at assumed service costs.

The electronics are subject to a seven- to 10-year replacement cycle, as compared to the 20- to 30-year lifespan of a fiber investment.

4.4.2.1 Core and distribution electronics

The core electronics connect the network to the internet. The core electronics consist of high-performance routers, which handle all the routing on both the network and to the internet. The core routers have modular chassis to provide high availability in terms of redundant components and the ability to "hot swap" line cards in the event of an outage.[29] Modular routers also provide the ability to expand the routers as demand for additional bandwidth increases.

The cost estimate design envisions running networking protocols, such as hot standby routing protocol, to ensure redundancy in the event of a router failure. Additional connections can be added as network bandwidth increases. The core sites would also tie to the distribution electronics using 10 Gbps links. The links to the distribution electronics can also be increased with additional 10 Gbps and 40 Gbps line cards and optics as demand grows on the network. The core networks will also have 10 Gbps to ISPs that connect the network to the internet.

The cost of the incremental core routing equipment is approximately $900,000. In addition, the network requires operations support systems, such as provisioning platforms, fault and performance management systems, remote access, and other operational support systems for operations. For a network of this scale, an operations support system costs approximately $100,000 to acquire and configure, if not provided by the network provider.

4.4.2.2 Fiber-to-the-premises access electronics

The access network electronics at the fiber distribution cabinets connect the subscribers to the network by connecting the backbone to the fiber that goes to each premises. We recommend deploying access network electronics that can support both gigabit passive optical network and Active Ethernet subscribers to provide flexibility within the fiber distribution cabinet service area. These electronics are commonly referred to as optical line terminals. We also recommend deploying modular access network electronics for reliability and the ability to add line cards as more subscribers join in the service area. Modularity also helps reduce initial capital costs.

The cost of the access network electronics for the network is estimated at approximately $600,000. These costs are based on a take-rate of 60 percent and include optical splitters at the fiber distribution cabinets aligned to that take-rate. An alternative design places the optical line terminals at the core location, with the fiber distribution cabinets containing only splitters. As the County or its partner examines more closely the specific electronics architecture, this

[29] A "hot swappable" line card can be removed and reinserted without the entire device being powered down or rebooted. The control cards in the router should maintain all configurations and push them to a replaced line card without the need for reconfirmation.

alternative may be a suitable approach, which would reduce size of the fiber distribution cabinets and provide a small cost savings.

4.4.3 Service drop installation and customer premises equipment (per-subscriber costs)

Each activated subscriber would also require a fiber drop cable installation and related customer premises equipment, which would cost on average roughly $1,750 per subscriber, or $6.3 million total—again, assuming a 60 percent take-rate.

Customer premises equipment is the subscriber's interface to the network; for gigabit passive optical networks, these electronics are referred to as an optical node terminal. For this cost estimate, we selected customer premises equipment that both terminates the fiber from the network and provides only Ethernet data services at the premises (however, there are a wide variety of additional customer premises equipment offering other data, voice, and video services). The customer premises equipment can also be provisioned with wireless capabilities to connect devices within the customer's premises. Using the assumed take-rate of 60 percent, we estimated the cost for subscriber customer premises equipment and installation to be $500 per subscriber, or approximately $1.8 million systemwide.

The drop installation cost is the biggest variable in the total cost of adding a subscriber. A short aerial drop can cost as little as $250 to install, whereas a long underground drop installation can cost upward of $5,000. Based on the prevalence of aerial and underground utilities, and sample designs, we estimate an average of approximately $1,250 per drop installation. The drop installation follows the existing utilities, so that if the existing utilities in the public right-of-way are aerial, the drop would be installed aerially and vice versa for underground. Average drop distances are extrapolated from sample designs developed for similar rural fiber-to-the-premises projects. Actual drop costs will vary for each premises.

The other per-subscriber expenses include the labor to install and configure the electronics, and the incidental materials needed to perform the installation. The numbers provided in Table 7, below, are averages and will vary depending on the type of premises and the internal wiring available at each premises.

Table 7: Per-Subscriber Cost Estimates

Construction and Electronics Required to Activate a Subscriber	Estimated Average Cost
Drop Installation and Materials	$1,2500
Subscriber Electronics (Optical Node Terminal)	$200
Electronics Installation	$200
Installation	$100
Total	*$1,750*

4.5 Annual fiber-to-the-premises technical operating costs would total approximately $1.3 million

Some of the ongoing costs of operating a fiber-to-the-premises network include fiber maintenance, fiber locating, pole attachment fees, and equipment replacement. These estimates include costs directly related to the maintenance and operations of the physical and network electronics layers of the network, but does not include costs associated with higher layer services and other fixed administrative expenses that would otherwise be incurred regardless of the technical approach to network transport.

Regular fiber maintenance includes any add, moves, and changes required of the network. For example, if a roadway is widened a pole line may be moved or undergrounded, requiring the County to relocate this fiber. We estimate that 1 percent of the total capital costs is required annually for fiber maintenance, or $460,000.

Fiber locating includes the marking of underground utilities as part of the state's Miss Utility process. Each underground utility is responsible for locating and marking their utilities in the right-of-way. We estimate the cost at $1,800 per mile of underground construction annually for utility locates, or $125,000 annually for the estimated 70 miles of underground plant.

For every pole that the fiber network attaches to, the County or its partner must pay the pole owner an attachment fee for using the pole. Pole attachment fees go toward the maintenance of the utility pole line. We estimate a pole attachment fee of $20 per pole per year or a total of $455,000 annually for approximately 650 miles of aerial plant. Pole attachment fees are estimated and would be negotiated with the pole owners as part of the pole attachment process.

We also recommend establishing an equipment replacement fund where the County or its partner puts a portion of the necessary funds to replace the network electronics. We recommend planning on replacing the network electronics every seven years, requiring the County or its partner to place approximately $220,000 into the equipment fund annually.

Table 8 summarizes the fiber-to-the-premises technical operating costs.

Table 8: Estimated Annual Fiber-to-the-Premises Technical Operating Costs

Description	Annual Cost
Fiber Maintenance	$460,000
Fiber Locating	$125,000
Pole Attachment Fees	$455,000
Equipment Replacement Fund	$220,000
Total	*$1,260,000*

5 A Fixed-Wireless Solution to Partially Fill the Category 1 Broadband Gaps Would Have Lower Capital Costs Than Fiber but High Ongoing Operating Costs

As an alternative to deploying fiber-to-the-premises, the County could consider a fixed-wireless network to deliver broadband services to unserved members of the community. To that end, CTC's engineers developed a fixed wireless network model to assess the viability of serving Somerset County's approximately 6,000 unserved Category 1 addresses using existing towers within the County.

Our analysis found that, although it would have clear technical limitations relative to a fiber optic network, a fixed wireless network could be used to serve a portion of the County's Category 1 unserved homes and businesses. Equipment mounted on government-owned towers could enable coverage of approximately 40 percent of the Category 1 unserved premises (while also reducing the cost of constructing and operating the network). Mounting equipment on existing commercial towers, as well, would enable the network to serve up to approximately 82 percent of the Category 1 unserved premises (but would require the ongoing payment of lease fees for space on the commercial towers).

5.1 Fixed wireless networks can deliver broadband speeds

As opposed to an underground or aerial cable, wireless broadband is provided from access point antennas on towers, monopoles, or rooftops. The customer antenna may be on the home or business or on a mast on the customer premises (Figure 19).

Figure 19: Example Fixed Wireless Network with Various Customer Antenna Configurations

Broadband speeds in compliance with the FCC's definition (i.e., 25 Mbps download, 3 Mbps upload) are more readily available from fixed wireless networks than in the past, owing to the

recent introduction of the Citizens Broadband Radio Service (CBRS) spectrum and new wireless technologies. While wireless ISPs (WISP) typically are not able to offer connection speeds on a market-wide basis comparable to cable or fiber networks built to each premises, a fixed wireless connection may be a desirable solution if cable or fiber is not cost-effective. This is especially true in low-density rural areas with few homes and high costs of building wired networks.

The fixed wireless networks in our model use the following spectrum:

- TV White Space (TVWS) 500 MHz
- Unlicensed 900 MHz, 2.4 GHz, 5 GHz
- Citizens Broadband Radio Service (CBRS) 3.5 GHz

Of these bands, only CBRS and 5 GHz technology have channel widths capable of consistently delivering 25 Mbps downstream and 3 Mbps upstream. For unlicensed spectrum, there exists the potential for others to be operating on the same, adjacent, or other interfering frequencies. Precautionary measures should be taken to mitigate different types of interference; such efforts include checking for a clean frequency in the area of interest and appropriate antenna and antenna pattern choice.

TVWS delivers service over unused television frequencies (known as white space). TVWS bands have much better non-line-of-sight transmission qualities than the other bands; however, due to its narrower bandwidth, TVWS is not capable of delivering 25 Mbps down, and therefore should only be considered in cases where other connectivity is not available or feasible. Also, because white space technology is still in an early phase of development, compatible equipment is far more expensive than other off-the-shelf wireless equipment. Finally, because Somerset County has a metropolitan area and many existing broadcast television channels, the potential TVWS spectrum is significantly more limited than in more remote areas.

Most fixed wireless network solutions require the antenna at the subscriber location to be in or near the line of sight of the base station antenna. This can be especially challenging in highly wooded regions. It is also a problem in areas with dense vegetation or multiple tall buildings. WISPs often need to lease space at or near the tops of radio towers; even then, some customers may be unreachable without the use of additional repeaters. And because the signal is being sent through the air, climate conditions like rain and fog can impact the quality of service. In our model, we assumed that the top of any existing towers is already utilized, and that any new equipment would be placed at 80 percent of the current tower height.

In addition, there is a tradeoff in these bands between capacity and the ability to penetrate obstructions such as foliage and terrain. The higher frequencies have wider channels and

therefore the capability to provide the highest capacity. However, the highest frequencies are those most easily blocked by obstructions. Wireless equipment vendors offer a variety of point-to-multipoint and point-to-point solutions. A medium-sized business location would be more likely to obtain a point-to-point solution with dedicated bandwidth from the service provider to obtain the needed bandwidth and quality. Small businesses and homes would obtain a point-to-multipoint solution, which is more affordable to implement. Point-to-point networks may have limited network capacity, particularly in the upstream, making the service inadequate for applications that require high-bandwidth connections. The models in this report assume point-to-multipoint equipment, which is typical for a residential or small business connection.

5.2 Fixed wireless network deployment costs depend on a range of factors

The following factors determine the costs associated with a fixed wireless network:

- **Wireless equipment:** Different wireless equipment has different aggregate bandwidth capacity and use a range of different spectrum bands, each with its own unique transmission capabilities.

- **Backhaul connection**: Although the bottleneck tends to be in the last-mile connection, if a WISP cannot get an adequate connection back to the internet from its tower, equipment upgrades will not be able to increase available speeds beyond a certain point.

- **Future capacity and lifespan of investment:** Wireless equipment generally requires replacement every five to 10 years, both because exposure to the elements causes deterioration, and because the technology continues to advance at a rapid pace, making decade-old equipment mostly obsolete. The cost of deploying a wireless network is generally much lower than deploying a wireline network, but the wireless network will require more regular investment.

- **Availability of unobstructed line of sight:** Most wireless networking equipment requires a clear, or nearly clear, line of sight between antennas for optimum performance. WISPs often lease space near the tops of radio towers, to cover the maximum number of premises with each base station.

- **Use of public safety infrastructure**: Public safety infrastructure must be built to public safety grade guidelines and is therefore more costly that commercial infrastructure. "'Public Safety Grade' is a conceptual term that refers to the expectation of emergency response providers and practitioners that their equipment and systems will remain operational during and immediately following a major natural or manmade disaster on

a local, regional, and nationwide basis. [The term] is used to refer to network hardening or network sustainability."[30]

5.3 Choosing the best-fit spectrum for a given tower location can improve coverage and reduce deployment costs

Our study examined three of the most suitable candidate frequency bands (and the associated technologies) for fixed wireless services: CBRS, unlicensed 5 GHz, and TVWS.

Because each band needs its own set of equipment, we sought to identify the most effective bands for each tower location with the understanding that if one or more bands can be eliminated from specific sites, then the overall cost of deployment and operations will be reduced.

The CBRS band is predicted to connect the most addresses—primarily due to its spectrum properties, and the fact that FCC licensing rules allow CBRS antennas to be mounted higher than TVWS antennas. It also has the greatest broadcast power of the three technologies. In addition, CBRS is the only band that can be licensed.

Of the frequencies examined, only CBRS and unlicensed technologies have channel widths (and therefore bandwidth) capable of delivering 25 Mbps down and 3 Mbps up. Because TVWS is not capable of delivering 25 Mbps down, we used that technology only in places where there is no 5 GHz or CBRS connectivity.

5.4 Cost-effective fixed wireless service depends on precise tower selection

To examine the potential for government and other towers to provide service to the County's Category 1 unserved addresses, we analyzed multiple commercial and government databases and identified approximately 43 existing tower locations in Somerset County. Of these towers, we selected 30 that could potentially provide fixed wireless service to the unserved areas (based on the towers' locations, heights, and ownership).

CTC's engineers assessed the potential coverage that would be enabled by equipment mounted on each of the selected tower sites; using CloudRF software, we estimated how many of the Category 1 unserved address would be within the predicted coverage area of each of the three fixed wireless frequency band options (CBRS, 5 GHz, and TVWS). We based our analysis on the following assumptions:

[30] Definition of public safety grade from the National Public Safety Communications Council (NPSTC) report *Defining Public Safety Grade Systems and Facilities* which is under consideration to contribute to a future public safety grade standard.

- Antennas are placed at 80 percent of the tower height for 5 GHz and CBRS, and at the maximum allowable height of 30 meters for TVWS
- Broadcast power is at the FCC limit for all three bands
- Channel bandwidth is 20 MHz for 5 GHz, 10 MHz for CBRS, and 6 MHz for TVWS
- Subscriber equipment antennas would be placed at 4.57 meters (15 feet) above ground level
- Ground elevation and clutter resolution is 30 meters

5.5 Using existing towers, a fixed wireless network could cover about 82 percent of unserved Category 1 residents

Of the 30 optimal towers we identified, three are government-owned sites and the remainder are commercial sites (Figure 20).[31]

[31] We are making no assumptions regarding actual ability to negotiate access to towers or whether there is suitable space on the specific towers picked for the cost estimate. There generally are alternate towers available should a particular tower not be suitable. The cost estimate assumes such flexibility in swapping out towers and should not be considered part of a detailed engineering study.

Figure 20: Existing Towers in Relation to Category 1 Unserved Areas

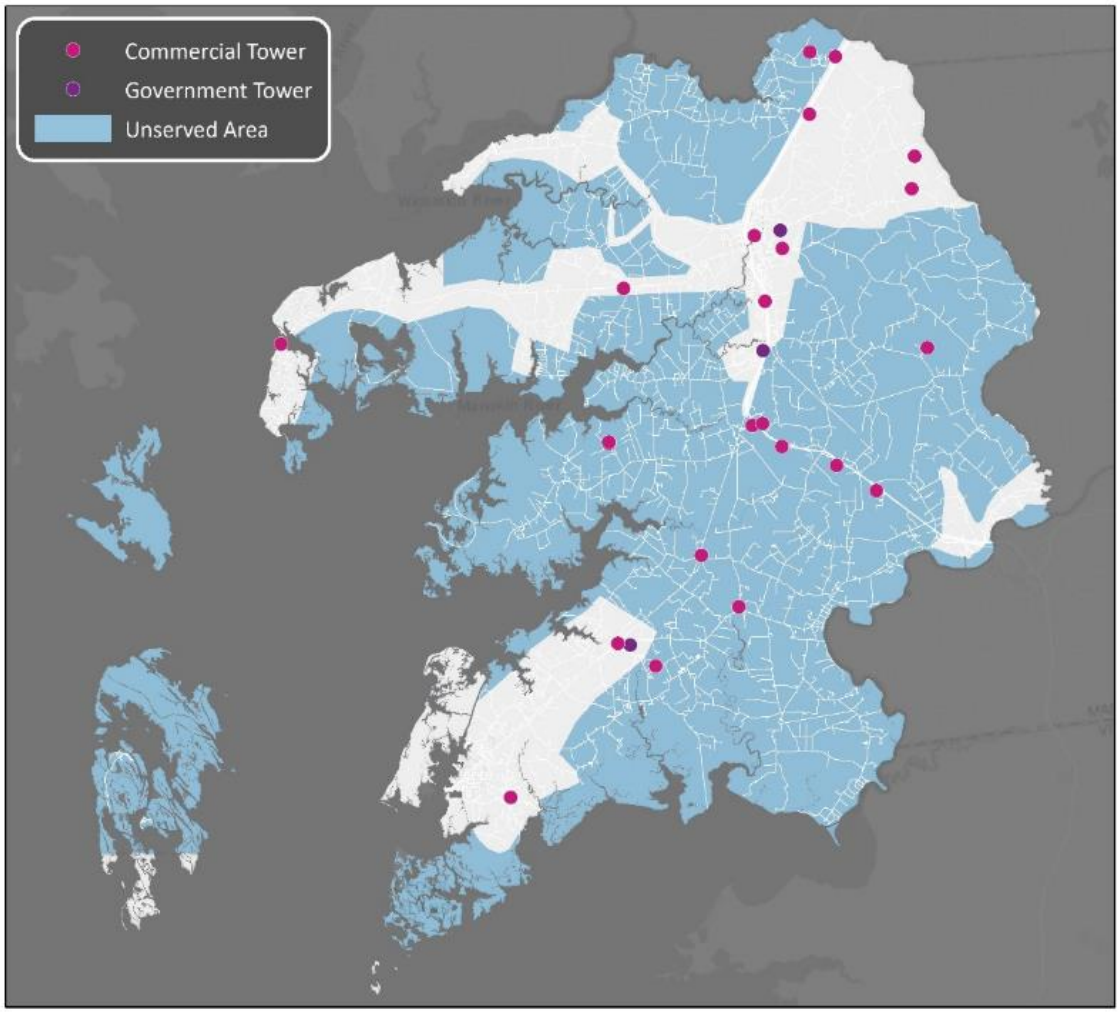


Table 9 (below) shows our cost breakdown for using existing towers for a Category 1 fixed wireless solution. Our assumptions are as follows:

- All served addresses will require subscriber equipment installed
- Towers will be configured with three sectors for each frequency used
- All selected towers will have CBRS deployed
- 25 percent of the towers will also have 5 GHz deployed
- 25 percent of the towers will also have TVWS deployed
- Towers will be connected to backhaul using microwave links; 10 percent of the sites will require an additional hop
- Engineering and design includes propagation studies, RF path analysis for point-to-point connections, structural analysis, construction plans, and permits

- Site acquisition costs include the costs of the preliminary equipment dimensioning, power needs, shelter requirements, RF suitability, escorts, and lease negotiations
- There is room within the shelter at the tower location for additional equipment
- To support a fixed wireless network, it is necessary to set up a core network to manage functions such as authentication, billing, security, and connection to the internet; CTC estimates $200,000 for equipment and setup of a core

Table 9: Estimated Capital Cost for Fixed Wireless Network Using Existing Towers

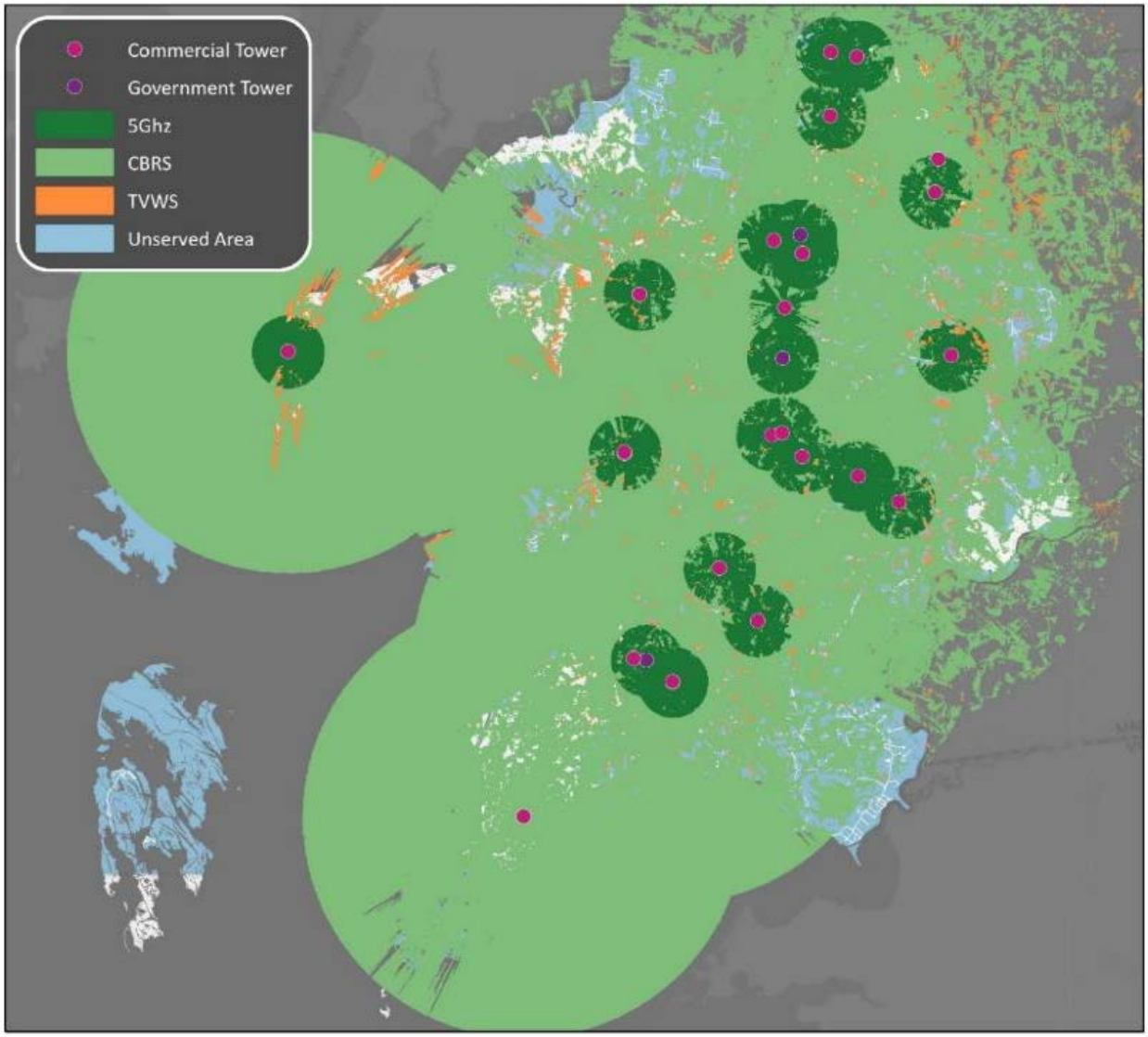
Item	Cost
Core Equipment	$200,000
Access Point Equipment	$510,000
Backhaul	$450,000
Installation, Engineering and Design	$2,100,000
Site Acquisition	$1,200,000
Estimated Total Distribution Network Cost	*$4,460,000*
Estimated Capital Cost (35% Take-Rate)	*$7,500,000*
Estimated Capital Cost (60% Take-Rate)	*$9,800,000*
Estimated Incremental Cost per Subscriber	*$2,700*

The costs outlined above are capital costs only and do not include operational costs—which include maintenance and tower lease expenses. Typical lease costs are $5,000 per month or $60,000 per year per tower.

Figure 21 shows the coverage areas for a fixed wireless solution using antennas mounted on the selected towers.[32] The dots illustrate the tower locations, while the green and orange areas illustrate coverage with three types of wireless technologies. TVWS access points are included in the design as an alternative for serving addresses with exceptionally high obstruction due to foliage or terrain. Blue shading indicates the remaining Category 1 unserved areas.

[32] CTC engineers conducted a high-level RF overage analysis (for planning purposes only) using CloudRF software.

Figure 21: Category 1 Fixed Wireless Coverage Using Existing Towers



Almost all Category 1 addresses that would have 5 GHz coverage would also have CBRS coverage. Although no more addresses are reached by adding 5 GHz than by simply deploying CBRS, there may be some cases where the CBRS capacity is at a maximum and 5 GHz could be deployed to offload some of the traffic.

Because CBRS covers the most addresses, and delivers 25 Mbps, we recommend it be deployed at all the towers; 5 GHz can be used selectively to add capacity at sites, and TVWS can be used selectively to pick up additional addresses at select locations.[33]

Our propagation analysis predicts approximately 1,100 addresses, or 18 percent of the Category 1 unserved premises, would not be covered by any frequency band from antennas mounted on the selected towers. Table 10 breaks down the results.

Table 10: Summary of Category 1 Coverage by Fixed Wireless Solution

Addresses	Estimated Number
Total addresses in Category 1 unserved area	6,000
Addresses served by CBRS band	3,600
Additional addresses served by TVWS band	240
Addresses served by one or more band	4,900
Addresses not served by any of the three bands	1,100
Percent of addresses served by one or more of the three bands	82%

5.6 Constructing new towers would enable additional service at a higher cost per premises

New towers could be constructed to cover some of the remaining addresses. (Many of the addresses are too far apart to feasibly build enough new towers to connect them all.) CTC determined optimal locations for new towers based on their ability to reach the most addresses, resulting in a design featuring nine additional towers. We found that on average each new tower would cover up to 84 additional addresses. This illustrates the difficulty of adding new towers that will cover a substantial number of addresses.

Figure 22 shows the resulting overall coverage after adding the nine new towers to the design. Approximately 750 additional addresses would be served, leaving about 300 unserved addresses.

[33] Determining which band would be deployed at each tower site is beyond the scope of this analysis.

Figure 22: Total Coverage Using Existing and New Towers

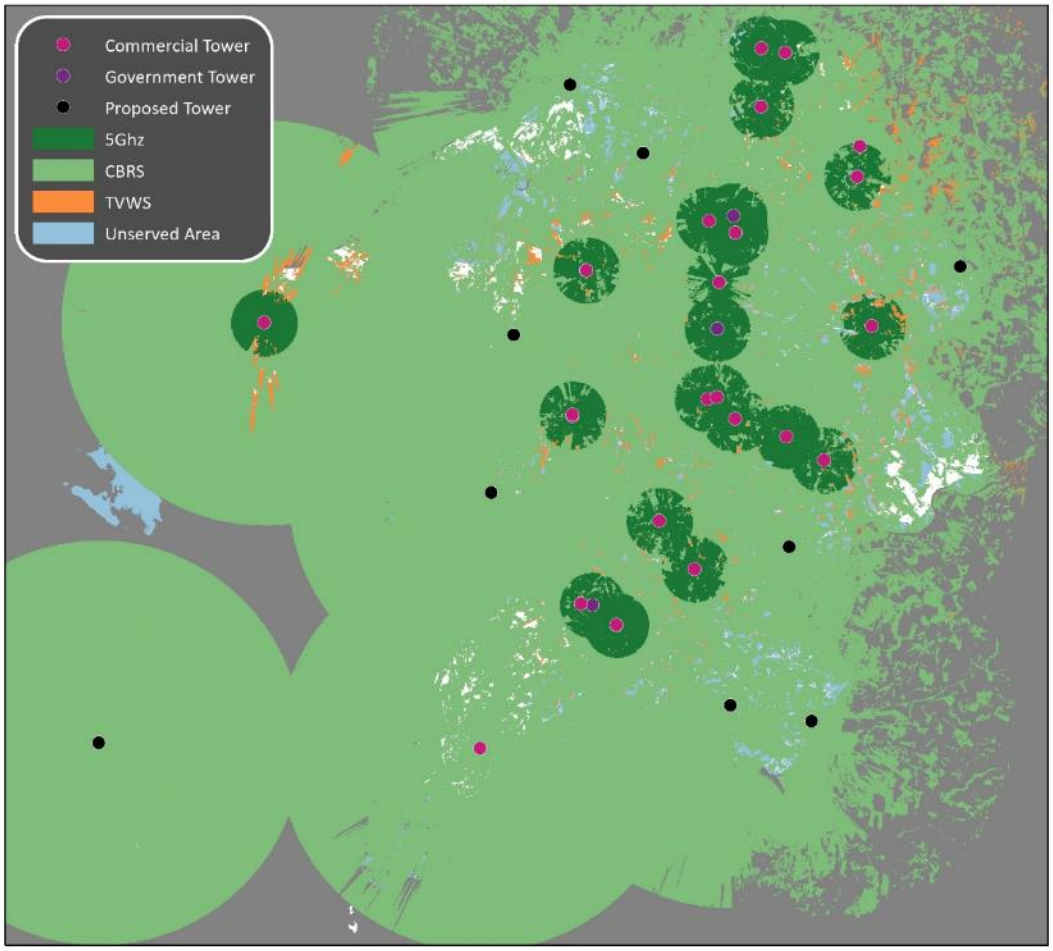


Table 11 shows the costs for the additional nine new towers. The assumptions are the same as for the existing tower sites.

Table 11: Estimated Capital Cost for Fixed Wireless Network Using New Towers

Item	Cost
Core Equipment and Towers	$1,350,000
Access Point Equipment	$155,000
Backhaul	$135,000
Installation, Engineering and Design	$630,000
Site Acquisition	$360,000
Estimated Total Distribution Network Cost	*$2,630,000*
Estimated Capital Cost (35% Take-Rate)	*$3,100,000*
Estimated Capital Cost (60% Take-Rate)	*$3,400,000*
Estimated Incremental Cost per Subscriber	*$5,300*

6 Fiber-to-the-Premises Is a Clearly Preferable Technical Solution with Significantly Lower Operating Costs as Compared to a Fixed Wireless Solution for Serving Category 1 Areas

Overall, fiber-to-the-premises represents a better broadband solution than fixed wireless for most unserved areas of the County. In general, the total cost of ownership for fiber-to-the-premises is lower than for wireless networks over extended periods of time.[34] A comparison of the two technologies must also recognize that fiber and fixed wireless each have technical advantages and challenges.

Fiber optics, once constructed, is the highest-speed and most scalable technology. Current off-the-shelf technologies enable fiber-to-the-premises networks to provide capacity in excess of 1 Gbps to each subscriber, with new electronics making it possible to go to 10 Gbps or beyond in the coming years. Moreover, the fiber-to-the-premises network is not subject to interference from other signals or subject to line-of sight limitations.

Over time, maintenance and repair costs of fiber optic cables are low—approximately 1 percent of construction costs annually. Equipment replacement occurs every seven years, but new equipment costs are only a percentage of the capital cost of a fiber-to-the-premises network.

As discussed in Section 3, however, construction costs can be high and can vary based on the availability of space on utility poles and in the right-of-way. Construction can be delayed by utility pole owners, other utilities on the poles, and by the requirement for permitting in the right-of-way (including on bridges, water crossings, and highway crossings).

By comparison, fixed wireless technology provides an aggregate capacity between 100 and 250 Mbps. Using unlicensed and CBRS spectrum and innovations like higher-order multiple input, multiple output (MIMO) antennas and spatial multiplexing, these capacities could increase to as fast as 750 Mbps.

It is important to note, however, that this is the aggregate capacity out of a single antenna or antenna array; in a point-to-multipoint architecture, this capacity will be shared among all users connected to a single base station. Even so, in most of the unserved environments in the County, download speeds in the tens or even low hundreds of Mbps per user may be possible. Additionally, wireless eliminates the need for new cable construction, significantly reducing the time to build and the complexity of construction.

Given the limitations of line of sight and of the available spectrum, however, the wireless solution is not as scalable as a wireline solution. The spectrum available for fixed wireless broadband is

[34] Total cost of ownership takes into account capital costs and maintenance costs—including tower lease fees and regular equipment replacement for wireless networks.

limited and provides much lower bandwidth than what is available in a fiber-to-the-premises network. Homes and businesses that have substantial tree cover and terrain will get poorer performance than others.

In addition, leasing space on a tower is costly. Leasing space for three sectors of antennas (as needed on each tower site) costs approximately $60,000 per year. This is a critical consideration, because the fixed wireless model uses 30 existing towers with an average of about 160 serviceable passings (potential customers) per tower, so the cost for tower leases alone exceeds $350 per year per passing.

Upgrading a wireless network requires replacement of the radios at the antenna site and at the user premises. Electronics may need to be replaced at five- to 10-year intervals due both to technological obsolescence and wear and tear—and unlike a fiber network, the electronics comprise almost all of the capital cost of the network, thus significantly increasing the ongoing cost.

7 Federal and State Grants and Loans Could Offer Opportunities to Address the Needs of Unserved Somerset County

Federal and state funding sources represent an important element of large-scale broadband deployments for unserved areas where no broadband is currently available. While these programs tend to have restrictions that affect their potential breadth of impact, our analysis is that the programs described below have the potential to assist the County's efforts to greatly reduce the number of unserved homes and businesses.

That said, we note that (as described elsewhere in this report), the wireless ISP Bloosurf has received funding from the federal Broadband Initiatives Program (BIP) and CAF II program, which effectively protects it from alternative provider applications for ReConnect funds in the previously funded areas—which cover the entire County. In the event its protected status expires or is challenged, however, these areas may open back up for new applications for federal support.

This obstacle does not apply to the Maryland grant programs, and does not present itself equally for all future federal grant programs. For example, the Rural Digital Opportunity Fund does not exclude all of the areas excluded under the ReConnect rules; while the CAF II areas would be excluded, the original BIP areas would be available. And, in the event Bloosurf's protected status expires or is challenged, the protected areas may open back up for new applications for federal support.

7.1 USDA's ReConnect program represents a unique rural funding opportunity

The ReConnect program represents the most significant congressional appropriation of broadband funding since the Recovery Act in 2009. The initial $550 million allocated for 2020 was expanded by an additional $100 million in the CARES Act,[35] which Congress passed in response to the coronavirus crisis); the program will likely see annual future appropriations. The program awards loans, grants, or a combination of the two for last-mile connections in rural areas. It is overseen by the Rural Utilities Service (RUS). We expect continued appropriations for ReConnect and for other RUS broadband loan and grant programs, as these programs enjoy strong bipartisan support.[36]

7.1.1 Bloosurf's previous awards create barriers for ReConnect funding in the County

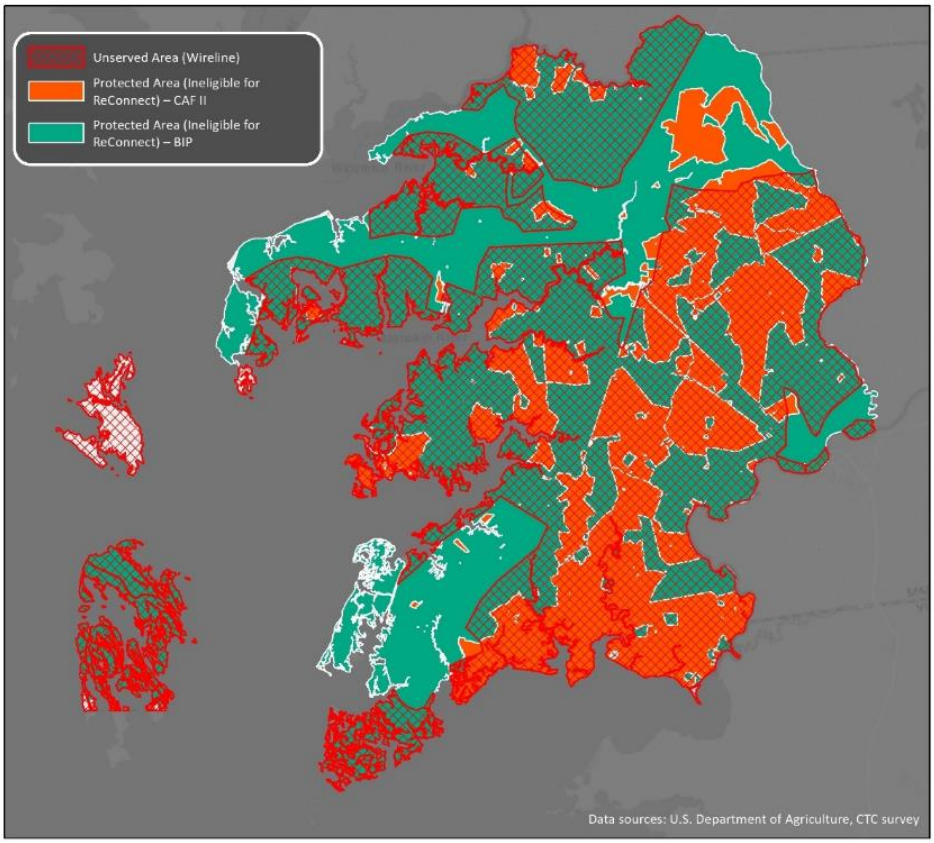
Congress created a significant barrier to ReConnect funding when it wrote the legislation: It made ineligible any areas for which any entity has received a previous broadband award under

[35] "Coronavirus Aid, Relief, and Economic Security Act," U.S. Congress, https://www.congress.gov/116/bills/hr748/BILLS-116hr748enr.pdf (accessed March 31, 2020).
[36] "USDA to Make $550 Million in Funding Available in 2020 to Deploy High-Speed Broadband Internet Infrastructure in Rural America," U.S. Department of Agriculture, News Release, Dec. 12, 2019, https://www.usda.gov/media/press-releases/2019/12/12/usda-make-550-million-funding-available-2020-deploy-high-speed (accessed December 13, 2019).

certain programs. This barrier unfortunately complicates the County's path forward and its options for accessing federal funds.

Bloosurf was awarded $3.2 million in USDA Broadband Initiatives Program (BIP) grant and loan funding in 2010 for service across Somerset and other counties,[37] and in 2018 won the Connect America Fund II (CAF II) auction for additional portions of the County;[38] those areas (shaded in green or orange, respectively, in Figure 23) are technically ineligible for ReConnect funding. While there is some chance that the protected status of the areas in green (where Bloosurf received funding from the BIP program in 2011) will expire in 2021, this is not certain. Further, the protected status of the areas in orange (in which Bloosurf received CAF II funds) will continue for an undetermined time that may be as long as, or longer than, a decade.[39]

Figure 23: Bloosurf's Grant-Funded Service Area as Compared to Wireline-Unserved Areas



[37] "Advancing Broadband," USDA BIP Awards Report, January 2011, https://www.rd.usda.gov/files/reports/RBBreportV5ForWeb.pdf (accessed December 2019).
[38] FCC, https://ecfsapi.fcc.gov/file/10102081816708/Bloosurf%2C%20LLC%20PETITION%20FOR%20ELIGIBLE%20TELECOMMUNICATIONS%20CARRIER%20DESIGNATION%20WC%20Docket%2009-197.pdf (accessed March 2020).
[39] See Section 1.3.1 for more details regarding how the County might challenge Bloosurf's protected status in a ReConnect application.

Given that Bloosurf is already purporting to serve the market and has protected status[40] for ReConnect, the County is in the position that engaging with Bloosurf is a necessary first step for pursuing future ReConnect funding. The County can either seek to work with Bloosurf to improve the company's services and fill in service gaps—or the County can challenge Bloosurf's coverage claims.

If the County chooses to adopt a robust approach to challenging Bloosurf's claimed service for purposes of ReConnect, it would need to do so with a willing partner—because ReConnect and other federal grant programs currently lack a delineated process for challenging a previous awardee's service claims. Such documentation would therefore need to be incorporated into a formal ReConnect grant application—which would become a record of protest with the appropriate federal entities. In other words, working with a willing wireline partner, the County would need to document the lack of Bloosurf service in the County (for the protest, but also to identify the gaps) and file a new ReConnect application. The application would likely be a marker for future, more flexible grant opportunities—because the County's partner would have little guarantee of being awarded a grant (and, thus, the burden would be largely on the County to develop the documentation and complete the work required to submit the application).

7.1.2 ReConnect program details and application requirements

The ReConnect program currently comprises three separate funding categories: 100 percent grants (covering up to 75 percent of eligible project costs, with a 25 percent match), 50 percent grants with a 50 percent loan or other form of match, and 100 percent loans. All categories require that funds go to rural areas where 90 percent or more of the households lack access to broadband (defined as speeds of at least 10 Mbps download and 1 Mbps upload).

Applicants must propose networks capable of providing access to every premises in the PFSA at minimum speeds of 25 Mbps downstream and 3 Mbps upstream.

Matching funds are another point of distinction. Applicants for 100 percent grant awards will need to provide matching funds equivalent to 25 percent of the project's cost—and that matching contribution must be expended first, followed by grant funds. For 50 percent grants with a 50 percent loan or other form of match, applicants can propose a cash alternative to the loan at the time of application. (For an awarded project in this scenario, all cash proposed must be expended first, followed by loan funds and then by grant funds.)

Generally, we anticipate that USDA will prioritize applications from experienced internet service providers and public-private partnerships, so it will be important for the County to build a public-

[40] "Protected" in this context (i.e., under USDA Rural Utilities Service rules) means that Bloosurf is the only entity allowed to apply for ReConnect funds in areas originally awarded to it under previous federal broadband funding programs, such as BIP and CAF II.

private partnership strategy. RUS will consider public networks that lack extensive experience to be startups and may disfavor their applications. Therefore, the County should consider partnering with an experienced public or private ISP to compete for these funds. And any experienced ISP, whether public or private, will require the strong collaboration and support of its local (and state) government to present a compelling case for funding.

We anticipate RUS will make grant/loan combinations in the $3 million to $10 million range. This is quite a bit more than RUS's Community Connect grants—and, because the program's funding is larger in total dollars, we anticipate ReConnect will make more awards. Further, ReConnect does not have the low-income requirements of Community Connect, making it more flexible.

Applications to this program will require a detailed business plan and pro forma. In addition, it will be critical to provide documentary evidence of the fact that the PFSA is unserved under the statutory definition (i.e., no 10/1 service available). Importantly, Form 477 data are insufficient to prove that an area is unserved for purposes of being eligible for ReConnect funding. Under the ReConnect rules, an applicant is required to demonstrate that its PSFA is indeed unserved—and the USDA will conduct field verification of projects before approving them for funding.

As such, business planning and engineering will be essential. The PFSA must be defined with a count of the number of rural premises to be connected, including homes, farms, schools, libraries, healthcare facilities, and businesses (which are important because they confer additional points in the application). The engineering methodology used to demonstrate that the PFSA lacks service must also be documented.

Furthermore, applicants must verify that the PFSA contains no Connect America Fund II award census blocks and that the PFSA does not overlap an area of an existing RUS grantee or borrower.

RUS will grant application review points based on many factors. The rurality of the PFSA can earn almost 25 points alone. RUS will also award points to applications proposing to build networks capable of at least 100/100 Mbps. Additional points can be scored if the proposed area includes a healthcare center, education facility, or critical community facility. And points will be awarded for projects in states with an updated broadband plan in the past five years.

7.2 USDA's Community Connect program represents another, more modest opportunity

Community Connect is another program to which the County could apply with a partner. The USDA administers this modestly sized grant program for local and tribal governments; it targets broadband deployment to unserved (defined as speeds less than 10 Mbps download and 1 Mbps upload), low-income rural communities with fewer than 20,000 residents in a contiguous PFSA (*and* not adjacent to cities with more than 50,000 residents). To prepare the most competitive

Community Connect grant application possible, we would recommend the County target the lowest-income portions of its unserved areas.

Grantees must ultimately offer service at the broadband grant speed (defined as 25 Mbps download plus 3 Mbps upload) to *all* households and community institutions in the PFSA, with free service for at least two years to a community center.

The application process is rigorous and competitive (i.e., only about 10 percent of applicants receive an award) and once awarded, program requirements can be demanding (e.g., requiring last-mile service be available for all households in the service area). The program has been funded consistently since it was introduced in 2002 and represents an important opportunity for qualifying communities.

Eligible applicants include local or state units of government, incorporated organizations, Indian tribes or tribal organizations, cooperatives, private corporations, and limited-liability companies organized on a for-profit or not-for-profit basis. Individuals or partnerships are not eligible. Any public or private applicant must have the legal capacity and authority to own and operate the proposed broadband facilities, to enter into contracts, and to otherwise comply with applicable federal statutes and regulations. Thus, awards cannot be granted to a local government entity that does not want to own or operate the broadband service.

Once awarded, projects must offer last-mile service at the broadband grant speeds (25 Mbps download and 3 Mbps upload) to *all* businesses, residents, and community facilities in the PFSA, with free service provided to all critical facilities,[41] and at least one community center (with weekend hours and two to 10 public computer access points) for at least two years from the grant award. Grants can be used to offset the cost of providing such service and to lease spectrum, towers, and buildings as part of the project design.[42] The lesser of 10 percent of the grant or $150,000 can be used to construct, acquire, or expand an existing community center.[43]

7.3 Department of Commerce economic development grants assist distressed communities

The Department of Commerce's Economic Development Administration (EDA) oversees the Economic Development Assistance program, which has provided economic assistance to distressed communities for many years. Public broadband projects in economically distressed

[41] Critical community facilities include public schools, public libraries, public medical clinics, public hospitals, community colleges, public universities, law enforcement, and fire and ambulance stations.
[42] Leasing costs can only be covered for three years.
[43] Note that additional funds can be used to provide the computer access points and their connection to the network. Applicants may use their own resources to cover costs exceeding this limit. The program historically required provision of at least 10 computer access points in a public community center; however, now requires only two such access points—with a *maximum* of 10 computers.

communities are eligible for funding under the Public Works and Economic Adjustment Assistance (PWEAA) programs.

The EDA program coordinates with a $587 million grant program[44] also under the oversight of the Department of Commerce. This opportunity attempts to remedy disaster-stricken areas of the economic burdens that such disasters impose. Disasters are defined per the President's declaration. If the County were to qualify, this opportunity would provide a similar application process to the broader, non-disaster Economic Development Assistance grants.

EDA's materials on Public Works funding explicitly mention broadband,[45] but it does not appear that broadband funding has been a significant part of the portfolio. Over a period of a decade (2007–2017), the EDA's annual reports included only eight references to relevant projects.[46] While broadband funding to date through the EDA appears to be modest, both construction and technical assistance are clearly eligible. Moreover, applicants can apply existing federal funds toward the cost-share, which allows them to leverage available resources. Given this, we recommend the County consider this opportunity.

The PWEAA Notice of Funding Opportunity (NOFO) emphasizes the importance of consulting with the appropriate regional EDA contacts.[47] Regional staff is available to review project proposals, assess proposed cost shares, and preview all application materials. Though optional, we believe that such consultation would ultimately be beneficial if the County were to consider applying.[48]

7.4 The FCC's Rural Digital Opportunity Fund is an emerging opportunity

The Rural Digital Opportunity Fund represents the latest iteration of the FCC's Universal Service Fund's (USF) high cost program. Since 1996, the FCC has used the high cost program to subsidize telecommunications services in rural and remote areas, where the return on investment would otherwise be too low to prompt companies to invest in telecommunications infrastructure.

While the program initially provided subsidized telephone service on an ongoing basis, in 2011 the FCC began reorganizing the high cost program, creating the Connect America Fund (CAF) with the goal of accelerating the buildout of broadband-capable infrastructure to unserved areas. Instead of providing an ongoing subsidy in exchange for serving eligible areas, the CAF program provides an annual subsidy for a fixed period of time to help cover the initial cost of building out broadband-capable infrastructure in rural and remote areas.

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[44] See https://www.grants.gov/view-opportunity.html?oppId=302953 (accessed November 2019).
[45] "Broadband Funding Guide," U.S. Department of Commerce EDA, December 12, 2018, https://broadbandusa.ntia.doc.gov/sites/default/files/funding_eda_01_0.pdf (accessed December 2019).
[46] EDA annual reports available online at: https://www.eda.gov/annual-reports/ (accessed November 2019).
[47] "Notice of Funding Opportunity – FY 2020 EDA Public Works and Economic Adjustment Assistance Programs," https://www.grants.gov/web/grants/view-opportunity.html?oppId=321695 (accessed December 2019).
[48] EDA regional contacts available online at: https://www.eda.gov/contact/ (accessed November 2019).

The CAF program uses a cost model to estimate the appropriate subsidy for each eligible census block, and first made these funds available to incumbent price-cap carriers in exchange for a commitment to serve every household and business with service with speeds of at least 10 Mbps download and 1 Mbps upload. For those areas where the price-cap carrier declined CAF support, the FCC made funds available to any qualifying service provider through a multi-round, reverse, descending clock auction, with added weight given to those bids that committed to offering faster and lower latency broadband services.

The CAF Phase II auction took place in 2018 and was widely viewed as a success. The auction awarded just under $1.5 billion in support in exchange for a commitment to serve 713,176 homes and small businesses in 45 states, a total of 73 percent of eligible areas. Thanks to the weighting system that favored service providers willing to offer higher tiers of service, 99.75 percent of locations will have speeds of at least 25/3 Mbps, 53 percent will have at least 100/20 Mbps, and 19 percent will have 1 Gbps/500 Mbps. The 103 winning bidders will receive an annual sum each year for 10 years, provided they meet buildout requirements. Winners must offer service to 40 percent of homes and businesses by year 3 and continue to increase by 20 percent each year until year 6 when 100 percent of eligible homes and businesses must be served.[49] The total amount of support awarded was 70 percent less than the Connect America Cost Model (CAM) estimated would be needed.[50] Although the reverse auction process was complex, it secured higher-quality service for consumers at a significantly lower cost to the Universal Service Fund than previous methods of allocating subsidies.

The Rural Digital Opportunity Fund builds on the success of the CAF Phase II auction, with a proposal to allocate an additional $20.4 billion over the next decade in order to support the buildout of high-speed broadband networks in unserved areas of the country. The FCC announced that the $20.4 billion will be distributed in two phases. The first phase, which relies on highly misleading Form 477 self-reported coverage areas, will consist of up to $16 billion, while the remaining Phase I budget, along with $4.4 billion, will be awarded for Phase II of the auction. The Phase I auction is scheduled to begin on October 22, 2020, and "will target over six million homes and businesses in census blocks that are entirely unserved by voice and broadband with download speeds of at least 25 Mbps."[51]

The FCC believes that by the time Phase II starts, it will be able to rely on more accurate maps of unserved areas, which will include areas that the FCC currently denote as partially served as well

[49] "Connect America Fund Auction to Expand Broadband to Over 700,000 Rural Homes and Businesses," *FCC*, August 28, 2018, https://docs.fcc.gov/public/attachments/DOC-353840A1.pdf (accessed November 2019).
[50] Joseph Gillan, "Lessons from the CAF II Auction and the Implications for Rural Broadband Deployment and the IP Transition," *National Regulatory Research Institute,* https://pubs.naruc.org/pub/9F958420-E885-F843-1AEC-4D290DC9A28E (accessed November 2019).
[51] "Fact Sheet – Rural Digital Opportunity Fund Information." https://www.fcc.gov/auction/904/factsheet, accessed 4/1/2020

as locations not funded in Phase I. The FCC has not so far commented on what will happen to areas currently marked as served that could be found to be unserved if more accurate maps are used.

As in the CAF Phase II auction, the FCC will use the CAM to establish the maximum subsidy available for each eligible area, and bidders compete for available subsidies with preference given to those bidders willing to commit to offering faster speeds and lower latency service. The bidder willing to commit to providing an area with the best quality service at the lowest subsidy amount wins the available support.[52]

The biggest change the FCC proposes is raising the service availability threshold to 25/3 Mbps, making even those areas where a provider received CAF funding for 10/1 Mbps service potentially eligible for support. The Commission is also considering a number of other minor adjustments, such as changing the minimum bidding areas from census blocks to census block tracts or counties, as well as adding a subscribership benchmark which would make some percentage of funds contingent on a winning bidder gaining sufficient market share.[53]

The Rural Digital Opportunity Fund became a reality thanks to the broad, bipartisan consensus in Washington that rural areas need better broadband. We note, too, that a Rural Digital Opportunity Fund application would not exclude applying to other federal and state programs. The County could have a partner applying for funding from multiple sources.

7.5 State of Maryland broadband grants are designed to address unserved areas and provide matching for federal funding applications

The Governor's Office of Rural Broadband focuses on efforts to extend broadband service to unserved rural parts of the state "through partnerships with local jurisdictions and the private sector."[54] The Office currently oversees both a small pilot program and a larger rural broadband grant initiative that explicitly seeks to complement federal and local funding sources—an approach that would enable the County or a partner, if it receives one of those larger grant awards, to use the state's funding as a match for a federal ReConnect grant application. For both opportunities, the unserved areas we documented in Section 2 would be eligible for funding—provided the County can successfully work with Bloosurf to expand its service—or challenge Bloosurf's claimed coverage (see Section 1.3).

[52] Federal Communication Commission, "Rural Digital Opportunity Fund, Connect America Fund," 84 FR 43543, August 21, 2019, https://www.federalregister.gov/documents/2019/08/21/2019-17783/rural-digital-opportunity-fund-connect-america-fund (accessed November 2019).
[53] Federal Communication Commission, "Rural Digital Opportunity Fund, Connect America Fund."
[54] "Maryland Rural Broadband," Maryland Department of Housing and Community Development, https://dhcd.maryland.gov/RuralBroadband/Pages/default.aspx (accessed December 2019).

The Office announced the details of its rural Broadband Infrastructure Network Buildout Program, with grants of $1 million to $3 million (up to a total of at least $9 million in available funding), in late November 2019.[55] The deadline for applying for the first round of funding has already passed, but we expect the state to make additional funding available in the future. The applicant has to be a local jurisdiction or the jurisdiction's recognized partner. The grant will cover up to 50 percent of construction costs—with the applicant committing a 100 percent match—for a project that delivers at least 25/3 service to an unserved area.[56] Our sense is that these requirements intentionally put larger companies in a better position because of their access to cash for the match and ability to file for larger grants. The proposed service area does not have to be contiguous and can cross county boundaries.

The Office earlier solicited statements of interest from local jurisdictions for "Assistance for Broadband Expansion Pilot Projects." The state will award relatively small grants of up to $200,000 to local jurisdictions, in partnership with an incumbent ISP, to cover as much as "50 percent of the construction costs related to an ISP extending service [from the ISP's existing network] to unserved households." Pilot project applications were due in January but, like the Broadband Infrastructure Network Buildout Program, we fully expect that the state will create new opportunities of this sort annually. The County and its partner would be required to commit a 100 percent match for this line-extension funding, and to delivering at least 25/3 service.

[55] "Maryland Broadband Infrastructure Grant Program: Grant Application Guide," Governor's Office of Rural Broadband, State of Maryland, November 27, 2019, https://dhcd.maryland.gov/RuralBroadband/Documents/FY2020-Broadband-Infrastructure-Program-Grant-Application-Guide.pdf (accessed December 2019).

[56] The match must be in cash, not in-kind, and must be shown to be available at the time the grant contracts are executed. There is an exception to level of match requirements for Sustainable Communities (DHCD) and Priority Funding Areas (MDP) which have some limited overlap with some of the unserved area of Somerset County.

Appendix A: Wireless Testing Methodology and Results

Frequency

CTC engineers identified Bloosurf's frequency information in the FCC's universal licensing system (ULS). The frequency licensed to Bloosurf was found to be between 2502 – 2551.5 MHz and 2572 – 2590 MHz, meaning the company has 67.5 MHz of spectrum available for serving Somerset County users. No other Bloosurf licensed frequencies for the Somerset County area appeared in the FCC's ULS.

Signal Strength Thresholds

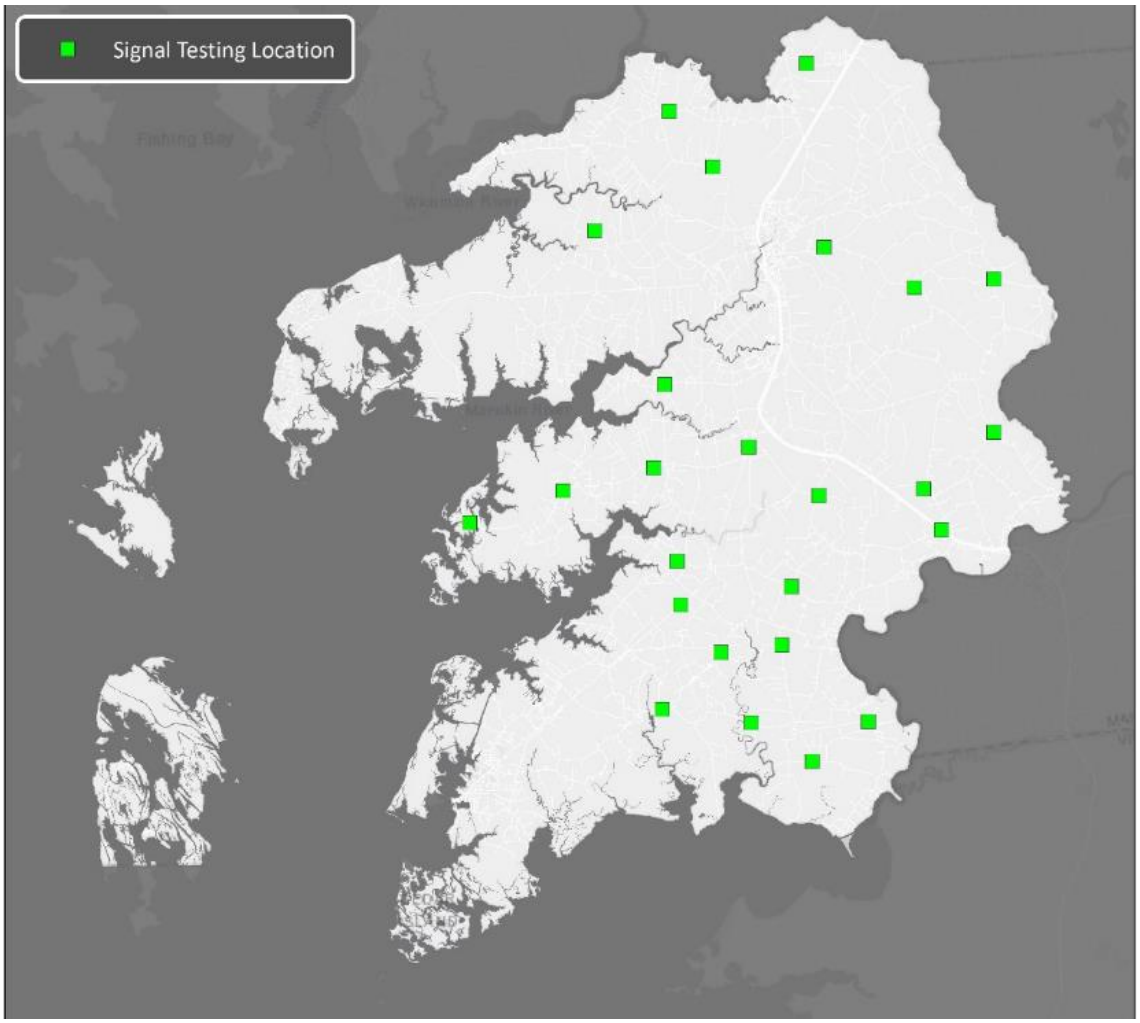
There is a direct relation between the throughput/speed and signal strength at a given locations. The bandwidth of Bloosurf's licensed frequency is theoretically enough to provide 25/3 broadband service. To meet that required throughput, the signal strength would need to be at least -88.5 dBm. This signal strength would enable at least 28 Mbps throughput (i.e., 25 Mbps download and 3 Mbps upload). We note, however, that signal strength levels do not reflect network capacity; actual capacity depends on factors such as user location and network congestion.

Testing Site Location Selection

As a starting point in selecting test locations, CTC utilized the served/unserved coverage map of the County we developed based on separate field surveys of areas unserved by wireline broadband options, such as cable broadband. Viewing only the areas we believe to be unserved by wireline broadband, a CTC engineer used the ArcGIS Network Analyst extension tool to select 25 locations (Figure 24). These locations were chosen based on a distribution across relatively high-density sites in areas that are not served by wireline broadband infrastructure; in other words, we chose sites close to multiple neighboring dwellings.

This approach allowed us to test locations geographically distributed across the County that we have good reason to believe are not already served with wireline broadband, while in proximity to as many unserved residences as possible. Each data point therefore provides a meaningful estimate of coverage that is relevant to a significant number of neighboring addresses.

Figure 24: Signal Testing Locations



Testing Process

Wireless testing at each site location was performed using a portable "RF Explorer" spectrum analyzer (standard version 1.26), which can detect wireless channels in a known frequency range. RF Explorer also helps in determining channel size and maximum power levels for the each of the channel used. The RF Explorer was connected to a directional Yagi antenna mounted at a height of 12 feet above ground to simulate the location of an antenna that might be installed on a subscriber's home to receive Bloosurf service.

At each test location, the CTC engineer conducting the test set the frequency range in the RF Explorer by specifying the center frequency and the frequency span (i.e. the difference between the start and stop frequency). The engineer then set the test equipment's mode of operation to "max hold," which can detect activity over a prolonged period of time, then records the maximum signal levels and lists the frequency corresponding to it. Finally, the engineer rotated the antenna 360 degrees to capture the signals from all directions.

Test Results

For each of the 25 test locations we measured the signal strength and compared it to the minimum needed to deliver 25/3 service (i.e., -88.5 dBm). All 25 test locations had a signal strength greater than the receiver sensitivity threshold required to meet the 25 Mbps throughput for downloads.[57] The signal strengths ranged from 4.5 to 26.5 dBm stronger than the minimum needed (Table 12).

Table 12: Test Results

Sr. no	Latitude	Longitude	Maximum signal level (dBm)	Frequency for maximum signal level (MHz)	Spectrum range (in Mhz)
1	38.279718	-75.674012	-64.5	2531.878	2502-2551.5
2	38.260809	-75.745854	-75	2528.31	2502-2551.6
3	38.237681	-75.723605	-75.5	2527.42	2502-2551.7
4	38.212179	-75.78544	-82.5	2526.75	2502-2551.8
5	38.204101	-75.666198	-63.5	2520.729	2502-2551.9
6	38.187007	-75.619464	-77.5	2526.75	2502-2551.10
7	38.189895	-75.577885	-82.5	2517.16	2502-2551.11
8	38.126964	-75.579106	-71	2526.53	2502-2551.12
9	38.104165	-75.616162	-67.5	2504.23	2502-2551.13
10	38.122515	-75.607142	-79.5	2516.72	2502-2551.14
11	38.122515	-75.706829	-62	2587.41	2572-2590
12	38.102104	-75.670554	-79.5	2516.27	2502-2551.14
13	38.064738	-75.685714	-83.5	2526.08	2502-2551.15
14	38.041034	-75.691055	-81	2521.18	2502-2551.16
15	38.009015	-75.646707	-83	2526.97	2502-2551.17
16	37.992965	-75.676045	-73.5	2550.61	2502-2551.18
17	38.00912	-75.707627	-84	2526.53	2502-2551.19
18	38.015197	-75.753835	-63	2526.972	2502-2551.20
19	38.038204	-75.722788	-64.5	2528.756	2502-2551.21
20	38.057988	-75.743511	-66.5	2551.499	2502-2551.22
21	38.075885	-75.74492	-82	2527.864	2502-2551.23
22	38.114444	-75.756344	-83	2526.53	2502-2551.24
23	38.105549	-75.803812	-79	2527.42	2502-2551.25
24	38.092953	-75.852418	-73.5	2550.61	2502-2551.26
25	38.148573	-75.750148	-83	2526.08	2502-2551.27

[57] While the Yagi antenna that was used for wireless testing had an 8 dB gain, the objective of using a Yagi antenna was to simulate the behavior of customer premises equipment that would have an equivalent gain. This means that even if the 8 dB is subtracted from signal levels, it would be added back due to the gain provided by home devices. Therefore, the signal levels obtained with the RF Explorer can be treated as accurate values in terms of estimating feasible throughputs.