ctc technology & energy

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Broadband Strategic Plan

Prepared for Queen Anne's County, Maryland
June 2020

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1 Executive Summary

Over the past several years, Queen Anne's County has undertaken an ongoing effort to ensure that all County residents and businesses have access to high-speed, affordable broadband services. 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, unserved areas of the County, based on data and maps provided by the County, other public data sets, and desk and field surveys
- 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

1.1 Project findings

Most residents of Queen Anne's County have access to a mix of internet services, but many locations do not have robust broadband[1] services. For example, Comcast delivers service in only a small portion of the County. And while Atlantic Broadband provides residential wired broadband service in the County's denser neighborhoods, it does not provide service that meets the definition of broadband in sparsely populated areas.

[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.

Because of the challenging economics of broadband deployment in rural areas, private ISPs likely will not invest in ubiquitous 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.

1.1.1 The County has unserved residents and businesses in contiguous areas and scattered locations

Unserved areas are those where no 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] Determining whether an area is served by wireline infrastructure can therefore typically be accomplished through visual inspection—either through a review of available route photography (i.e., a desk survey) or a field survey.

Determining whether locations are considered served or unserved from a fixed wireless perspective requires a different methodology. Whether an address can "actually" be served wirelessly, with service fitting the definition of broadband, can be derived from propagation analysis. Such analysis takes into consideration geography and lines of sight, the type of base station and termination technology, wireless spectrum utilized, distance of an address from a tower, the height of the tower, placement and orientation of the antennas, number of subscribers, backhaul capacity, and other considerations. In other words, visual inspection is not sufficient to establish whether a premises can be served. Ideally, a wireless provider would submit such information so models can be built to establish the likelihood of delivering service at broadband speeds to individual addresses.

Regardless of whether a service is wireline or wireless, the FCC also determines that an area can be considered served if addresses can receive service at broadband speed without extraordinary commitment of resources and within a typical service period. If delivering service would require building a tower at the customer premises or replacing a base station at a tower, that address would not be considered served.

In the absence of rigorous field and premises testing of actual wireless network speeds, which were outside of the scope of this engagement, practical determination of wireless broadband availability will therefore have to rely on feedback from citizens who have asked for service in

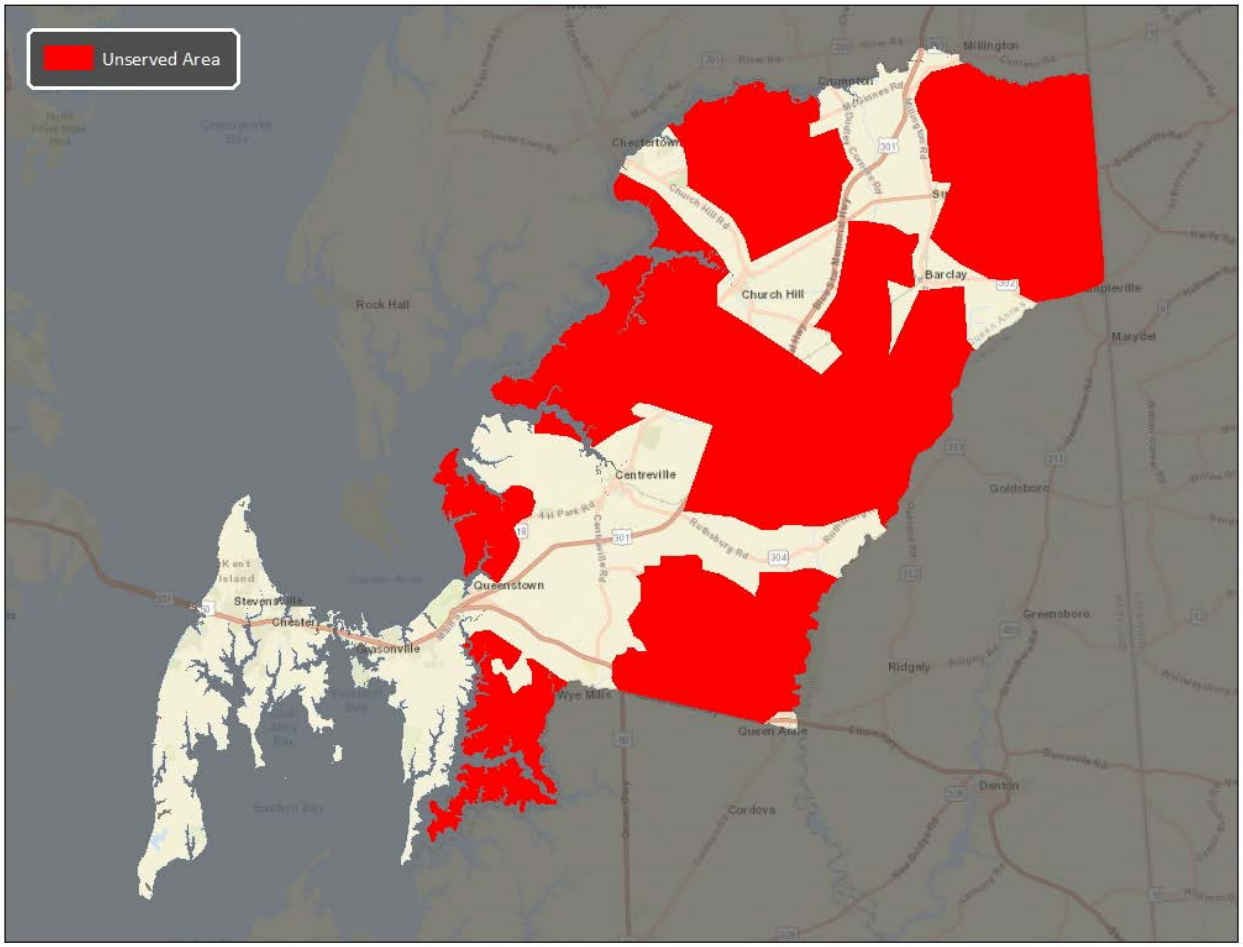
[2] A "passing" is the infrastructure that literally "passes" a home or business along the road but it does not include the "service drop"—the portion of the network that connects from the road to the home or business itself. The availability of a passing to a home or business is the universally understood 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.

areas that a wireless provider reports as being served—and who have been denied service because of lack of line of sight, or who receive service at far below broadband speeds.

Considering the above definition and considerations—and based on County-collected data on unserved addresses, as well as feedback from subscribers and potential subscribers—we do not find the claims of fixed wireless providers to be credible in terms of areas where they purport to deliver 25/3 service. ***The findings below about the County's unserved areas therefore focus on premises that are unserved by wireline infrastructure; we discuss the wireless technology and claims in more detail elsewhere in the report.***

Based on our review of a range of data sets and our own high-level surveys, we estimate the County has approximately 4,000 unserved premises (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 Atlantic Broadband nor Comcast 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, the cable companies are not 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 cable company 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.

1.1.2 The economics of rural broadband limit ISPs' interest in deploying broadband to unserved areas

Unserved portions of Queen Anne's 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.

1.1.3 Building fiber-to-the-premises in the County's contiguous unserved areas would require an estimated $38.1 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 $38.1 million. Considering only the outside plant infrastructure costs—not the service drops to the premises or the customer premises equipment—the network would cost approximately $8,250 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 3 describes this cost estimate in more detail.

1.1.3.1 Fixed wireless could serve about 87 percent of the contiguous unserved areas 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.

1.1.3.2 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 the 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.

1.1.3.3 The potential exists for public-private partnerships, including some that are lower risk

Based on our discussion with the private sector, we believe there is opportunity for the County to address some of these challenges while sharing risk with the private sector—and indeed, ideally substantially transferring most of the risk to the private sector. We make recommendations below about potential partnerships, but note that the County could also seek additional partnership opportunities through an RFI or RFQ process. As we explain in the discussion of potential partnerships below, we recommend the County partner with entities that have some or all of the following attributes:

- First, capability and experience in cost-effectively building communications infrastructure. These capabilities can range from demonstrated experience to ownership of the poles (which conveys structural benefits and enables lower-cost construction) to existing communications infrastructure in the area, such as fiber optic or coaxial plant.
- Second, a partner with demonstrated experience as an internet service provider. Our experience is that USDA in particular requires a showing of such experience for funding grants—and it certainly conveys additional benefits for any state or federal grant application.
- Third, a strong and experienced management team.
- Fourth, a track record in successfully applying for state or federal grants or both. This is a demonstration of the fact that grant makers have already vetted the company and approved its capabilities.
- Fifth, experience partnering with local governments and a clear willingness to work collaboratively with a local government on grant applications and toward shared goals.

1.1.4 The County has multiple potential private partners to fill some broadband gaps

During our study, several internet service providers expressed strong interest in partnering with the County to deliver services in specific areas of the County. These ISPs include Talkie, Last Mile Broadband, ThinkBig, and Atlantic Broadband; the first three are fiber-to-the-premises operators, while Atlantic Broadband might deploy coaxial cable or fiber to the premises. In addition, Choptank expressed interest in potentially providing fiber connectivity for its entire service area in the County, and the County's incumbent wireless providers expressed general interest in partnering with the County on fixed wireless expansion.

This significant and promising level of partner interest sets Queen Anne's County apart from other counties in the region.

1.1.5 Federal and state funding programs are an opportunity for the County and its private partners to fill some broadband gaps

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 recently announced 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.

First, USDA's ReConnect program represents the most significant congressional appropriation of broadband funding since the Recovery Act in 2009—with $550 million made available for the 2020 round 2 rollout, $100 million added in emergency funding,[3] and likely 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 round 2 application window closed April 15, 2020.[4]

Second, the FCC's Rural Digital Opportunity Fund will be awarded through a reverse-auction process that will take place in mid-October. The announced plans are for the FCC to award up to $16 billion in the first phase, then conduct another auction to award whatever funds remain from phase 1, as well as the remaining $4.4 billion. These funds will be disbursed over the next decade

[3] "USDA Implements Immediate Measures to Help Rural Residents, Businesses and Communities Affected by COVID-19," USDA Rural Development, News Release, April 15, 2020, https://www.rd.usda.gov/sites/default/files/USDA_RD_SA_COVID19_CUMULATIVEUpdate04152020.pdf (accessed April 17, 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).

in periodic increments to support the buildout and operation of high-speed broadband networks in unserved areas of the country.

Third, Maryland's Office of Rural Broadband 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 plans to award grants of $1 million to $3 million from a total funding budget of at least $9 million. Applications were due by February 21, 2020. However, the Office sees this as a multi-year campaign, and a new round of funding is expected to be announced towards the end of the year, with an application window closing in early 2021.

1.2 The County can undertake a multi-year effort to leverage state and federal funding programs with potential partners

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 unserved areas. (We note, however, that the Rural Digital Opportunity Fund does represent a unique opportunity for which time is of the essence, as we expect the reverse auction will be held in 2020 for a decade's worth of ongoing funding.)

While we cannot predict what partnerships and funding opportunities might come to fruition, we note that many different scenarios could play out—ranging from one entity building infrastructure to all of the County's unserved areas, to multiple entities each building in smaller parts of the unserved areas.

We also note there is no silver bullet that will solve the County's broadband needs. While some partners may be willing and able to take on the risk and financial burden with state or federal support alone, filling the broadband gaps will, in all likelihood, require a significant County investment as well.

The following are our recommendations for immediate, intermediate, and long-term steps the County can take in light of what we have learned in conducting this study, to begin to remedy the broadband challenges identified.

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

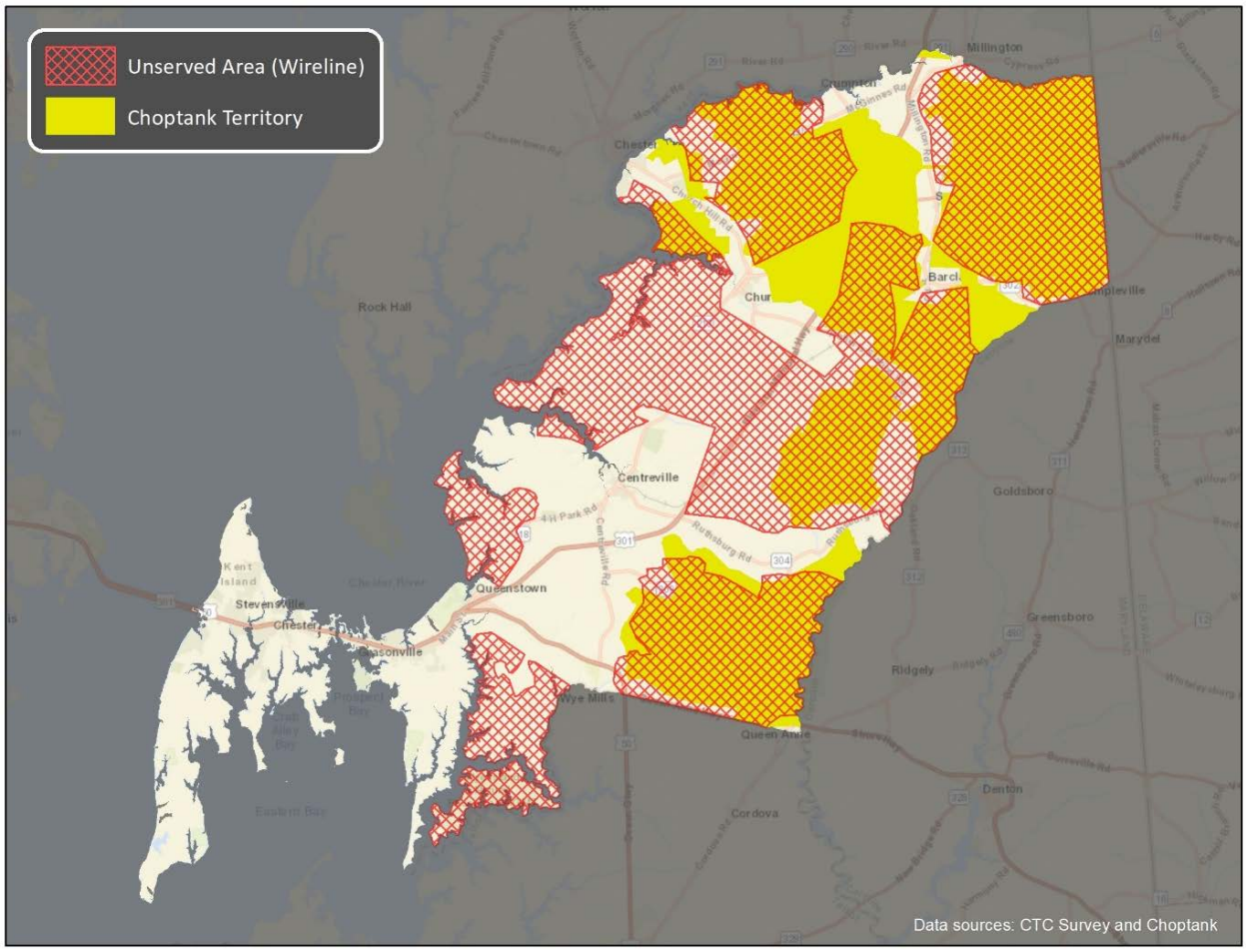
We recommend the County prioritize, first and foremost, engagement with Choptank on serving Category 1 and Category 2 unserved areas within Choptank's electric service territory with fiber-to-the-premises. Choptank is an obvious, strong choice for a partner in the County's broadband deployment efforts. Indeed, Choptank has positioned itself for this opportunity by leading a successful effort with the Maryland legislature to give cooperatives the regulatory flexibility to enter the broadband market.[5] Choptank has already announced its intent to target the federal Rural Digital Opportunity Fund.

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. The figure below shows Choptank's self-reported electric coverage map and the County's Category 1 unserved broadband areas.

[5] See, for example: "Support Choptank Fiber," https://supportchoptankfiber.com/ (accessed December 2019). *See also:* "Cooperative's Broadband Bill Passes in Annapolis" https://www.choptankelectric.coop/victory-broadband-bill-passes-during-last-day-session. The bill must be signed by Governor Hogan; Choptank will also need to conduct two regional information meetings with its members, and Choptank's members will need to vote in favor of Choptank becoming member-regulated.

Figure 2: Choptank's Electric Service Area Compared to Category 1 Unserved Portions of the County[6]

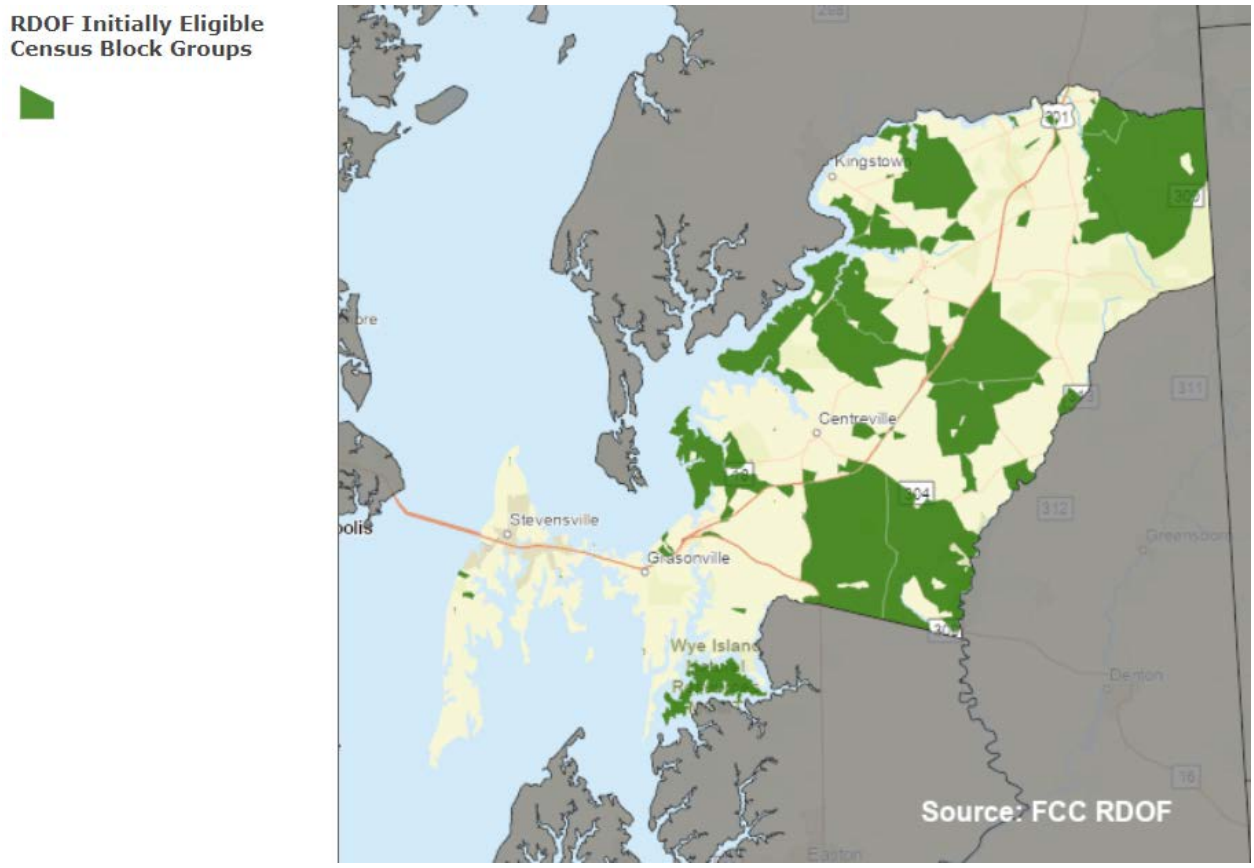


We expect electric cooperatives such as Choptank to benefit from the Rural Digital Opportunity Fund, in particular, because of its ownership of poles in unserved areas. Choptank would have the lowest cost to build of any entity other than Verizon, which would be a competitive advantage if it were to 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 initially eligible for the Rural Digital Opportunity Fund (Figure 3); for Queen Anne's, these maps seem to disregard the coverage claimed in Form 477 filings by fixed wireless providers such as BridgeMAXX (Figure 4) and Delmarva WiFi (Figure 5).

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

Figure 3: Census Block Groups Initially Eligible for Rural Digital Opportunity Fund[7]



Existing providers had until April 10, 2020, to challenge these areas by claiming they had added coverage since June 2019; our review of posted challenges after this deadline found that neither of these wireless ISPs had mounted challenges, and that Atlantic Broadband challenged only seven census blocks out of 391 posted as initially eligible. Choptank should therefore be able to apply for funding to serve a significant portion of its current service area.

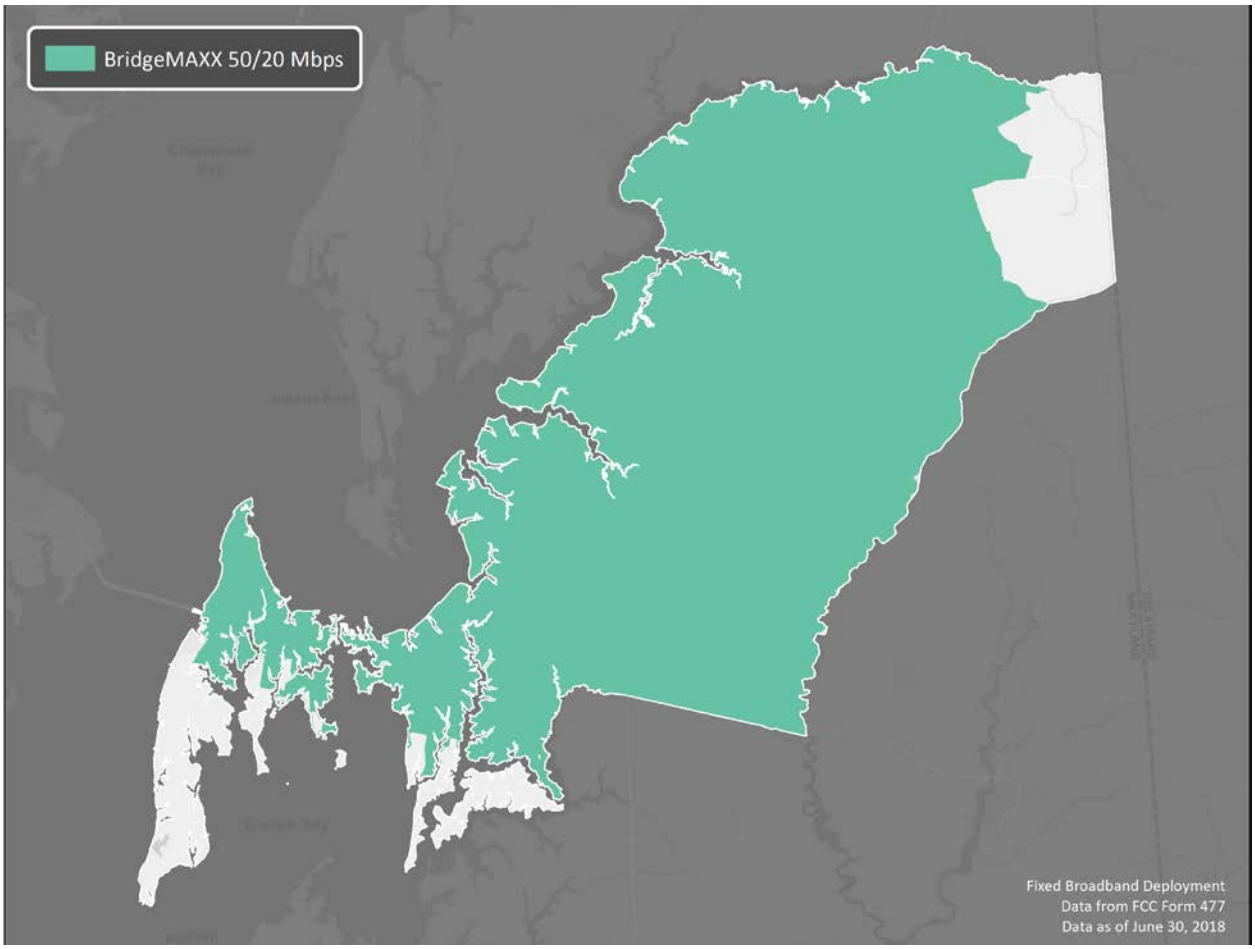
In addition to Rural Digital Opportunity Fund, Choptank could also apply for state and ReConnect grants. The caveat in regard to ReConnect grants, and to a lesser extent state grants, is that a process would need to be established for challenging the fixed wireless providers' claims that they serve most of the County with 25/3. BridgeMAXX, for example, claims 50/20 coverage in the County (Figure 4, below), while Delmarva WiFi is claiming 100/100 (Figure 5). As mentioned in Section 1.1.1, we do not find it credible that these fixed wireless providers are capable of uniformly providing this service in their claimed coverage areas. In order to position the County to take advantage of federal and state grants that rely on or take into account such self-reported

[7] 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 after the FCC adjusts the maps to reflect challenges filed by existing providers prior to the April 10, 2020, deadline.

claims form fixed wireless providers, we recommend the County commission a systematic wireless study to establish where the wireless providers can and cannot provide 25/3 service (or 10/1 service in the case of ReConnect).[8] Collecting baseline performance metrics on fixed wireless performance will also allow the County to work with these providers to pinpoint and address performance issues, and give the County a better picture of where fixed wireless can play a constructive role in expanding coverage to difficult-to-reach locations.

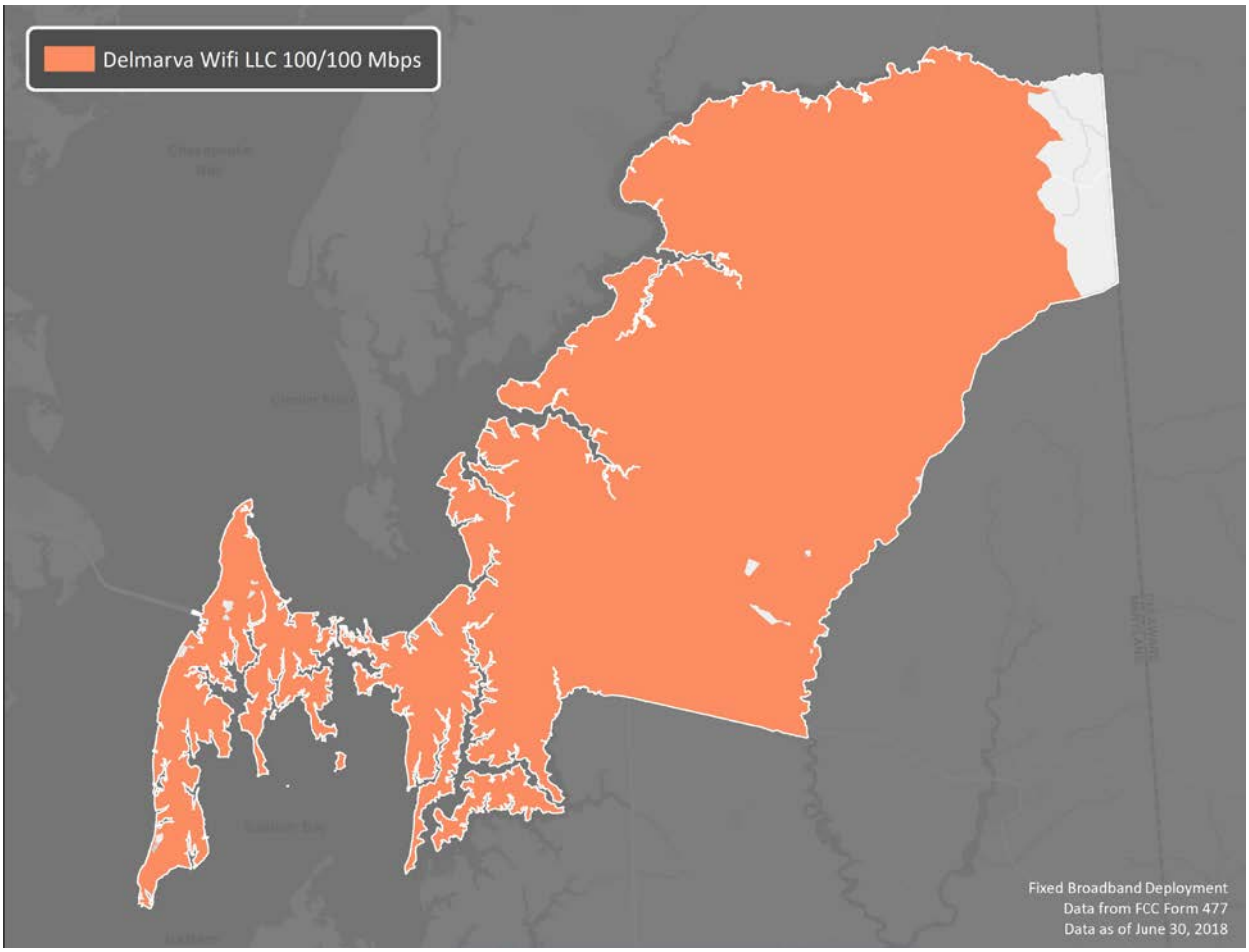
If Choptank were to miss the Rural Digital Opportunity Fund application window, it would still be eligible to apply for later rounds of state funding, and possibly ReConnect if its application includes a process for challenging fixed wireless providers' coverage and speed claims.

Figure 4: BridgeMAXX 50/20 Mbps Service Claims



[8] This might include collecting data from online speed tests performed by residents across the County; conducting premises-based speed tests at the homes of residents who volunteer to allow the County or its contractor to perform the brief tests; and conducting in-field speed testing at representative outdoor locations throughout the County.

Figure 5: Delmarva WiFi 100/100 Mbps Service Claims



1.2.2 Partner with a provider such as ThinkBig on a state broadband grant application and support federal funding applications for Category 1 unserved areas and RDOF-eligible areas

In addition to Choptank Electric Cooperative, CTC and the County engaged with a range of potential private partners for this effort during preparation of this report. Of those entities, one that appears to be a promising partner for the County is ThinkBig Networks, a Maryland company that is operating fiber-to-the-premises in Kent County and parts of Baltimore. ThinkBig appears willing and engaged in preliminary discussions with the County—and could be a viable partner for state and federal grant applications to construct fiber to serve the County's unserved areas in those areas that Choptank does not serve (or in some form of collaboration with Choptank).

We recommend the County proceed with evaluating a partnership with ThinkBig to address the Category 1 unserved areas that are not addressed through Choptank's efforts. Fully addressing these challenges is likely to be a multiyear effort, but first steps can certainly be taken in 2020. ThinkBig has indicated an interest in working with the County to apply for state and potentially

federal grants—and has already engaged with the County in discussions. The best opportunity for a partnership with ThinkBig might be to prioritize areas that are outside of Choptank's current service area. The County could also facilitate discussions about a strategic partnership between ThinkBig and Choptank to serve as many unserved areas as possible. In particular, discussion between Choptank, ThinkBig, and the County could address eligible Rural Digital Opportunity Fund areas that are partially within Choptank's service areas and partially outside it.

The County's role would be to provide strong letters and other indications of support, as well as to facilitate and support the development of the grant applications. As is discussed above, we preliminarily anticipate that both the state of Maryland and the federal government will continue current rural broadband grant programs in coming years, so both state applications and ReConnect applications anticipated in early 2021 could be targeted.

All of these programs are highly competitive. Many very deserving grant applications will not be funded simply because there are insufficient funds appropriated to meet the demand. So ThinkBig's applications may not succeed in their first efforts, but this is one of the reasons we recommend a multiyear strategy and a persistence in applying to these grant programs over time. Even if the initial set of applications is successful, the funding is unlikely to be sufficient to address all of the Category 1 unserved areas—further reinforcing the need for a multiyear effort and an expectation that that broadband solution will take time.

1.2.2.1 ThinkBig has many attributes of a strong partner

We recommend ThinkBig as the County's partner for a number of reasons. First, ThinkBig's multiyear track record in fiber-to-the-premises deployment and operations, including on the Eastern Shore, means the company represents an able partner for the county. The company reports having constructed more than 40 miles of fiber in Maryland in the last couple of years. Based in Chestertown, ThinkBig offers fiber-to-the-premises gigabit connectivity in southern portions of Baltimore City (with plans to expand into the central city) as a competitive alternative to Comcast in those areas. In addition, ThinkBig has been working with Kent County to expand access to unserved rural areas supported by state grants.

Just as importantly, that track record is a critical element of experience, and based on our conversations with the funding authorities, only experienced entities are likely to succeed in applying for broadband grant funds. While ThinkBig is not a large company, its management team is experienced, it appears well-capitalized, and it holds a number of years of operating experience as a rural and urban ISP. These elements will be critical, non-negotiable components of a successful federal grant application.

Second, we recommend ThinkBig because it has a track record of successfully applying for rural broadband grants from the state of Maryland. That success record suggests that the state's grant-

makers have vetted the company and are comfortable with funding it. This factor appears to us to be a strong consideration in favor of the County selecting ThinkBig as its partner with an eye toward supporting the most viable and fundable potential partner.

Finally, we recommend ThinkBig because, while we and the County engaged with a wide range of different potential private partners for this initiative, none of the others appear as viable for funding or as low-risk for the County. Whatever the amount the County invests in this initiative, either in the form of capital support or efforts to support its private partner's grant applications, we believe this selection is the most prudent for the County, and that ThinkBig's stability and track record, despite its modest size, would make the County's investment lower risk than would be the case with a company with less experience or capacity.

1.2.2.2 The County and ThinkBig should act quickly on funding opportunities

ThinkBig will not have the low cost to build that Choptank or Verizon would have, because it does not own the utility poles. But it would potentially be competitive for state grant funding, federal ReConnect funding, or the Rural Digital Opportunity Fund; if ThinkBig can successfully secure a state grant or support from the County, it could bid lower for Rural Digital Opportunity Fund funding and potentially position itself to win. However, such an arrangement would need to satisfy the Rural Digital Opportunity Fund requirement that the areas bid on have not previously been subsidized by the state or County—meaning the County or state support should be concurrent or subsequent to a Rural Digital Opportunity Fund award.

Given the timing for both state applications and ReConnect (the most recent application window closed March 16, 2020),[9] we recommend the County and ThinkBig consider developing the partnership with an eye toward 2021 grant opportunities to look beyond the upcoming Rural Digital Opportunity Fund auction. If ThinkBig were awarded state broadband funding, it could use those funds (and any County contribution to that program's match requirements) as its match for the federal application.

1.2.3 Encourage Atlantic Broadband to continue to apply for state funds for both Category 1 and for Category 2 isolated unserved pockets

Our next recommendation is that the County pursue a potential partnership with Atlantic Broadband to address Category 2 unserved locations and specific clusters of locations that are outside of Choptank's or ThinkBig's target areas. As is discussed in this report, isolated, low-density roads within areas that are otherwise served by Atlantic Broadband do not present a compelling business case or opportunity for a new provider. In addition, the full areas are not

[9] "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).

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.

Atlantic Broadband, however, is positioned to cost-effectively expand its infrastructure to those unserved pockets within its 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 Atlantic Broadband (see Section 6.1). 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 to apply for funds to build on multiple isolated roads within a larger geographic area (i.e., file on an aggregated basis for a single grant to build on unserved roads within their existing served footprints).

Atlantic Broadband has partnered with the County before, including on a state grant to construct fiber in the Bulle Rock area, and has provided rough estimates for a number of unserved areas in the County.

The areas targeted were north Centreville/south Church Hill, Kingstown/Crompton/Churchill, northeast Centreville, and south Centreville. The cost estimates fall on the low side of expected cost ranges for these areas. As one would expect, the areas Atlantic Broadband is interested in extending to have clusters of premises that would likely provide a better return on investment than would serving less densely clustered customers, especially given a subsidized arrangement with grants and matching funds that bring the capital costs within a regular range. The particular areas that Atlantic Broadband has targeted all lie wholly or mostly within Choptank's electric service areas.

For these reasons, we recommend the County further pursue these options with Atlantic Broadband for upcoming opportunities, including the Rural Digital Opportunity Fund and state grant funding, but only if Choptank decides not to pursue the Rural Digital Opportunity Fund-eligible areas, or decides to target only a subset of these.

1.2.4 Work with other interested fiber providers similar to ThinkBig

A couple of smaller fiber-to-the-premises providers have adopted business models similar to ThinkBig—identifying an affordable way to extend their networks from a current point of presence into a targeted area, and then build a distribution network. While generally more flexible than incumbent cable companies, these providers often are able to lower costs with innovative approaches to construction, electronics, or operations—but they typically require a higher level of support from local jurisdictions to make the economics work for them.

Talkie Communications, headquartered in Chestertown, Maryland, has discussed partnering opportunities with the County, including an expansion from their current presence in Chestertown across the river into Kingstown. Talkie was already planning the construction into Kingstown, and the County was exploring partnering arrangements to enable Talkie to expand into surrounding unserved areas. There may be opportunities to expand deeper into the County from there, depending on Choptank and Atlantic Broadband's targeted areas.

Last Mile Broadband, headquartered in Clinton, Maryland, similarly approached the County to explore partnering arrangements. Unlike ThinkBig and Talkie, however, they had less concrete plans in mind, and we were unable to establish whether Last Mile has any current network presence. While this does not mean the County should not engage with Last Mile, the company's lack of a construction and operational track record poses a risk to any County investment—and makes the company less competitive for grant opportunities such as ReConnect and state grants in which operational experience factors strongly into the evaluation.

That said, Last Mile could be a viable partner for the County down the road in a multi-year strategy. Their stated approach is to build either fiber-to-the-premises or hybrid fiber/fixed wireless solutions. Fixed wireless could be the most realistic option for serving the County's most remote areas (i.e., after other partners have claimed areas where fiber-to-the-premise works for them). What will remain, assuming the efforts to fill in denser unserved areas are successful, would have much higher average costs per passing, so the fixed wireless approach could therefore offer a cost-effective solution.

1.2.5 In the event other strategies do not succeed, explore opportunities to support fixed wireless providers

Given our analysis of capital and operating costs and the challenge in consistently providing the needed performance (see Section 4), fixed wireless deployment would not be our first recommendation for filling the County's service gaps. That said, the technology is feasible and, if the County were to identify a suitable partner, using fixed wireless might be a suitable option for serving some homes and businesses. In the course of preparing this report, CTC reached out to a number of fixed wireless companies that indicated interest but did not provide any concrete information regarding areas in which they would be interested or terms of a partnership with the County. Given the lack of an immediate partner and the preferability of fiber for this effort, we recommend that the County consider fixed wireless as a fallback option or last resort in the event other strategies proposed herein do not materialize.

2 The County Has Unserved Homes and Businesses 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[10] 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 4,000 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).[11]

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.

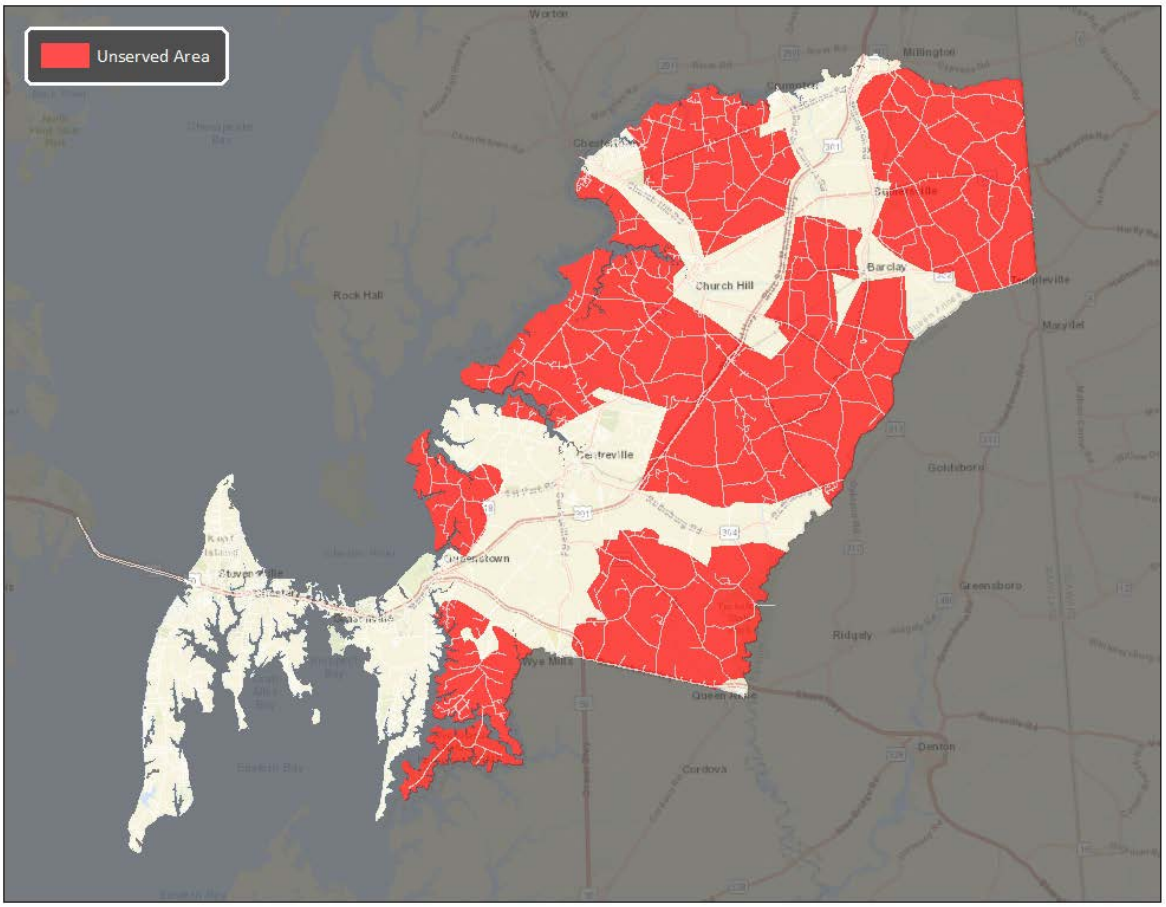
[10] A "passing" is the infrastructure that "passes" a home or business along the public rights-of-way, but it does not include the "service drop"—the portion of the network that connects from the road to the home or business itself. The availability of a passing to a home or business is the universally understood definition of what is served, both within the industry and among the state and federal government entities that fund broadband expansion[10] and regulate communications services.

[11] 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

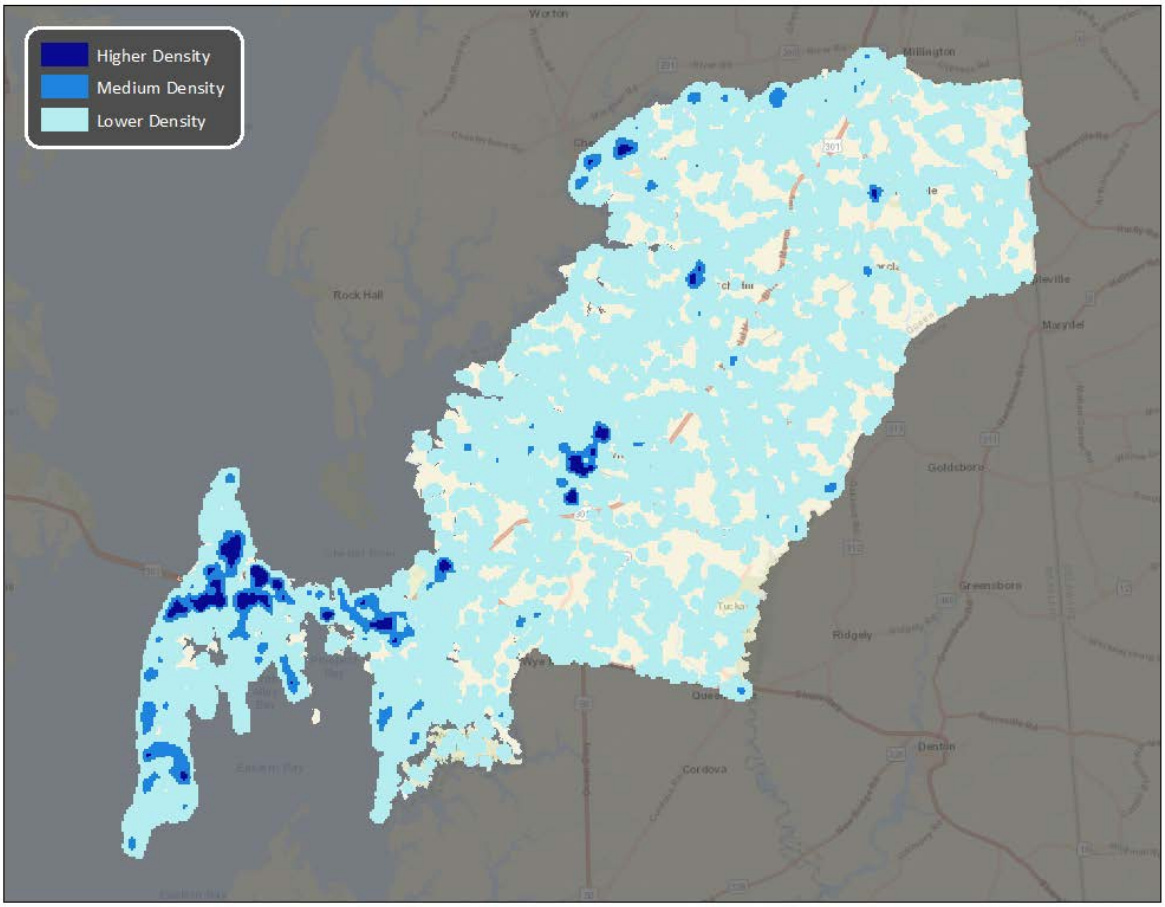
Category 1 comprises contiguous geographic areas where there exists no wireline infrastructure capable of delivering broadband speeds. Based on CTC's analysis of available data and our desk survey, we determined that the County has approximately 4,000 unserved locations in this category (Figure 6)—and that those contiguous unserved areas comprise the bulk of the area of the County.

Figure 6: Category 1 Contiguous Unserved Areas



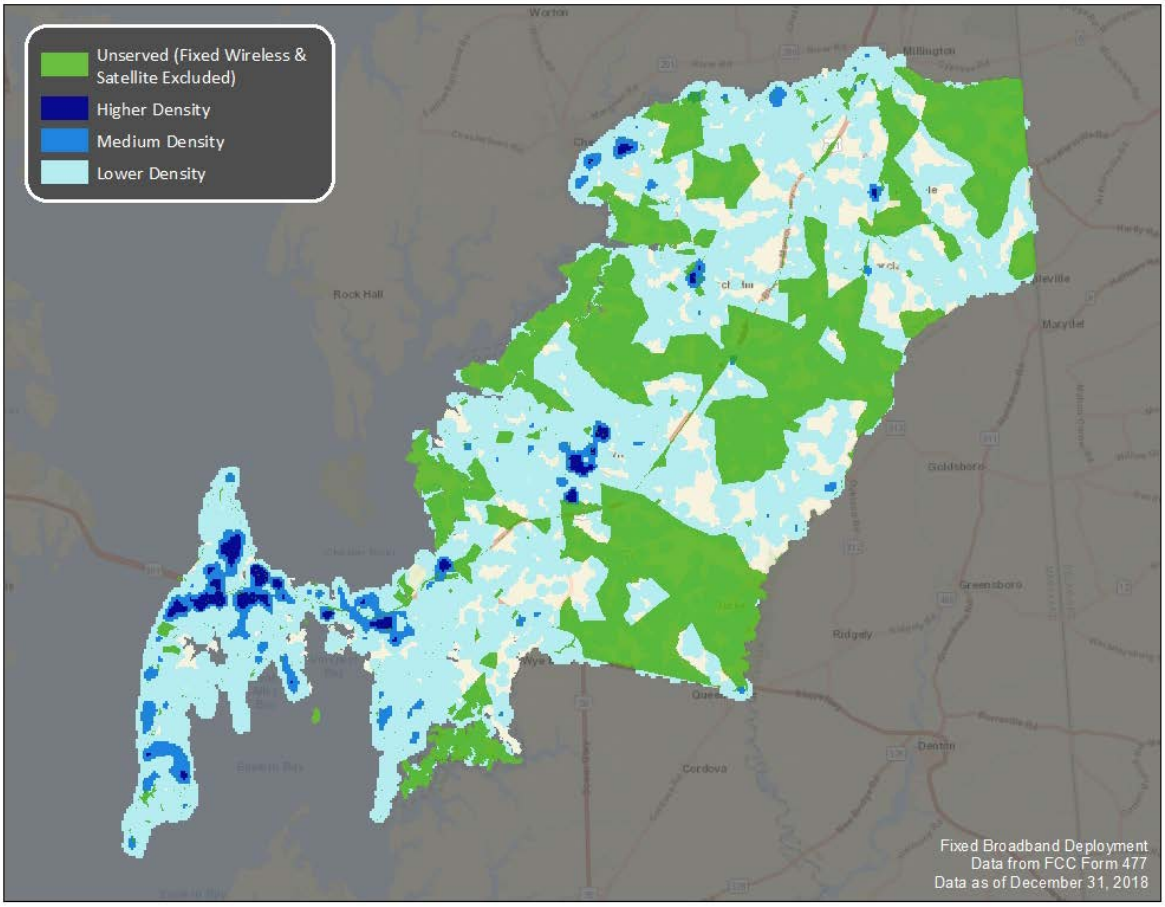
As a further step in our analysis of Category 1 unserved areas, we used the County's address data to develop a heat map of population density across the County (Figure 7). We developed the heat map of address points with a GIS mapping tool, which divided clusters of addresses into three groups relative 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 7: County Population Density Heat Map



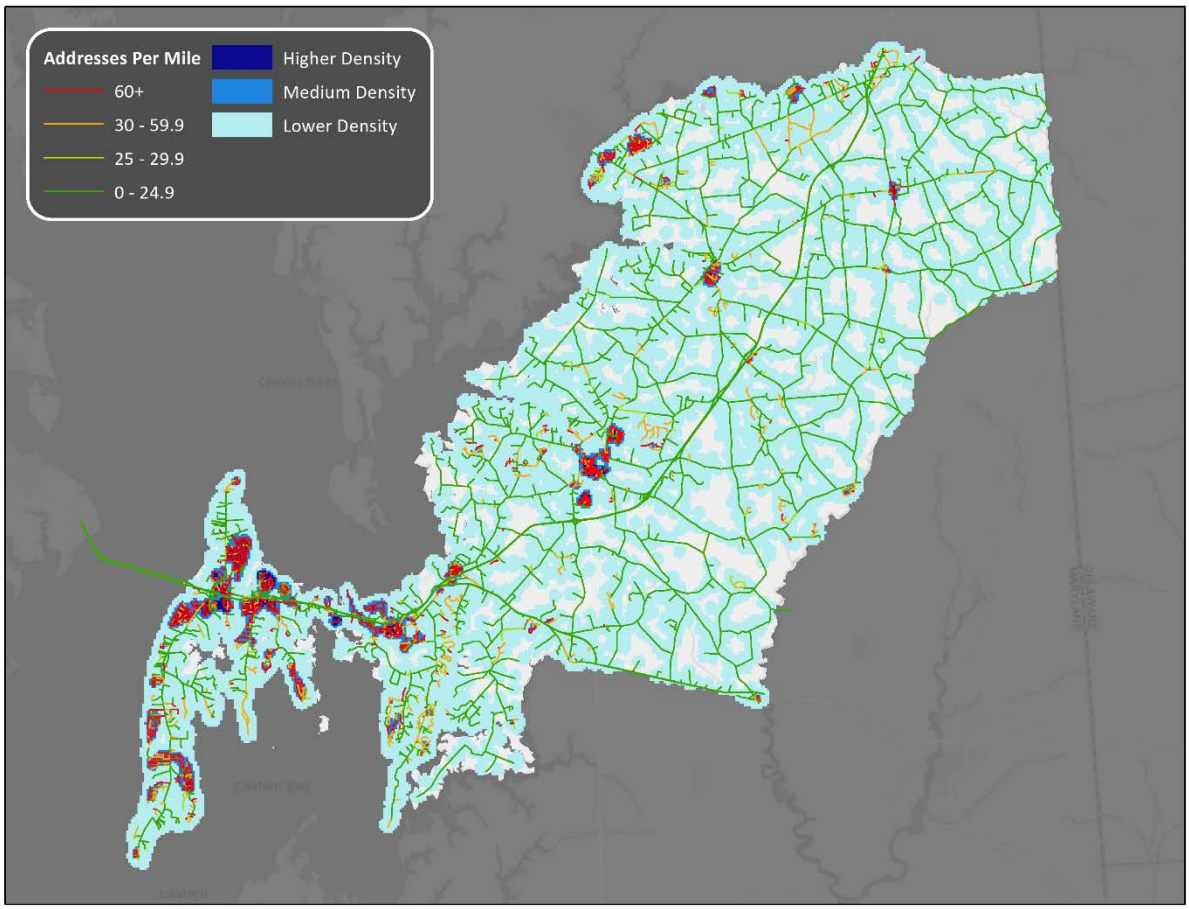
Not surprisingly, and very much in line with national broadband deployment patterns, the County's high-density areas align with the areas that our desk survey indicates as being served with wireline broadband (Figure 8). Similarly, we found that low population density is relatively homogeneous across 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 8: 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 9).

Figure 9: 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 Atlantic Broadband 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, the cable companies are not 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 a cable company 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 Atlantic Broadband and/or Comcast to seek grant funding to lower the cost to these 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.

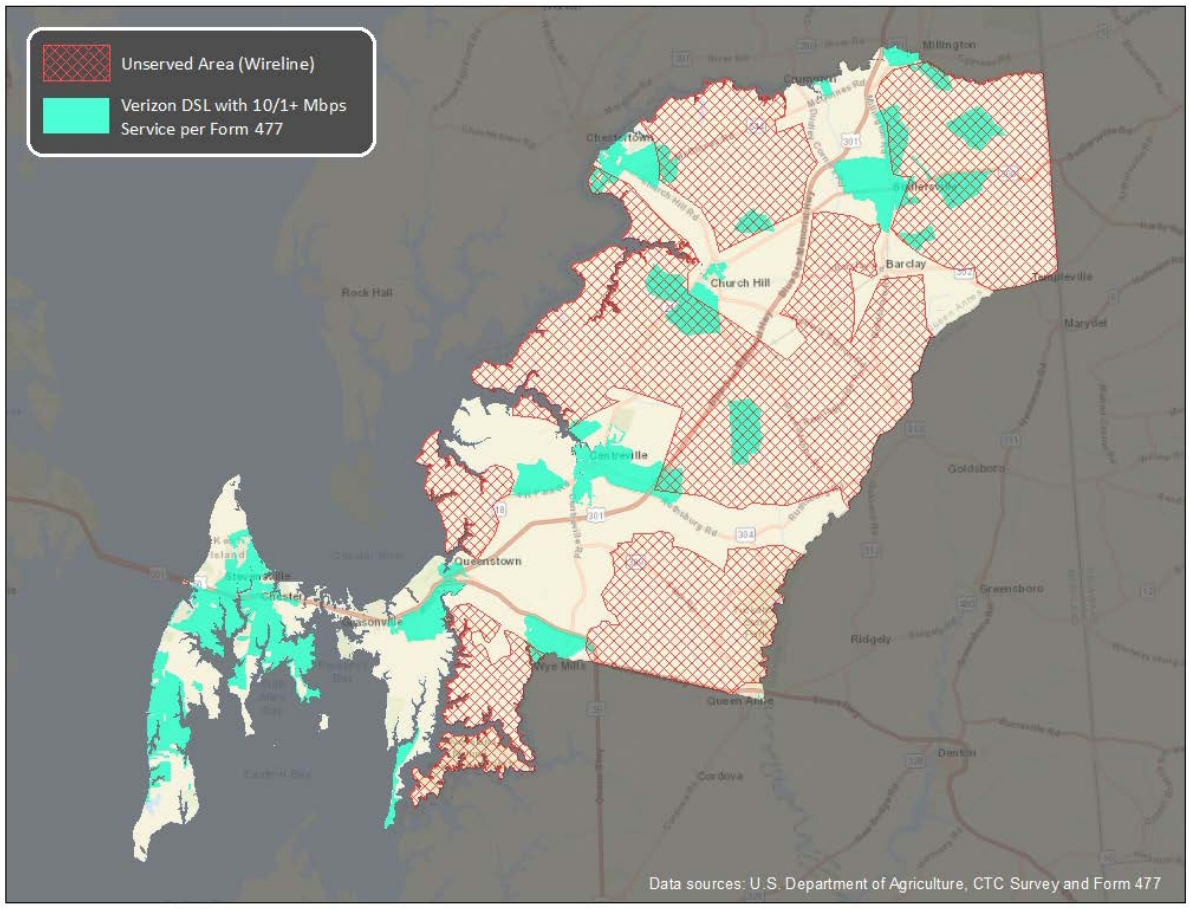
This is a situation that is extremely frustrating for those County residents who seek service but cannot afford to cover the cost of service drop installation, even if fiber passes their property (and thus they are considered to be "served with broadband" by the state and federal governments). Service 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.

2.4 Unserved Category 1 and Category 2 portions of the County are eligible for state and federal funding

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, 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.

For purposes of identifying ReConnect-eligible areas at a high level, the following map illustrates the areas lacking 10/1 wireline service (i.e., fiber or coaxial cable) as reported on Form 477 (Figure 10). 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.

Figure 10: Areas Potentially Eligible for ReConnect Funding Because They Lack 10/1 Service According to Form 477 Data



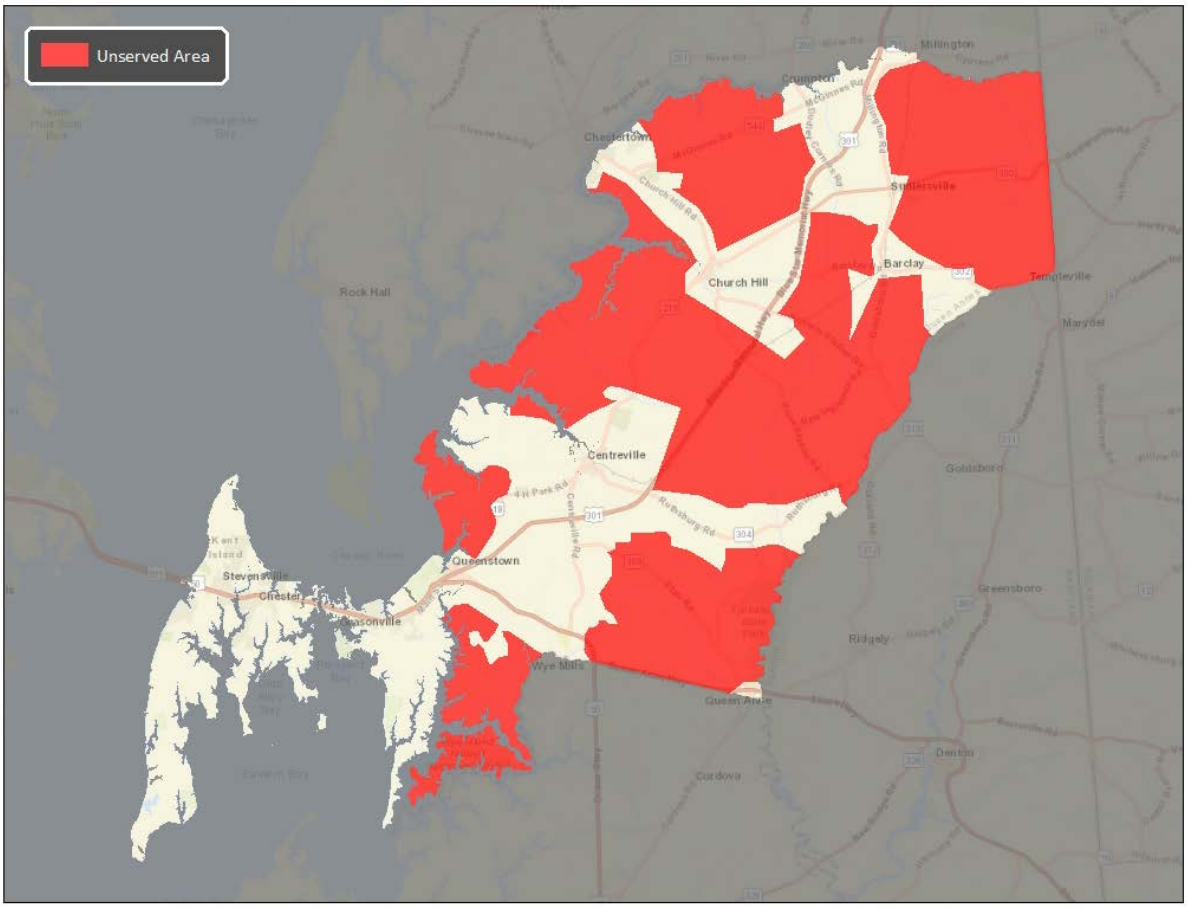
The shaded and teal areas are not necessarily eligible for state funding, because the state's service threshold for eligibility is less than 25/3. In addition, the shaded areas only capture fiber and cable, but fixed wireless providers claim 25/3 in much of the County, which would need to be contested and/or verified to establish grant eligibility. Importantly, too, while the Form 477 data for the more conservatively drawn shaded areas is a strong starting point, they 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.

Given the distribution of the County's Category 2 unserved premises, it is also important to note that ReConnect applications can aggregate isolated unserved addresses in rural areas—meaning an application to serve the County could include non-contiguous eligible unserved areas.

3 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 and field surveys identified an estimated 4,000 Category 1 unserved homes and businesses (Figure 11) that could be served by a new ISP or by the incumbent providers.

Figure 11: 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 Category 1 areas is $38 million; details are shown in Table 1.[12]

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

Cost Component	Estimated Cost
Outside Plant	$32,900,000
Central Network Electronics	$1,000,000
Fiber Service Drop Installations	$3,000,000
Customer Premises Equipment	$1,200,000
Total Estimated Cost:	*$38,100,000*

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 $8,200 (Table 2).

Table 2: Estimated Outside Plant Cost per Passing for Category 1 Unserved Areas[13]

Cost Component	Estimated Cost
Outside Plant	$32,900,000
Passings	4,000
Outside Plant Cost per Passing[14]	*$8,200*

These cost estimates—and the estimated operating costs described below (Section 3.5)—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.

3.1 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 Street View. The engineer reviewed available green space, estimated the modifications that

[12] These numbers have been rounded.
[13] Unrounded numbers are used in the engineering calculations; these are then rounded in the discussion.
[14] 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.

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	90%
Poles per Mile	35
Average Moves Required per Pole[15]	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. The cost of boring through rock is added to the cost of traditional boring. In Queen Anne's case, we did not find hard rock in the unserved areas, and estimated intermediate rock to be only 1 percent.

[15] 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 in the County's Category 1 unserved areas. In Figure 12, 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 entity could attach to the pole.

Figure 12: Utility Pole Requiring Make-Ready

Tree trimming is required to add an attachment on the utility poles in Figure 13. 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 13: Pole Line Where Tree Trimming Will Be Required

Figure 14 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 14: Low-Make-Ready Pole Line in Unserved Area

3.2 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.[16]

Figure 15, 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:

[16] 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.

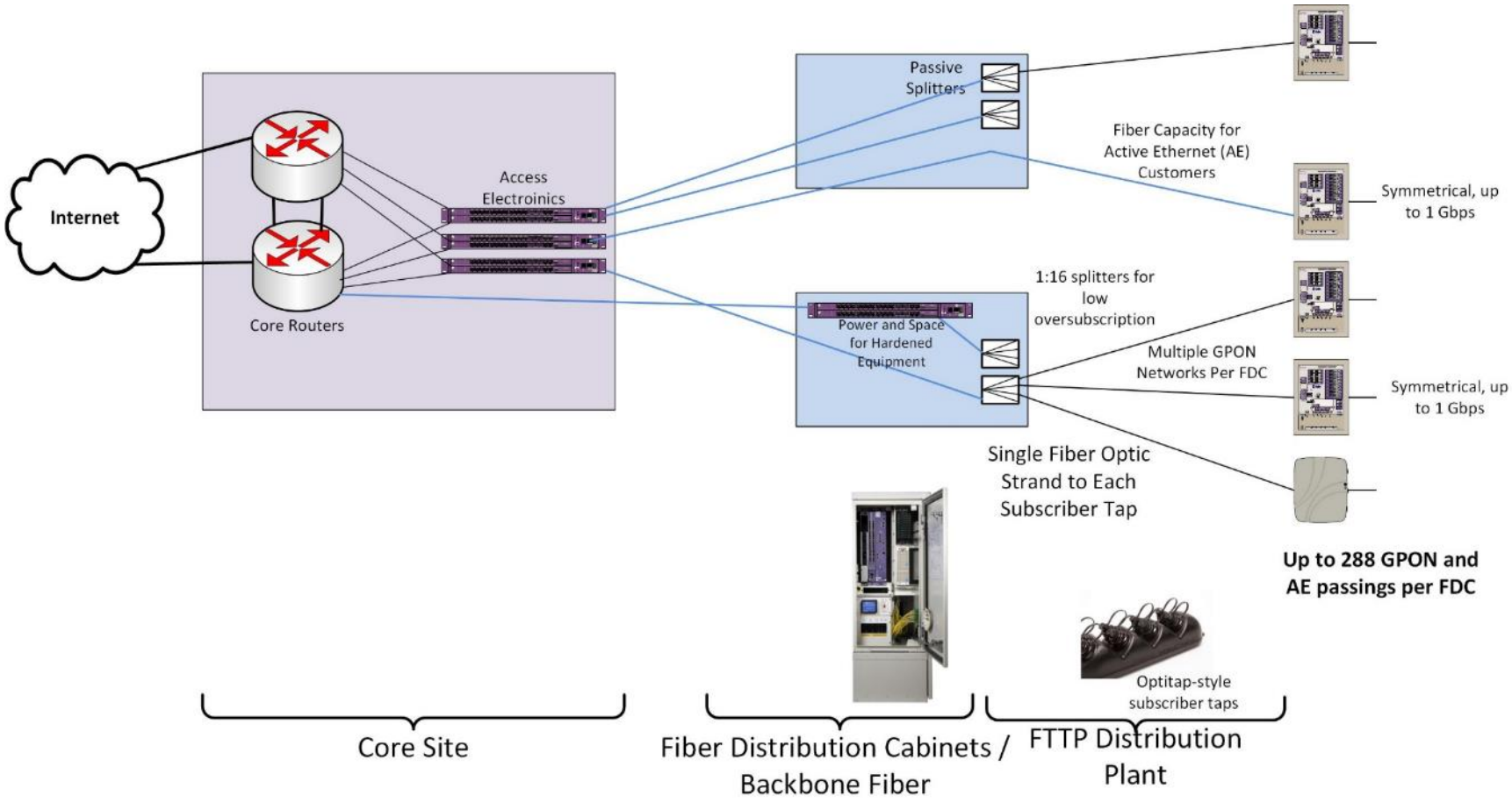
- **Capacity** – ability to provide efficient transport for subscriber data, even at peak levels
- **Availability** – high levels of redundancy, reliability, and resiliency; ability to quickly detect faults and re-route traffic
- **Failsafe operation** – physical path diversity in the network backbone 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.[17]

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 private drives to access homes in those neighborhoods.

[17] 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 15: High-Level Fiber-to-the-Premises Architecture



3.3 Network design assumptions include constructing 91 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 91 miles of backbone network[18] to connect the unserved communities to the core via 11 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 478 miles of fiber optics from the fiber distribution cabinets to approximately 4,000 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:

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

- Fiber will vary between 12- and 288-count based on the projected need in the area.
- 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 be installed in the public right-of-way or in an easement on the side of the road.
- The network will target up to 512 passings per fiber distribution cabinet.
- Fiber distribution cabinets will support hardened network electronics and provide backup power and an active heat exchange.[19]
- The network routes will avoid 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, such as the prevalence of subsurface rock; 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 3.1, 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.

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 public

[19] 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.

right-of-way—which cannot be fully mitigated without physical excavation and/or testing. In Queen Anne's, however, congestion of utilities appears to be reasonable for most areas, which makes underground construction more viable than typical.

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.

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

3.4.1 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 $69,000.

The distribution plant covers approximately 478 miles, leading to a total outside plant cost of approximately $33 million. This leads to an average outside plant cost per passing of approximately $8,200. Table 5 provides a breakdown of the estimated outside plant costs.

Table 5: Estimated Outside Plant Costs[20]

Cost Per Plant Mile[21]	Distribution Plant Mileage	Total Cost	Estimated Passings	Cost per Passing[22]
$69,000	478	$33 million	4,000	$8,250

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

[20] Unrounded numbers are used in the engineering calculations; these are then rounded in the table and the discussion.
[21] The cost per plant mile is the average cost of constructing a mile of outside plant for the fiber-to-the-premises network.
[22] 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.

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;
- 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.

3.4.2 Central network electronics costs

Central network electronics equipment to serve the unserved area will cost an estimated $1 million, assuming a 60 percent take-rate.[23] (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	$600,000
Fiber-to-the-Premises Access Electronics	$400,000
Total	*$1,000,000*

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.

[23] 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.

3.4.2.1 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.[24] 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 $600,000. 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.

3.4.2.2 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 $400,000. 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 alternative may be a suitable approach, which would reduce size of the fiber distribution cabinets and provide a small cost savings.

[24] 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.

3.4.3 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 $4.2 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 $1.2 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 (or approximately $3.0 million systemwide, assuming a 60 percent take-rate). 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	$1,250
Subscriber Electronics (Optical Node Terminal)	$200
Electronics Installation	$200
Installation	$100
Total	*$1,750*

3.5 Annual fiber-to-the-premises technical operating costs would total approximately $900,000

Some of the ongoing costs of operating a fiber-to-the-premises network include fiber maintenance, fiber locating, pole attachment fees, and equipment replacement (Table 8). 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 $330,000.

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 $90,000 annually for the estimated 50 miles of underground plant (i.e., 10 percent of the 478 miles of distribution fiber).

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 approximately $350,000 annually for approximately 430 miles of aerial plant i.e., 90 percent of the 478 miles of distribution fiber). 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 $140,000 into the equipment fund annually.

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

Description	Annual Cost
Fiber Maintenance	$330,000
Fiber Locating	$90,000
Pole Attachment Fees	$350,000
Equipment Replacement Fund	$140,000
Total	*$910,000*

4 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 the County's unserved Category 1 addresses using existing government and commercial 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 cover more than 3,400 addresses[25] (or approximately 87 percent of the homes in the Category 1 unserved areas) at an estimated cost of $11 million, assuming a 60 percent penetration rate. The network would leverage existing telecommunications towers where available and build new support structures where needed. It would use point-to-point wireless connections for backhaul connections.

The approach we outline below is divided into two wireless networks scenarios, each with its own budget, time to market, and number of addresses covered. The cost per address increases with the scenario number:

- Scenario 1: Use 30 existing telecommunications towers (includes two government-owned towers) to serve 3,197 unserved addresses at a cost of $8 million
- Scenario 2: Build eight new towers in strategic locations to cover an additional 286 unserved addresses at a cost of $2.7 million

4.1 Overview of analysis

We developed two fixed wireless network scenarios for serving Queen Anne's County's Category 1 unserved addresses:

- **Scenario 1:** Using existing towers to serve the unserved addresses
- **Scenario 2:** Using Scenario 1 towers, plus deploying new towers to serve additional unserved addresses

Table 9 summarizes the cost of the scenarios.

[25] We note that, in the event a wireless provider built the network in this model, it would also be capable of serving many customers in currently served areas, since those customers are also within the reach of the proposed antennas. The per address costs in this Section therefore are per (currently) unserved address—because the focus of this analysis is to determine the optimal way to reach those unserved addresses.

Table 9: Fixed Wireless Analysis Results

Scenario	Cumulative Towers & Coverage			Costs per Scenario		
	Number of Towers	Unserved Addresses Connected	Percent Served	Capital Cost	Average Distribution Network Cost per Connected Passing	Installation and CPE Cost per Customer
1	30	3,197	80	$8,000,000	$1,400	$1,800
2	38	3,483	87	$2,700,000	$16,000	$1,800

Note: Capital cost assumes a penetration rate of 60 percent for Scenarios 1 and 2.

In Scenario 1, we found that an average of more than 106 unserved addresses could be served by each of the 30 existing towers. In Scenario 2, we found that an average of more than 35 additional addresses could be served by each of the eight new towers.

Table 9 illustrates that fixed wireless technology can be a technically feasible approach to providing broadband to unserved addresses. Although there are technological limitations relative to a fiber optic service (as well as higher operational costs and a shorter technology lifetime), wireless technology has benefits in terms of lower capital costs and reduced time to deploy. Furthermore, as discussed below, new developments in wireless technology are improving the reliability and speed of wireless broadband, and therefore these technologies are a better option now than they were in the recent past.

The following sections:

- Provide a high-level introduction to fixed wireless connectivity (including technologies, basic architecture, spectrum, and elements of costs)
- Describe the use of existing and new structures to deploy a fixed wireless solution for the County's unserved homes and businesses

4.2 Introduction to fixed wireless network connectivity

Broadband speeds in compliance with the FCC's definition (i.e., 25 Mbps download, 3 Mbps upload—which is also the definition of "served" approved by Queen Anne's County for this project) 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 into the market and new wireless technologies. While wireless internet service providers (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 where there are few homes and

businesses per mile, and therefore the cost of building wired networks is often high. However, in areas like Queen Anne's County, foliage is still a significant obstacle to service, and the variation in the line of sight in a wireless service area corresponds to a wide variation in the quality of service to individual customers.

As opposed to an underground or aerial cable, wireless broadband is delivered via access point antennas mounted on towers or rooftops. Customers' antennas may be mounted on a building (i.e., the home or business) or on a mast on a customer's premises (Figure 16).

Figure 16: Sample Fixed Wireless Network with Various Customer Antenna Configurations

4.2.1 Fixed wireless spectrum and architecture

Fixed wireless networks typically 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

It is useful to determine which band may be most effective to use in different areas. Each band will need its own set of equipment; if one or more band can be eliminated from specific sites, then the overall cost of deployment and operations will be reduced.

Of these bands, only CBRS and 5 GHz unlicensed technology have channel widths capable of delivering 25 Mbps down and 3 Mbps up—so those are the two primary bands we considered. The CBRS band is predicted to connect the most addresses. (In addition to the spectrum properties, the ability to connect is due to the antennas being allowed to be mounted higher

than the TVWS antennas under the licensing rules of the FCC, and CBRS being allowed to have the greatest broadcast power of the three technologies.)[26]

That said, we also considered TVWS—which 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 stage of development, compatible equipment is far more expensive than other off-the-shelf wireless equipment. Finally, because Queen Anne's County has many existing broadcast television channels, the potential TVWS spectrum may be limited.

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 mountainous 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 Scenario, we assumed that the tops of any existing towers are 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. The Scenarios in this document assume point-to-multipoint equipment, which is typical for a residential or small business connection. Point-to-point service would typically be chosen by a medium-sized business, because it would enable dedicated bandwidth (at a higher cost than a point-to-multipoint service); that said, point-to-point networks may have limited network capacity, particularly in the upstream, making the service inadequate for applications that require high-bandwidth connections.

4.2.2 Fixed wireless network deployment costs

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

[26] CBRS channels may be preempted by incumbent users, such as the U.S. military, at unpredictable times, temporarily reducing the spectrum availability. The impact of this preemption has not yet been document in detail in broadband networks and depends on movements of the Navy fleet and its use of radar. The impact would likely only be on parts of the spectrum and would slow, rather than shut off, CBRS services.

- **Wireless equipment used:** Different wireless equipment has different aggregate bandwidth capacity and uses 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

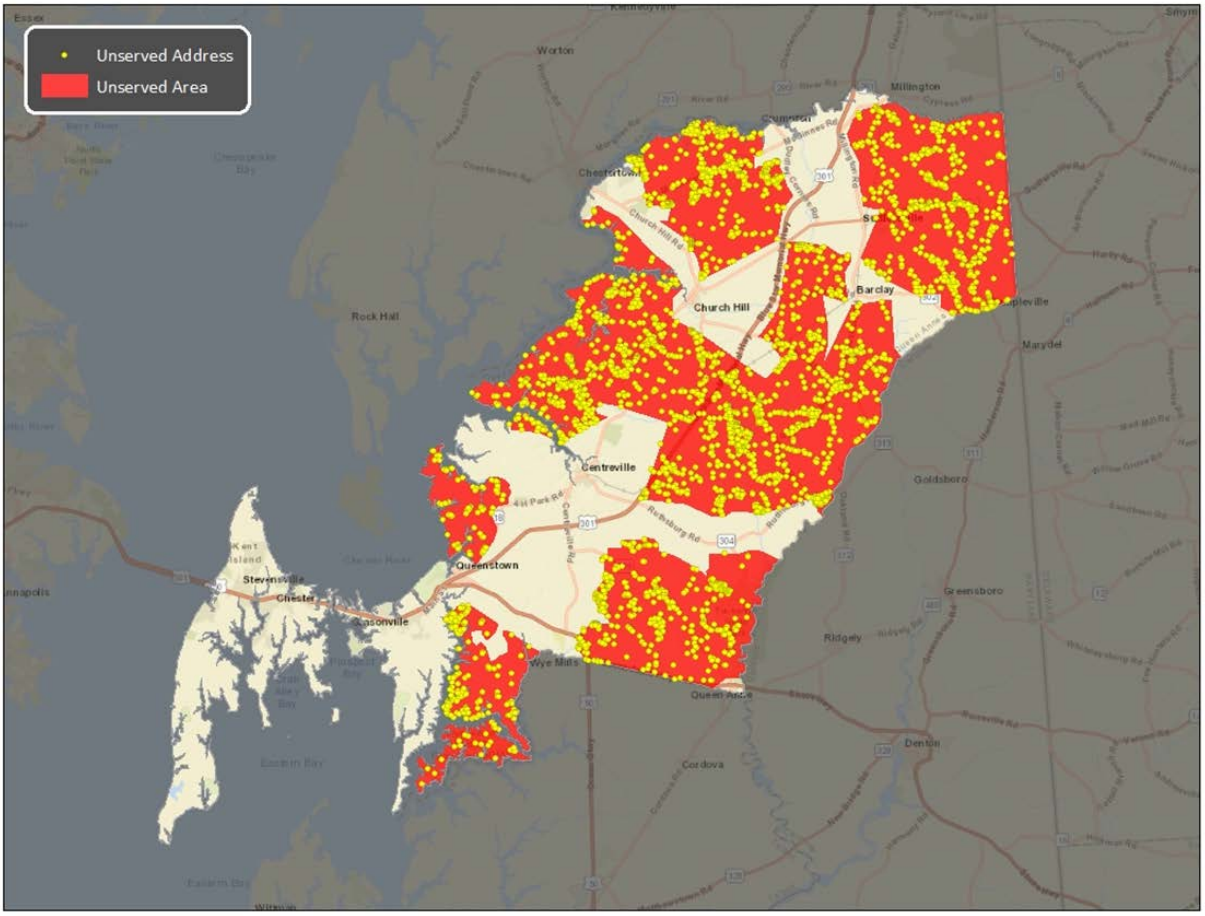
- **Future capacity and lifespan of investment:** Wireless equipment generally requires replacement every five to 10 years, both because exposure to the elements causes deterioration, and because the technology continues to advance at a rapid pace, making decade-old equipment mostly obsolete; the cost 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

4.3 Determining unserved areas and addresses in Queen Anne's County

CTC defined the unserved areas within the County based on a detailed analysis of current broadband service. Figure 17 shows the County's unserved areas addresses.

Figure 17: Unserved Areas and Addresses in Queen Anne's County



4.4 Analyzing radio frequency coverage

We conducted a wireless analysis to determine how the County's unserved address could be served via fixed wireless. The high-level scenario is for planning purposes only. The radio frequency (RF) coverage analysis was modelled using CloudRF, which is an online service available for modelling RF propagations. The software was chosen because of its ability to output coverage maps in a GIS layer than can be overlaid on the unserved address points, and therefore identify which of the addresses would be covered by the wireless scenario.

Various propagation scenarios are used for RF analysis. Widely used scenarios are Line of Sight (LOS), cost 231, Okumura Hata, and Longley-Rice (also called the irregular terrain model, or ITM). For our analysis we used ITM, which is the most conservative and takes into consideration the atmospheric conditions, the ground elevation, the deployment environment, the obstacles between the base and mobile stations, and the ground clutter.

We generated coverage propagation maps, such that the signal levels would achieve a minimum throughout for each of the frequencies used. For the 5 GHz and CBRS frequencies, the coverage

maps indicate the coverage area where throughputs of 25 Mbps download and 3 Mbps upload speeds could be achieved at the cell edge (Figure 18). Because TVWS will not achieve these throughputs, the coverage maps indicate areas where 10 Mbps download and 1 Mbps upload speed could be achieved.

4.5 Tower selection methodology

To examine the potential of antennas mounted on existing towers to provide service to the County's unserved addresses using CBRS, unlicensed 5 GHz, and TVWS, we analyzed multiple commercial and government databases and identified approximately 44 existing tower locations in Queen Anne's County. We examined their height and ownership relative to their potential use as part of a solution, then selected 30 of these existing towers (includes two government-owned towers) based on the number of addresses each could serve. (All towers that could cover fewer than five addresses were removed.)

For Scenario 2, our analysis indicates that constructing eight new towers would enable the network to serve an additional 286 addresses that could not be served by the existing towers in the County.

CTC assessed the coverage provided by each of the selected tower sites using the three fixed wireless frequency band options (CBRS, 5 GHz, and TVWS) to determine how many of the unserved addresses would be within each spectrum band's predicted coverage area. We based our analysis on the following assumptions:

- New towers would be 160 feet high
- Antennas on towers would be placed at 80 percent of the tower height for 5 GHz and CBRS, and at the maximum allowable height of 30 meters (about 98 feet) for TVWS
- Broadcast power would be at the maximum FCC limit for all three bands
- Channel bandwidth would be 10 MHz for the CBRS band
- Subscriber equipment antennas would be placed at 4.57 meters (15 feet) above the ground
- Ground elevation and clutter resolution would be 30 meters

4.6 Cost analysis

A cost analysis for each of the scenarios is provided in the sections below. The analysis makes the following assumptions:

- All served addresses will require the installation of subscriber equipment

- 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 costs include propagation studies, RF path analysis for point-to-point connections, structural analysis, construction plans, permits
- Site acquisition costs include 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
- Core network equipment to manage functions such as authentication, billing, security, and connection to the internet would cost $200,000 (including the equipment and setup of a core)
- The costs outlined are capital costs only and do not include operational costs

4.7 High-level coverage and cost estimate – Scenario 1

Of the 44 existing telecommunications towers presently in the County, 30 were identified which could serve at least five addresses within the unserved areas. Out of the 30 towers, two of them were government-owned towers.

Base stations and antennas deployed to those 30 towers could deliver service to an estimated 80 percent of the County's unserved premises. The blue shading in Figure 18 depicts the predicted coverage areas. The red indicates the remaining unserved areas. The dark blue dots show the existing tower locations.

Figure 18: Scenario 1 Coverage and Tower Locations

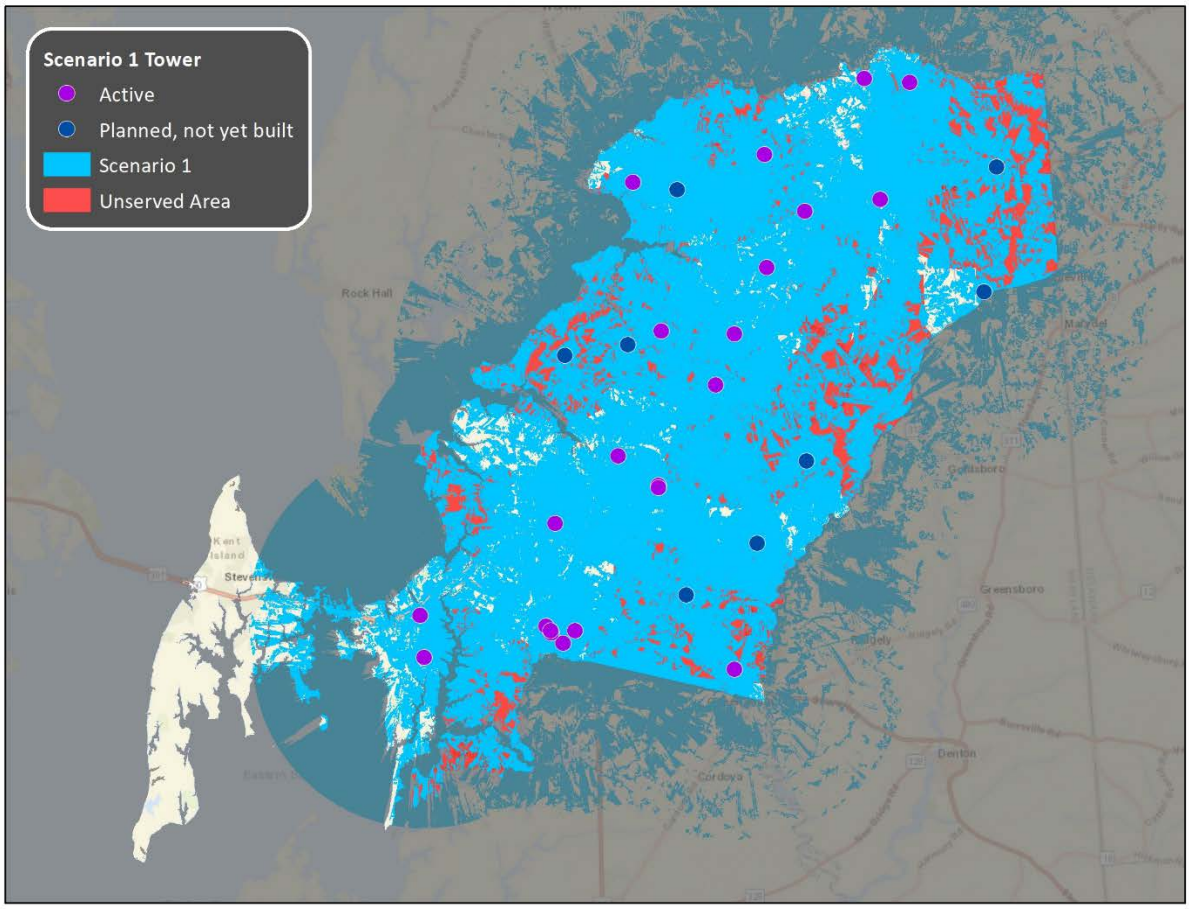


Table 10 indicates the penetration into the unserved addresses.

Table 10: Predicted Coverage with Existing Towers (Scenario 1)

Addresses	Number
Total addresses in unserved area	4,011
Addresses covered in Scenario 1	3,197
Addresses not covered	814
Percent of addresses covered	80%

The cost breakdown for Scenario 1 is shown in Table 11 and Table 12.

Table 11: Capital Cost Estimate for Scenario 1

Item	Cost
Network Core	$200,000
Access Point Equipment	$510,000
Microwave Backhaul	$450,000
Installation, Engineering, and Design	$2,100,000
Site Acquisition	$1,200,000
Total Distribution Network Costs	$4,500,000
Total Addresses	3,197
Cost per Unserved Address (Distribution Network Only)	$1,400

Table 12: Total Cost Estimate for Scenario 1 at Different Penetration Rates

Item	Cost
Total Incremental Cost (Distribution Only)	$4,500,000
Total Incremental Cost (35% Penetration)	$6,500,000
Total Incremental Cost (60% Penetration)	$8,000,000
Incremental Cost per Unserved Address (Distribution Only)	$1,400
Incremental Cost per Added Unserved Customer (35% Penetration)	$5,800
Incremental Cost per Unserved Customer (60% Penetration)	$4,200

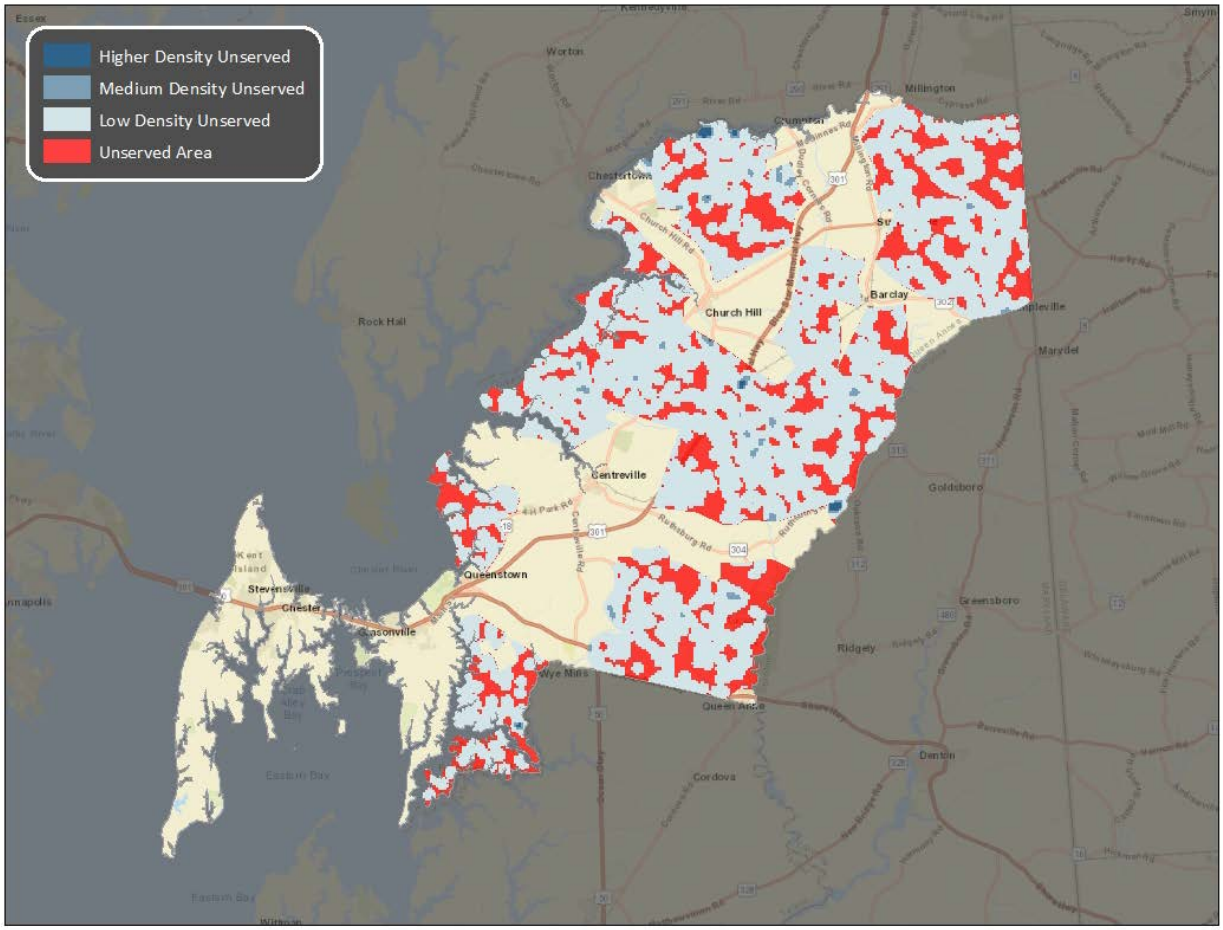
4.8 High-level coverage and cost estimate – Scenario 2

Scenario 1 does not reach all the addresses in the unserved areas. Our propagation analysis predicts there would still be 814 addresses, or 20 percent, in the unserved areas that would not be covered.

To reach more addresses, we determined where new towers could be built.

Figure 19 shows the heat map indicating high-, medium-, and low-density populations that are not covered by the antennas in Scenario 1. More homes are likely to be covered if antennas are deployed in the relatively high-density unserved areas. We selected these areas for Scenario 2 towers.

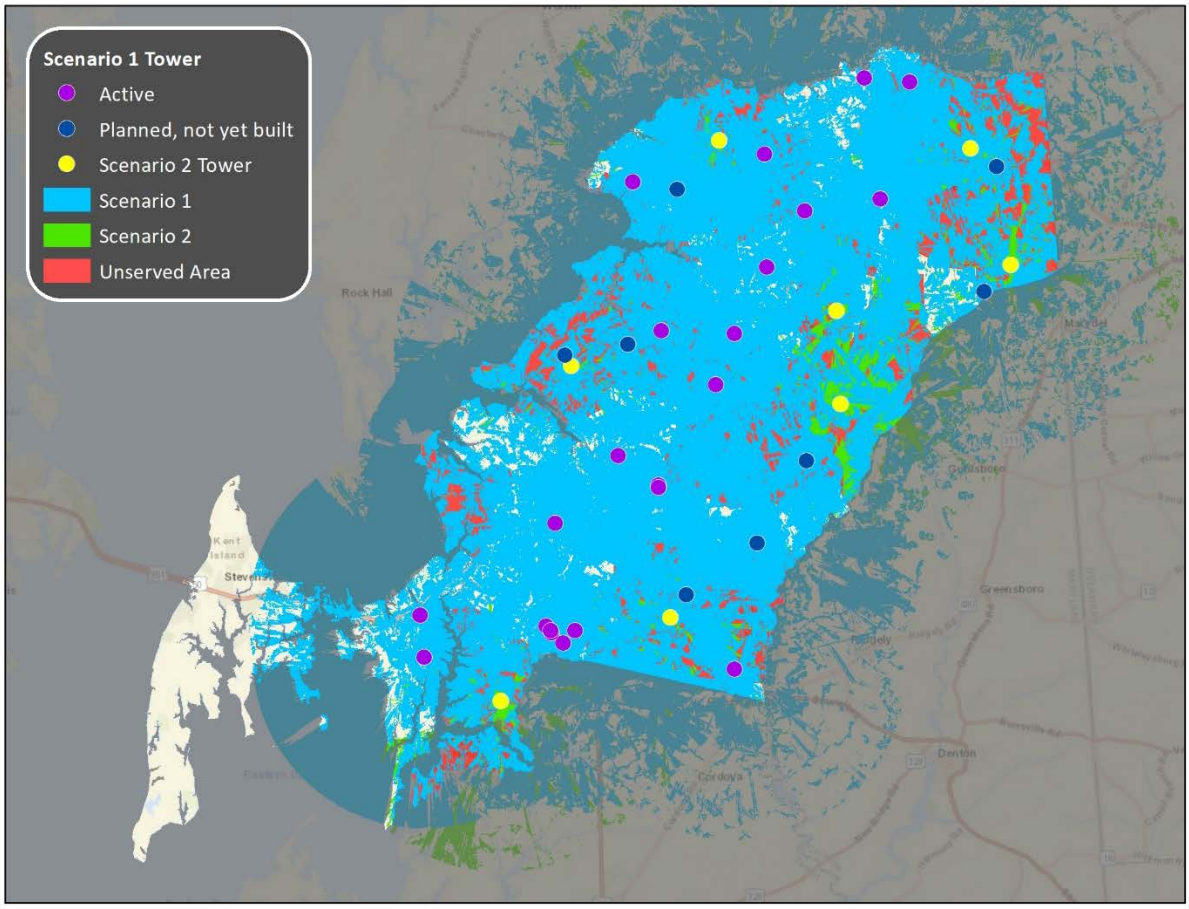
Figure 19: Population Density Heat Map for Remaining Addresses (Scenario 2)



CTC determined optimal locations for new towers based on their ability to reach the most unserved addresses, resulting in eight additional towers.

Figure 20 shows the resulting overall coverage (Scenario 1 + Scenario 2) after adding the eight new towers. An additional 286 unserved addresses would be served, leaving 528 unserved addresses. The blue areas indicate coverage by Scenario 1 existing towers. Green areas indicate additional unserved area covered by the new towers in Scenario 2.

Figure 20: Scenario 2 Coverage Using Existing Towers and New Towers



Our propagation analysis predicts that about 87 percent of the County's unserved addresses will be covered after building out Scenario 1 and Scenario 2.

Table 13: Predicted Coverage for Scenario 2

Addresses	Number
Total addresses in unserved area	4,011
Addresses covered in Scenario 1 & 2	3,483
Addresses not covered	528
Percent of addresses covered	87%

The following table shows the costs for the additional eight new towers. The assumptions are the same as for the existing tower sites.

Table 14: Additional Capital Cost Estimate for Scenario 2

Item	Cost
Building New towers	$1,200,000
Access Point Equipment	$135,000
Microwave Backhaul	$120,000
Installation, Engineering, and Design	$560,000
Site Acquisition	$320,000
Total Distribution Network Costs	$2,400,000
Total Addresses	286
Cost per Unserved Address (Distribution Network Only)	$8,200

Table 15: Additional Total Cost Estimate for Scenario 2 at Different Penetration Rates

Item	Cost
Total Incremental Cost (Distribution Only)	$2,400,000
Total Incremental Cost (35% Penetration)	$2,600,000
Total Incremental Cost (60% Penetration)	$2,700,000
Incremental Cost per Address (Distribution Only)	$8,200
Incremental Cost per Customer (35% Penetration)	$26,000
Incremental Cost per Customer (60% Penetration)	$16,000

5 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.[27]

A comparison of the two technologies must also recognize that fiber and fixed wireless each have technical advantages and challenges—and again, fiber-to-the-premises represents a better overall solution.

Fiber optics, once constructed, is the highest-speed and most scalable technology. Current off-the-shelf equipment enables fiber-to-the-premises networks to provide capacity in excess of 1 Gbps to each subscriber—and new electronics will enable those networks to go to 10 Gbps or beyond in the coming years. Moreover, fiber-to-the-premises networks are 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, fiber-to-the-premises 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 the requirement for permitting in the right-of-way (including on bridges, water crossings, and expressway crossings).

By comparison to fiber-to-the-premises, 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—lower than current fiber-to-the-premises capabilities.

It is important to note, too, that this is the aggregate capacity 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. That said, 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 because of the low population density in those areas. Additionally, deploying fixed wireless rather

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

than fiber-to-the-premises 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 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 in the candidate fixed wireless solution) costs approximately $60,000 per year. This is a critical consideration, because the fixed wireless model uses 30 existing towers, only two of which are government towers; with an average of about 110 serviceable passings (potential customers) per tower, the cost for tower leases alone exceeds $540 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 fixed wireless network, so equipment replacement significantly increases the network's ongoing cost.

6 Federal and State Funding Programs Present Opportunities for the 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 discussed below have the potential to assist the County's efforts to greatly reduce the number of unserved homes and businesses.

Determining which funding programs the County should target will depend on the identification of a willing partner, the County's ability and willingness to contribute capital to the effort, and the timing of the grants. That said, the state's grant program provides a very attractive funding options because the state is faithful to the federal 25/3 broadband definition of unserved, and does not have exclusions—meaning that the County could target some of the areas that are ineligible for federal grants.

The Rural Digital Opportunity Fund also stands out with its massive budget and program design that favors fiber optic solutions. The FCC announced eligible areas that cover a large portion of the unserved areas in the County; while those eligible areas are subject to existing providers' challenges, the window for contesting eligibility closes soon—and much of the County's unserved areas are likely to remain eligible.

6.1 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 (the Office), which is housed in the Department of Housing and Community Development, focuses on efforts to extend broadband service to unserved rural parts of the state "through partnerships with local jurisdictions and the private sector."[28] 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 potential federal ReConnect grant application (if the County determines that such an application would be feasible).

The unserved areas we documented in the PFSAs in Section 2 would be eligible for state funding—as would additional areas, because the state adopts the federal definition of broadband to delineate unserved areas. This is in contrast to federal grants which have exclusions, restrictions, and requirements that effectively shrinks the areas eligible for funding under its

[28] "Maryland Rural Broadband," Maryland Department of Housing and Community Development, https://dhcd.maryland.gov/RuralBroadband/Pages/default.aspx (accessed December 2019).

programs. Should the County be interested in pursuing a state grant, we recommend that it update the PFSA maps to allow for the full unserved areas to be targeted.

The Office announced the details of its rural Broadband Infrastructure Network Buildout Program, with grants of $1 million to $3 million (with a total of at least $9 million in available funding program-wide), in late November 2019.[29] While the deadline for the first grants has passed, we expect several more phases—with largely the same requirements—beginning in the third or fourth quarter of 2020.

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 cash match—for a project that delivers at least 25/3 service to an unserved area.[30] Our sense is that these requirements intentionally put larger companies in a better position to apply because of their access to cash for the required match and ability to file for larger grants. The proposed service area does not have to be contiguous and can cross county boundaries.

Awardees will not be eligible for future grants from the program in the awarded jurisdiction for two years or until construction is complete, whichever is later.

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 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." The County and its partner would be required to commit a 100 percent match for the funding, and to delivering at least 25/3 service. We anticipate that this pilot project program will have a similar timeline to the network buildout program, with a slightly earlier deadline in the next phase of funding.

6.2 USDA's ReConnect program represents a new, unique rural funding mechanism

The ReConnect program represents the most significant congressional appropriation of broadband funding since the Recovery Act in 2009—with $600 million allocated in 2019 and $550 million (with an added $100 million as part of the CARES Covid-19 response package) made

[29] "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).

[30] 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 (Maryland Department of Housing and Community Development) and Priority Funding Areas (Maryland Department of Planning).

available in 2020. The program awards loans, grants, or a combination of the two for last-mile connections in rural areas—with priority given to private-sector applications and public-private partnerships. It is overseen by the Rural Utilities Service (RUS). The most recent round of grant applications opened on January 31, 2020, and closed April 16, 2020. However, the program is well regarded in Congress and future rounds are considered likely.

Congress created a significant barrier to ReConnect funding for the County when it wrote the legislation: It made ineligible any areas for which another grantee or loan recipient has received a previous broadband award. This is not relevant for eligibility for any current funding opportunities for Queen Anne's County, since there are no areas for which federal funding was previously awarded in the County. But it is relevant for the County's consideration of appropriate partners for ReConnect applications: A fixed wireless provider receiving an award from this program would be protected from any other subsequent applicant for the entire originally funded service area for up to 10 years.

Our models for fixed wireless, however, have not found a way to serve all unserved premises in a claimed service area, and the County would therefore risk have no remedy for those unserved premises for the entire, long protection period. And, as discussed, the actual network performance within a fixed wireless service area varies widely from customer to customer. We therefore recommend the County prioritize applications to ReConnect for wireline solutions, or write in robust remedies as conditions of support with the partner to manage risks.

The recent round of the ReConnect program comprised 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. Funds will go to rural areas where 90 percent or more of the households lack access to broadband speeds of at least 10 Mbps download and 1 Mbps upload. (In Round 1, 100 percent of the households in the PFSA had to lack access to 10/1 Mbps broadband for 100 percent grant awards.)

Applicants had to 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 a point of distinction. Awarded applicants for 100 percent grant awards will need to provide matching funds equivalent to 25 percent of the project's total 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 could 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 continue to prioritize private-sector applications and public-private partnerships, so it will be important for local governments to build a public-private

partnership strategy for future rounds of this program. RUS will consider public networks that lack extensive experience to be startups and may disfavor their applications. Should the County decide to take the lead, it should partner only with entities with extensive experience as an ISP to compete for these funds. 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.

Applications to this program will require a detailed business plan and pro forma. RUS will grant application review points based on those plans, as well as many other 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. Furthermore, points will be awarded for projects in states with an updated broadband plan in the past five years.

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 considerably larger in total dollars, we anticipate that ReConnect will make more awards. Further, ReConnect does not have the low-income requirements of Community Connect, making it a more flexible program.

6.3 The FCC's Rural Digital Opportunity Fund is a promising opportunity

6.3.1 The Rural Digital Opportunity Fund is the latest iteration of a 20-year-old effort

The Rural Digital Opportunity Fund (RDOF) 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 and underserved 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.

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.[31] The total amount of support awarded was 70 percent less than the Connect America Cost Model (CAM) estimated would be needed.[32] 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.

6.3.2 Parts of Queen Anne's County's unserved areas are eligible for Rural Digital Opportunity Fund subsidies

The Rural Digital Opportunity Fund builds on the success of the CAF Phase II auction, and will 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."[33] 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 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.

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[31] "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).
[32] 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).
[33] "Fact Sheet – Rural Digital Opportunity Fund Information," FCC, https://www.fcc.gov/auction/904/factsheet (accessed April 1, 2020).

Unlike in the most recent round of ReConnect, the FCC will fund areas that lack 25/3 service—even those that have another subsidized competitor. Also, unlike the USDA or state funding programs, the Rural Digital Opportunity Fund grant does not involve a discovery and documentation process for delineating unserved areas. Instead, it relies on Form 477 data with some further restrictions as mentioned earlier. The initial maps of eligible areas were released March 17, 2020, and are illustrated in Figure 21 and Figure 22. An overlay of the Category 1 unserved areas and these Rural Digital Opportunity Fund-eligible areas illustrates the narrower assumptions of eligibility adopted by the FCC for this round of the Rural Digital Opportunity Fund. Nevertheless, it shows some promises for reaching a substantial number of unserved addresses in the County. The overlay can be seen in Figure 23.

Figure 21: Areas Identified as Initially Eligible for Rural Digital Opportunity Fund

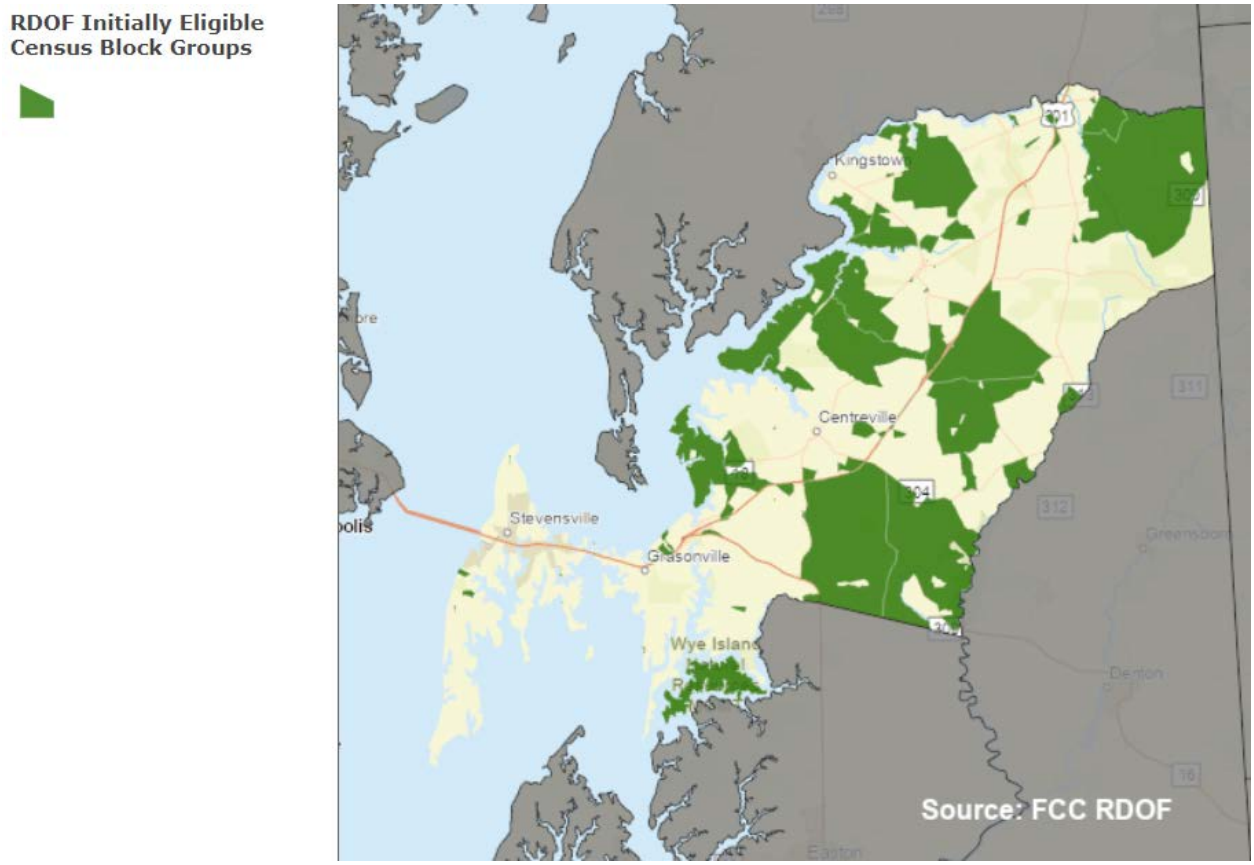


Figure 22: Areas Identified as Initially Eligible for Rural Digital Opportunity Fund – Unserved Addresses

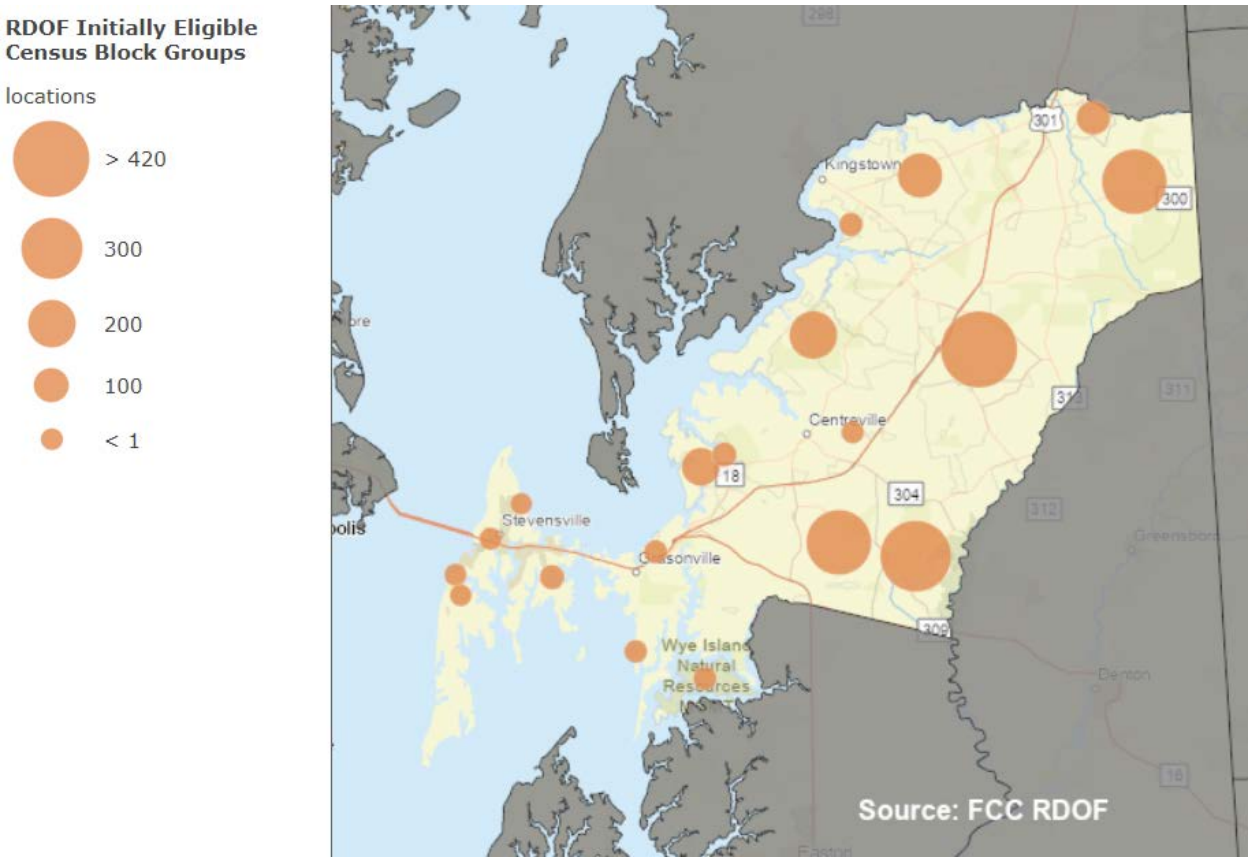
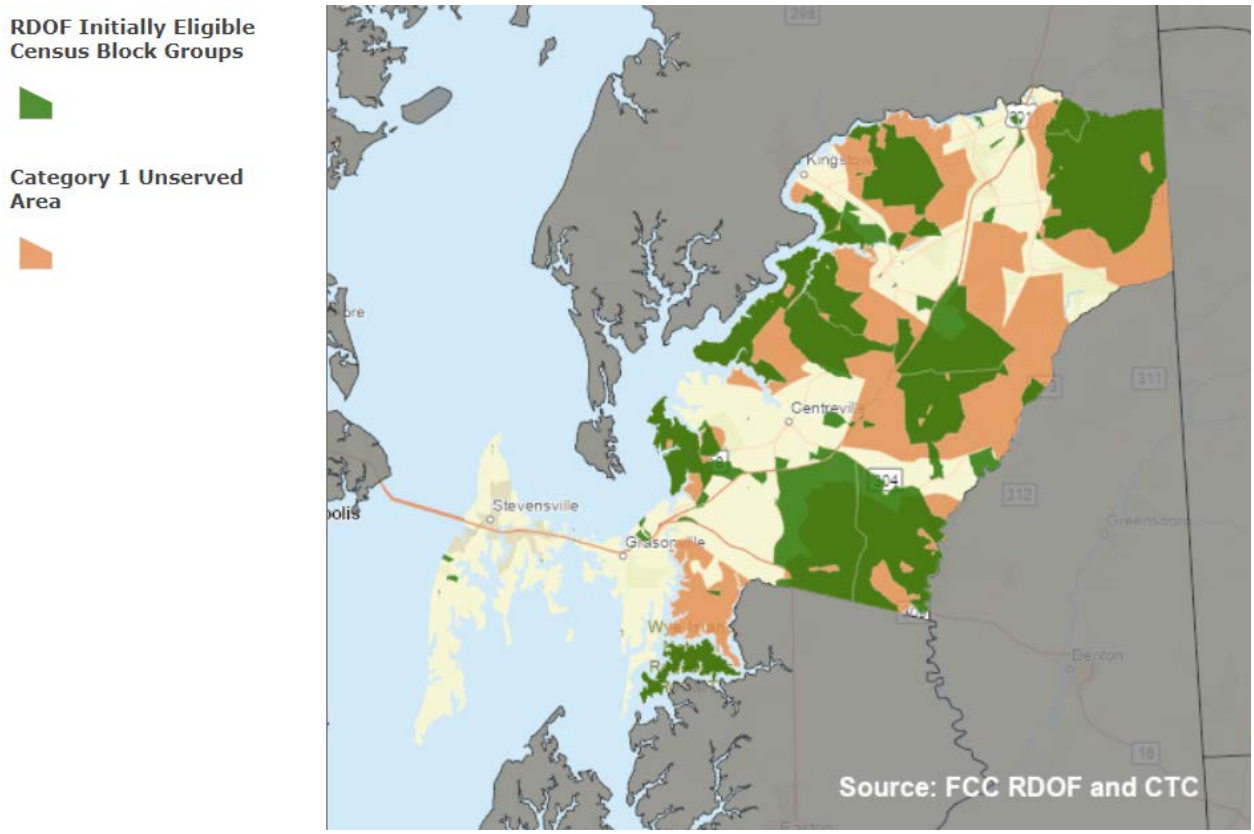


Figure 23: Initially Eligible Rural Digital Opportunity Fund Census Block Groups vs 25/3 Unserved Areas



The FCC will be using a reverse auction mechanism almost identical to the one used in the CAF Phase II auction, though this time incumbent price-cap carriers will not have the right of first refusal.

The FCC has announced it will be awarding funds through two phases, the first focused on those areas wholly unserved by broadband at speeds of 25/3 Mbps, and the second on partially-served areas. 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.[34] In fact, to incentivize more sustainable approaches to broadband deployment such as fiber and cable approaches rather than fixed wireless and satellite, FCC

[34] 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).

changes the weights assigned to the different proposed technologies further in the direction of higher speeds and lower latency.[35]

The biggest change the FCC adopted was 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 to census block groups, census tracts, or counties.

While the FCC had considered adding a subscribership benchmark[36] to the awardee to ensure that a high percentage of unserved addresses in the area would receive service, it ultimately decided not to include such a requirement as it concluded it would discourage bidders and change the program from a deployment to an adoption program. Should the County partner with a bidder or support a bidder directly or indirectly, it should therefore consider agreeing on targeted benchmarks of adoption as well.

The FCC did adopt a deployment benchmark so 40 percent of the targeted buildout need to be completed by year 3. If this benchmark is not met, the awardee will need to notify the FCC and will have six months to come into compliance to avoid a default.

In addition, the FCC has made some additional changes from CAF II to incentivize bidders further to build in unserved areas: The threshold for allowing CAM subsidies for unserved areas have been lowered from $52.50 to $40 to reflect that areas that many areas that were thought to have sufficient ROI not to require federal subsidies to attract deployment have remained unserved. And to reflect the particular difficulties for deployment on tribal lands, the threshold was lowered to $30.[37]

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. However, the Rural Digital Opportunity Fund does exclude previously funded and executed projects that include the same areas, so the timing of executing state funding awards for designated areas, and delineating those areas to which the County and its partner(s) apply for the Rural Digital Opportunity Fund, need to be aligned if the County and its partner want to leverage multiple funding sources to maximize support and the areas targeted.

[35] Federal Communication Commission, "Rural Digital Opportunity Fund, Connect America Fund - A Rule by the Federal Communications Commission on 03/10/2020". https://www.federalregister.gov/documents/2020/03/10/2020-03135/rural-digital-opportunity-fund-connect-america-fund (accessed March 2020).
[36] Federal Communication Commission, "Rural Digital Opportunity Fund, Connect America Fund."
[37] Ibid.

6.4 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. The eligible areas for funding are therefore identical to the PFSAs developed for the ReConnect grant, but with an additional low-income requirement.

Grantees must ultimately offer service at the broadband grant speed (defined as 25 Mbps download, 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,[38] 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

[38] Critical community facilities include public schools, public libraries, public medical clinics, public hospitals, community colleges, public universities, law enforcement, and fire and ambulance stations.

spectrum, towers, and buildings as part of the project design.[39] The lesser of 10 percent of the grant or $150,000 can be used to construct, acquire, or expand an existing community center.[40]

6.5 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 delivered funds to distressed communities for many years. Public broadband projects in economically distressed communities are eligible for funding under the Public Works and Economic Adjustment Assistance (PWEAA) programs—which do not require that an area is unserved, but do require that jobs be created or saved as a direct result of the proposed project.

The EDA program coordinates with a $587 million grant program[41] 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,[42] 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.[43]

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. Additionally, the program does not require proof of lack of service or poor service. Instead, a proposed project must demonstrate that it will positively affect the economic prospects of the area; generally, in the form of addition of or saving of jobs. A local community economic development plan that highlights a need for better broadband will be an essential first requirement.

[39] Leasing costs can only be covered for three years.
[40] 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.
[41] See https://www.grants.gov/view-opportunity.html?oppId=302953 (accessed November 2019).
[42] "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).
[43] EDA annual reports available online at: https://www.eda.gov/annual-reports/ (accessed November 2019).

The PWEAA Notice of Funding Opportunity (NOFO) emphasizes the importance of consulting with the appropriate regional EDA contacts.[44] 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.[45]

[44] "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).
[45] EDA regional contacts available online at: https://www.eda.gov/contact/ (accessed November 2019).