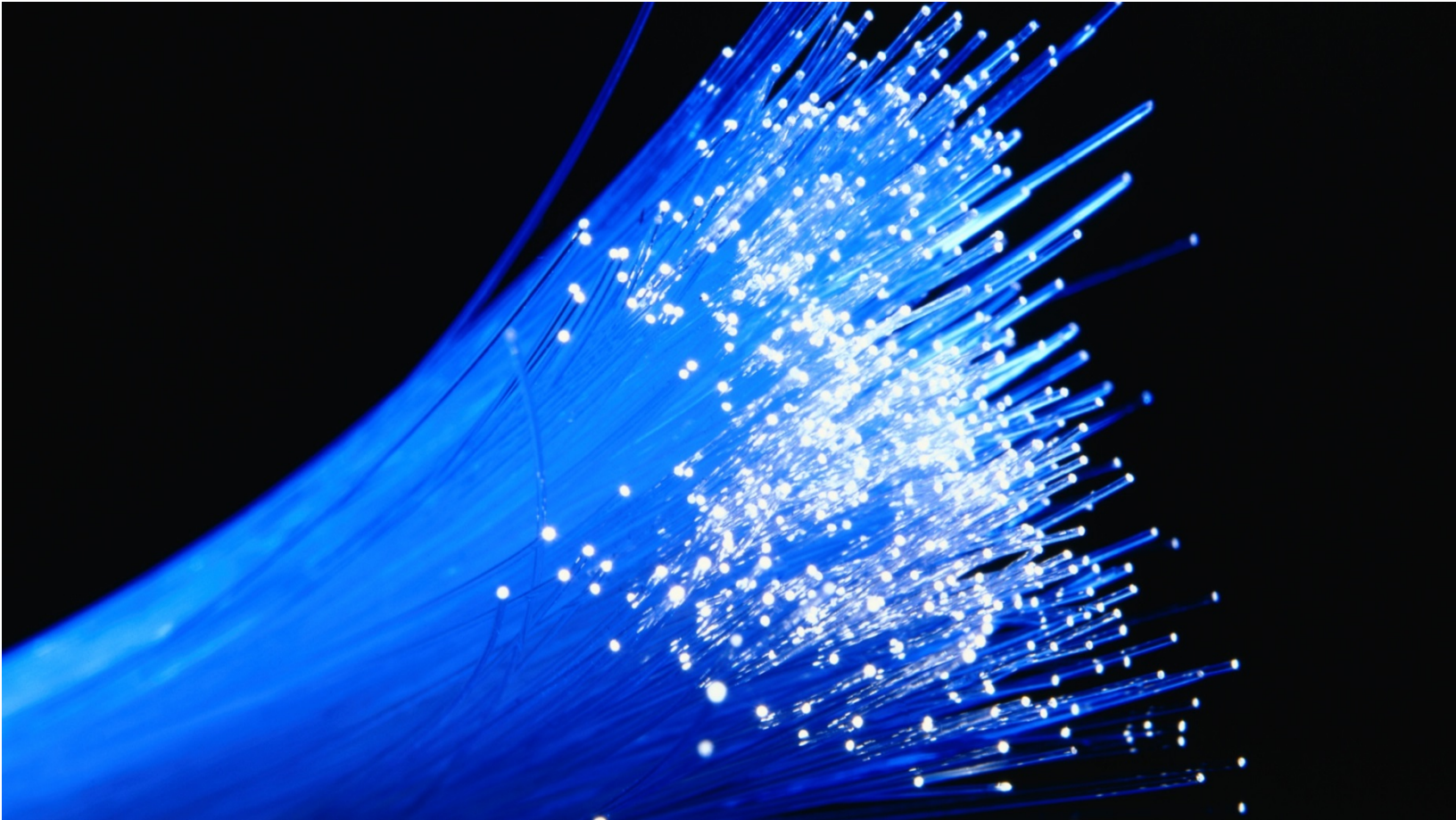


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## **Executive Report: Broadband Network Design and Business Case**

**Prepared for Loudoun County, Virginia  
February 2019**

**Contents**

- 1 Introduction 3**
- 2 Project Findings 4**
  - 2.1 Internet access is available to most residents in western Loudoun—but true broadband is only unevenly available 4*
  - 2.2 Broadband services in western Loudoun are not at parity with services available in the eastern County 5*
  - 2.3 The economics of rural broadband—and the nature of federal funding opportunities—mean that a County investment would be required to achieve parity 6*
    - 2.3.1 Sparsely populated areas like western Loudoun do not offer ISPs enough customers to justify ubiquitous fiber deployment 6*
    - 2.3.2 Federal funding programs generally focus on completely unserved communities 7*
  - 2.4 Creating parity would require a roughly \$130 million capital investment 7*
  - 2.5 The ISP industry’s interest in creative partnerships with the County suggests that less costly, incremental improvements are possible 8*
  - 2.6 A middle-mile fiber deployment to key County facilities and towers would cost \$16 million—and would offer the County government operational benefits while lowering barriers to ISP investment 9*
- 3 Recommendations 11**
  - 3.1 Consider, with caution, deploying FTTP in western Loudoun 11*
  - 3.2 Consider deploying middle-mile fiber to key County facilities in western Loudoun 11*
  - 3.3 Consider deploying middle-mile fiber to County facilities through a public-private partnership 11*
  - 3.4 Support ISPs in applying for federal grants 12*

## 1 Introduction

This summary report discussed options for Loudoun County, Virginia for bringing broadband service in western Loudoun to parity with the services available in the more densely populated eastern portions of the County.

This document summarizes the comprehensive report commissioned in spring 2018 by Loudoun County government. It reflects the County's ongoing efforts to ensure that all residents and businesses have access to high-speed, affordable broadband services—including in the Blue Ridge and Catoctin election districts in the rural western portion of the County.

As the County's consultant, CTC Technology & Energy (CTC) performed the following tasks at the County's direction:

- Conducted residential market research to identify broadband needs
- Evaluated the retail broadband market in western Loudoun County to identify the types of services available and their related pricing
- Facilitated discussions with internet service providers operating in western Loudoun to learn what market forces or County support might enable them to expand their service offerings
- Prepared a high-level network design, cost estimate, and financial analysis for a middle-mile fiber optic network deployment that might help ISPs fill broadband gaps in the western portion of the County<sup>1</sup>
- Prepared a high-level cost estimate for a fiber-to-the-premises (FTTP) network that would bring western Loudoun to broadband infrastructure parity with the eastern County
- Analyzed federal 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 western Loudoun

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<sup>1</sup> The scope of work (SOW) for this study included a middle-mile fiber conceptual design connecting the Catoctin and Blue Ridge election districts (which make up the western part of the County), Leesburg, and certain identified data centers.

## 2 Project Findings

Residents of western Loudoun County have access to a mix of internet and broadband<sup>2</sup> services, but robust broadband services are not uniformly available there—as they are in the more densely populated eastern portion of the County.

Because of the challenging economics of broadband deployment in rural areas, private ISPs will not invest in ubiquitous broadband infrastructure in western Loudoun. And because current federal grant opportunities generally apply only to completely unserved areas, federal funding is not an option for a comprehensive broadband solution, either.

Bringing western Loudoun to parity with eastern Loudoun would thus require the County to invest an estimated \$130 million in a fiber-to-the-premises (FTTP) network. Absent that investment, though, the County could pursue less costly strategies that might move the needle in important ways—such as through County investment in middle-mile fiber to support ISPs that seek to expand their services.

### 2.1 Internet access is available to most residents in western Loudoun—but true broadband is only unevenly available

Our analysis of available fiber, cable, digital subscriber line (DSL), fixed and mobile wireless, and satellite services demonstrates that **very uneven patterns of internet access exist in most of the western County**. Some of the services (e.g., DSL, satellite, some fixed wireless services) are insufficient to meet the federal definition of broadband. The services that do meet that 25 Mbps/3 Mbps threshold are available in many parts of Western Loudoun but are not ubiquitous.

This assessment demonstrates that the broadband picture in western Loudoun is not quite as dire as perhaps had been anticipated. More importantly, the wide but uneven availability of broadband services in western Loudoun indicates that **the County's ongoing efforts to promote broadband deployment, and particularly its encouragement of the wireless ISP (WISP) industry, have been effective in expanding the availability of fixed wireless in the west**.

The availability of broadband service to most portions of western Loudoun is testament to the County's friendliness toward internet businesses, the County's very productive pro-internet development policies, and County staff's ongoing efforts to support broadband availability.

That said, **the availability of broadband options for individual residences and businesses depends on location**. For example, while Comcast is the primary provider of residential wired service in the County, Comcast is less likely to provide service to sparsely populated areas. Several

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<sup>2</sup> Defined by the Federal Communications Commission as a 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>.)

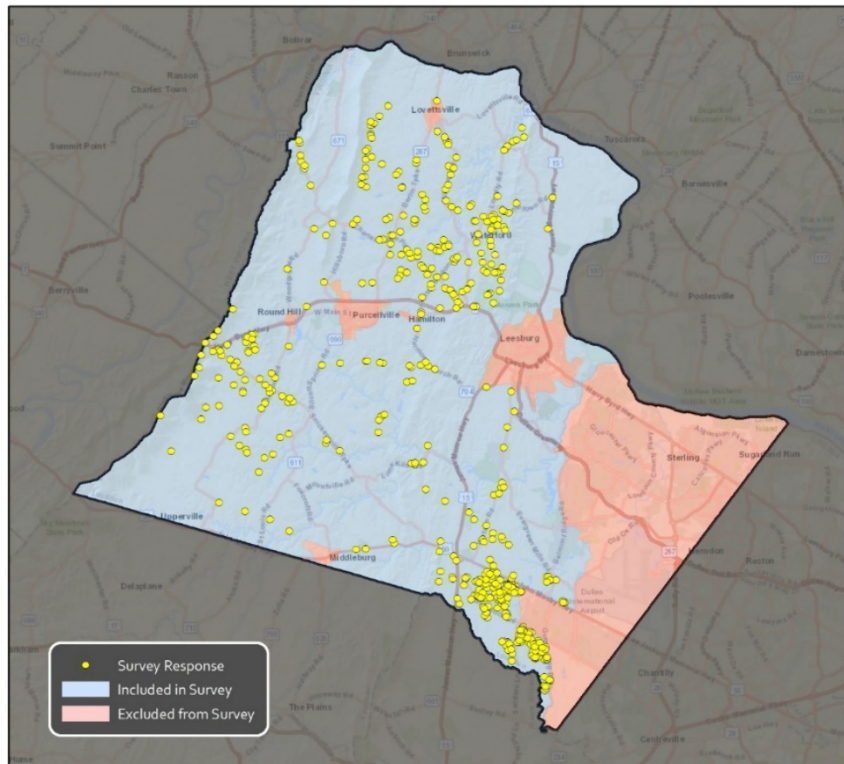
fixed wireless providers offer service, filling in some gaps, and DSL and mobile wireless services are also available. In some areas, there is limited FTTP coverage. Satellite services are generally available throughout the two districts.

## 2.2 Broadband services in western Loudoun are not at parity with services available in the eastern County

Analysis of survey data indicates that residents in western Loudoun have a high level of internet connectivity—though not necessarily at broadband speeds—and that many residents have deep concerns regarding the speed and reliability of their services.

The County surveyed residents in western areas of the County in 2018 to gain insight into residents' experience with broadband and internet services. The map below illustrates the locations of responses.

Map of Survey Responses



Survey results match the market assessment's findings; they indicate **that residents in the overall survey area are highly connected, with 96 percent of households having some form of internet connection.** Specifically, 85 percent of residents have home internet service, 84 percent have a cellular/mobile telephone with internet, and 72 percent have both.



However, despite this generally high level of internet use in western Loudoun, the survey results indicate that **one-half of internet subscribers in western Loudoun have only low to moderate satisfaction with the speed and reliability of their services**. These results match anecdotal reports the County has received about poor internet service.

A sizeable segment (nearly one-fourth of all subscribers) has very low satisfaction and perceives their connection speed to be slow or very slow. This segment is concentrated more in the Catoctin District, where there is less use of fiber internet connections and greater use of fixed wireless or other internet connection types.

### **2.3 The economics of rural broadband—and the nature of federal funding opportunities—mean that a County investment would be required to achieve parity**

There does not exist a federal grant or a private sector investment strategy that will support the investment needed to create infrastructure parity in western Loudoun.

For the private sector, the area is too costly to build on a per-customer basis (given the low population density) to merit extensive investment in the types of broadband available in eastern Loudoun. For federal grant-makers, the area does not generally qualify for funding programs because, even though the internet service is not satisfactory to many residents, the availability of 10 Mbps/1 Mbps means the area is not eligible for funding (other than in small pockets where no service exists).

#### **2.3.1 Sparsely populated areas like western Loudoun do not offer ISPs enough customers to justify ubiquitous fiber deployment**

Western Loudoun County faces the same challenges as other rural communities in terms of attracting broadband infrastructure investment. 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 Maryland's Eastern Shore—the economics simply do not exist for rural broadband deployment absent substantial government funding. The private sector will not build costly wireline infrastructure to reach all homes and businesses in rural 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 more stark because broadband is traditionally thought of as an area of private investment, rather than public investment. And yet the economics do not exist for private 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.

### **2.3.2 Federal funding programs generally focus on completely unserved communities**

Even absent parity with the east, the level of existing fixed wireless and other services in the western portion of the County effectively precludes the possibility of significant federal grant funding to support the expansion of broadband infrastructure there. That is because, in significant parts of the west, there is internet service that exceeds 10 Mbps/1 Mbps—which is generally the metric used as a minimum requirement for federal broadband funding eligibility.

With the exception of some unserved pockets, there does not exist a federal funding strategy for addressing the entirety of western Loudoun. While the available broadband services in that area may not be comparable to the services available in eastern Loudoun, the level of existing fixed wireless service is sufficient that it disqualifies western Loudoun with respect to significant federal grant and subsidy programs.

### **2.4 Creating parity would require a roughly \$130 million capital investment**

Bringing broadband infrastructure parity to western Loudoun would require the construction of a robust wireline connection to every home and business. Our analysis suggests that deploying an FTTP network in western Loudoun would cost up to \$130 million or more for capital costs alone, not including operating expenses.

We developed this estimate—which assumes a relatively high, 50 percent take rate (or the percentage of residences and businesses that choose to buy service)—based on high-level engineering that considered a range of factors that might affect fiber deployment costs, from the availability of utility poles to the number of fiber route miles necessary to reach every home and business in the two western Loudoun districts. The costs would be higher if more than 50 percent of the households and businesses chose to purchase service, given that there would be additional costs to connect all those homes with fiber from the road as well as electronics.

The capital costs include outside plant construction to pass all premises, the electronics necessary to operate the network, and fiber drop connections to individual subscribers.

Our engineers estimated the average cost per passing (to build fiber along all roads in western Loudoun, such that all premises have the potential for services in the Blue Ridge and Catoclin districts, based on the size, density, and topographical conditions of each. At the low end, that cost might be \$6,000. Realistically speaking, it would likely be \$7,500 to \$9,000 per passing. By comparison, in eastern Loudoun, the per passing cost would be in the \$1,500 to \$2,500 range, depending on the population density and the amount of underground construction, among other factors.

The construction costs may be reduced modestly if it is possible to leverage existing infrastructure in pockets of high-density developments in western Loudoun. But the fact remains

that the cost to build FTTP in western Loudoun is likely to be at least four times that of many metropolitan areas on a per premises basis.

Even though the market is attractive, there simply are not enough customers in western Loudoun for revenues to cover the costs of debt service and operations, which will be considerable. In the event that the County were to build and operate FTTP throughout the west, our expectation for a best-case scenario is that consumer revenues would cover approximately half of the debt service, and none of the operating costs.

In another scenario we have considered, in which the County would build the fiber and lease it to a private provider that would then purchase equipment and operate the network, we think that the return to the County would be similarly low. In similar projects we have negotiated in recent years, even the most flexible of private partners have offered lease fees to the government entity that that would be less than 25 percent of the County's likely debt service. Although the County's operating costs would be lower because the ISP would purchase equipment and operate the network, the County would still incur operating costs related to maintaining and managing the fiber infrastructure that would not be recovered.

This analysis is consistent with everything we know of the challenges of deploying rural infrastructure—and highlights the enormity of the challenge of bringing parity to western Loudoun relative to eastern Loudoun, absent a willingness by the federal government to help fund these kinds of initiatives.

## **2.5 The ISP industry's interest in creative partnerships with the County suggests that less costly, incremental improvements are possible**

Notwithstanding all these challenges, the competitive ISP industry in western Loudoun County is very interested in creative partnerships with the County (i.e., County support of various sorts) to reach the most remote areas of western Loudoun.

Over the course of the field work for this project, CTC analysts reached out to all (and subsequently spoke with a majority of) ISPs that are active in western Loudoun. While the larger incumbents did not respond to our requests for meetings, many of the smaller competitors were very willing and helpful in sharing data and ideas. We spoke extensively with a range of providers that have deployed wireless technologies—and, in a few cases, fiber.

There clearly is a vibrant community of competing smaller, entrepreneurial ISPs in the western part of the County. They range across the full geography of the west—some focused further north with corresponding holdings in Pennsylvania or Maryland, and others in the central or southern part of western Loudoun with further operations in West Virginia or other parts of Virginia.



Without exception, these ISPs indicated a willingness to partner with the County—with the expectation that the County could facilitate and support better and more extensive service in western Loudoun. All of the ISPs signaled some interest in access to County-owned fiber where feasible, both to supplement existing fiber and to provide more viable pricing than is frequently available on the commercial market, where high costs may make some existing fiber infeasible for use by a small provider.

Also, without exception, the ISPs signaled interest in collaborative efforts to leverage federal grant funding such as the U.S. Department of Agriculture's (USDA) emerging ReConnect program. But all noted that the paperwork-intensive, costly federal grant application process was burdensome for small companies—and that County support would be a necessary prerequisite to any ISP grant application.

In one case, a WISP's representative suggested the County should consider removing all permitting and process requirements for placement of wireless towers of up to 100 feet. One other WISP suggested a more streamlined process for towers of up to 50 feet. None of the other WISPs interviewed raised this particular consideration or flagged the tower permitting process as creating challenges. Generally, the consensus was that the sheer capital cost to build to low-density areas in the west, as well as the challenges of using wireless technology in areas where foliage and geographical features reduce the functionality of wireless signals, are the core problems faced.

## **2.6 A middle-mile fiber deployment to key County facilities and towers would cost \$16 million—and would offer the County government operational benefits while lowering barriers to ISP investment**

If the County were to construct a middle-mile fiber optic network to connect key government facilities in western Loudoun, it could replace the existing I-Net fiber in Leesburg and connect to third-party data centers to meet the County's internal connectivity needs. This approach would offer the County improved internal services to these facilities.

At the same time, for purposes of addressing the County's interest in achieving broadband parity between eastern and western Loudoun, this middle-mile approach might enable the County to lease excess fiber to ISPs, which would lower their barriers to deploying broadband services. In addition, the middle mile fiber, given that it is designed to come to or near certain critical tower locations, could enable significant new wireless deployment (in new spectrum bands like the 3.5 GHz band that is being made available by the FCC) to enable better wireless service in the west.

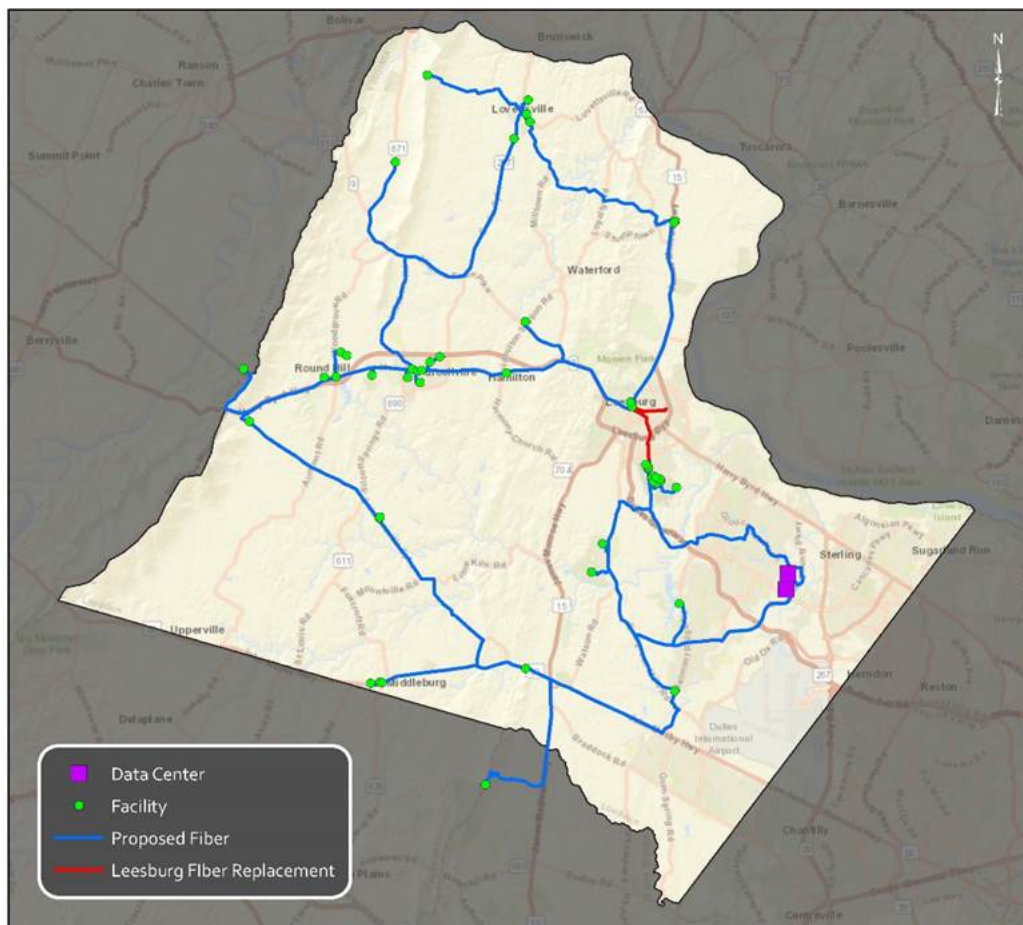
In sum, the network would be designed for the following priorities:

- Provide fiber connectivity to County facilities in western Loudoun

- Replace aging I-Net fiber in Leesburg with a high strand count fiber optic cable that is wholly owned by the County
- Provide fiber connectivity to two private datacenters in Ashburn where the County will lease space to host County servers and peer with the top-tier ISPs
- Provide sufficient fiber strand capacity so that private companies may lease strands to support their fiber or wireline deployments

The network would comprise approximately 140 route miles of fiber connecting a total of 60 sites, would cost approximately \$16.1 million to build. Over the course of 20 years, network operations, maintenance, and financing will cost the equivalent of approximately \$2,290 per site per month, or a total of \$1.65 million annually. The following map illustrates the routing of the network considered.

System-Level Middle-Mile Fiber Network Architecture



### **3 Recommendations**

An FTTP deployment in western Loudoun would comprehensively address the issue of broadband parity in Loudoun. If the County chooses not to invest in FTTP, it has other, less costly options that could lead to consequential improvements in broadband options for the least well served residents and businesses in that part of the County.

#### **3.1 Consider, with caution, deploying FTTP in western Loudoun**

Because it is the only comprehensive way to create broadband infrastructure parity, the County could, in the long term, consider deploying an FTTP network to connect all residents and businesses in western Loudoun. This approach would, potentially, provide ubiquitous access to connectivity at the highest technically available speeds.

But constructing an FTTP infrastructure would involve significant financial risks for the County: It would require a large capital investment on the order of \$130 million and possibly considerably more—with no feasible payback strategy—and a long-term commitment to sustaining network operations.

#### **3.2 Consider deploying middle-mile fiber to key County facilities in western Loudoun**

Building the middle-mile fiber described above—for an estimated capital cost of \$16.1 million, and with ongoing annual operating costs of about \$1.65 million—would lower ISPs' financial barriers to improving and expanding their fixed wireless services in western Loudoun while also meeting the County's own communications needs at 60 facilities.

This middle-mile strategy would not pay for itself (i.e., the County would need to commit to the capital investment and ongoing operations), but it would achieve two types of benefits. First, the County would have robust fiber connections to its facilities. Second, the availability of the County's fiber would be a relatively low-cost, low-risk way to incent WISPs in western Loudoun.

Spending on middle-mile fiber does not guarantee last-mile outcomes, so there is real risk that this investment will not dramatically improve the last-mile environment. But feedback from some of the existing WISPs in western Loudoun indicates that the availability of fairly priced middle-mile fiber will be helpful to WISPs that have an interest in incrementally expanding their footprints.

#### **3.3 Consider deploying middle-mile fiber to County facilities through a public-private partnership**

The County can also consider preparing a procurement for a public-private partnership to deliver fiber-based capabilities to the government facilities in the west; such an approach might enable the County to benefit from private sector execution while securing the efficiency benefits

of a competitive process. In this model, the County would use a competitive process to procure service to the 60 County locations in the western part of the County. The goal would be to incent and catalyze private fiber deployment to those locations, with the excess fiber (that not used by the County) available for the vendor to lease either dark fiber or leased services to ISPs.

The City of Boston successfully completed a similar, multi-year process. The City chose a model in which it would use its buying power to incent private sector deployment of massive fiber capabilities, some of which would go to satisfy City needs, and the balance of which would then be available to private ISPs for services deeper into the community, for backhaul, and for other uses that will improve broadband outcomes in the City.

To effectuate all this, Boston used a competitive process to secure a long-term, \$10 million dark fiber lease with Crown Castle. Now all schools, public safety agencies, and other operations throughout the City will get what they need today—plus long-term control of scalability for potential future smart city applications and public Wi-Fi—at an affordable price.

Under the deal, Boston will have end-to-end control of the fiber it leases for up to 30 years—and the new private sector fiber capabilities will mean not only greater opportunity for private ISPs to extend their networks, but also the efficiencies and reduced disruption of a single major fiber deployment serving multiple users, including both the City and the carrier market. And all this has been accomplished at relatively modest cost, with a significant return to Boston on its investment, both with respect to City broadband needs and to enhancing broadband services more generally.

### **3.4 Support ISPs in applying for federal grants**

Our primary and most urgent recommendation is that the County develop a grant collaboration and funding strategy to support private sector ISPs in western Loudoun with federal grant applications. In the next few months, the USDA will begin to accept grant and loan applications for the construction of broadband facilities in unserved areas of rural America. Pockets of western Loudoun will qualify for this program, which requires a showing that the area is currently unserved with 10 Mbps/1 Mbps (download/upload) service. This is not true across large swaths of western Loudoun, but it is true in many smaller pockets of one to a few square miles.

The benefit of this program is that the federal government will bear the cost and the effort of evaluating grant and loan applications, and then administering and enforcing their requirements. Our recommendation is that Loudoun County leverage that federal effort in two ways.

First, we recommend that the County commit funds to provide the matching amount necessary to enable western Loudoun ISPs to apply for the ReConnect program. For example, the grant program will require a 25 percent match to unlock a 75 percent federal award. The County can

encourage and incent providers to apply for these grants to serve areas of western Loudoun by committing to pay some or all of the 25 percent match for successful grantees. This commitment will make the grant applications more competitive and viable—and will likely increase the number of applications filed for western Loudoun.

Committing to fund the match on any successful application will also enable the County to avoid having to pick and choose among ISPs, as it would effectively be committing to fund all ISPs in the event the ISPs' applications are successful. Given that the federal government will only fund a single project in any given geography—and will very carefully vet those geographies to ensure that the area is indeed unserved—the County has a built-in set of protections against the risk of having to fund too many projects, or projects that are not focused on unserved areas.

The second way we recommend the County leverage the federal effort is to help private ISPs prepare grant and loan applications focused on western Loudoun. As we learned in our interviews of the smaller competitive ISPs in the west, they tend not to compete for federal funds because the cost and burden of preparing an application is very high for smaller companies.

Our recommendation is that the County support these ISPs with GIS data, engineering support, business planning help, and other tasks that will be part of preparing a competitive grant application. There is cost to the County associated with this approach, but the payoff could be considerable in terms of leveraging the investment to bring federal funds to western Loudoun.