Indian River County

BROADBAND FEASIBILITY STUDY

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Executive Summary

The future of our communities lies in their ability to participate in the digital economy. Fast, economical and always on broadband will support the ability of communities across the globe to keep government functioning efficiently, support the connectivity needed for a Smart County and allow citizens to access online education, telehealth, buy and sell goods online, utilize online banking, and access government services. Every year our lives increasingly move online and depend more and more on broadband access and connectivity. Communities that remain underserved or unserved by world class fiber and wireless connections will fall behind. The Indian River County's leadership recognizes that its current broadband connectivity is lacking the infrastructure and access needed to support a thriving community and citizenry. Leadership has a goal of ensuring all their citizens can access and connect to affordable state of the art broadband.

In late Fall 2021, Indian River County commissioned Magellan to enter into an agreement to provide the county with a broadband feasibility study. The study's goals were to understand any gaps in infrastructure and access to the community members, anchors, and businesses in Indian River County, and define solutions to solve those gaps. In addition, Magellan assessed and analyzed the County's current network assets and recommend improvements to the network that will lead the Indian River County community well into its technology future. Magellan employed considerable resources and can provide a complete and detailed Feasibility Study before February 28, 2022. For several years residents of Indian River County have complained about both the access and cost for quality broadband, and some areas, mainly in the far eastern and far western parts of the county, have little or no true broadband connectivity.

As part of the of the Feasibility Study, a detailed and comprehensive resident survey was conducted and confirmed that parts of the County are truly underserved. The Feasibility Study outlines the state of broadband in Indian River County, recommendations, and an informal plan to propel the County forward in helping to solve the unserved and underserved broadband problems within the county and make the County's own internal needs for connectivity world class, reliable, redundant, and cost effective.

Major findings from the Broadband Feasibility Study:

- The study demonstrates demand for high-speed internet.
- The study demonstrates and confirms areas with under and unserved residents.
- The County desires to facilitate the expansion of broadband to under and unserved residents.
- The study identified as many as 5,000 residents can be considered under and unserved residents.
- The County desires to both retain and expand business and economic development opportunities.
- The County desires to reduce operating cost and enhance services for its residents and businesses.

Based on the results of the Feasibility Study it became clear that the current funding environment and policy emphasis presents a unique opportunity for the County to serve as a driving force to help solve the broadband connectivity needs and challenges in various parts of the County. Magellan determined several ways in which the County could help the expansion of broadband services. These range from "smart policies" to subsidizing local ISP efforts in underserved areas, to building, owning and operating its own community fiber-optic broadband network, The Indian River County Fiber Network (IRFN).

"Smart policies" would encourage expansion of services by local ISP's. These would include areas like dig once, easy permitting, right of way use and sharing of assets. Subsidizing ISP's to expand and operate in underserved areas of the county mostly through joint applications of grant opportunities and co-investing and leveraging ARPA funds where appropriate. Based on this conclusion, several benefits of the network have been highlighted in the Feasibility Study and the results/recommendations will be presented to the county leadership.

The goals of these tactics are to eventually provide 1 to 10 Gigabit internet service to potentially all IRC residents and businesses in an ISP Public-Private Partnership arrangement, with special emphasis on the underserved residents and businesses. For fiber customers this would be a symmetrical service which has become a necessity in today's cloud-based application environment, the fiber should also be hardened and extremely reliable as a complete underground fiber network.

In the County-owned network model the network would also be a fully redundant system which does not exist today and a requirement for many businesses and all of the County's operated services. The network will have positive impacts for

economic development, students and education, and healthcare - especially related to the on-going pandemic. The network also ensures the County will have control of its broadband future and self-determination in supporting its residents. Important elements included that should be reviewed in detail is the survey results, conceptual network design, estimated cost both capital and operating cost, high-level financial outputs, business model assumptions and recommendations going forward.

PASSIVE AND ACTIVE MODELS

Risk aversity of key decision makers is a critical consideration in broadband not so much for the infrastructure itself—deployed fiber generally has strong long-term value as a real asset. Instead, risk comes from uncertainty about trade-off with other infrastructure and programs that need investment and about who will use the broadband infrastructure in the short-term. The County will certainly reduce its recurring costs for connectivity as soon as its deployed. It will eliminate cost and infrastructure barriers to new network-dependent applications or services, but that's relatively ill-defined, future benefit.

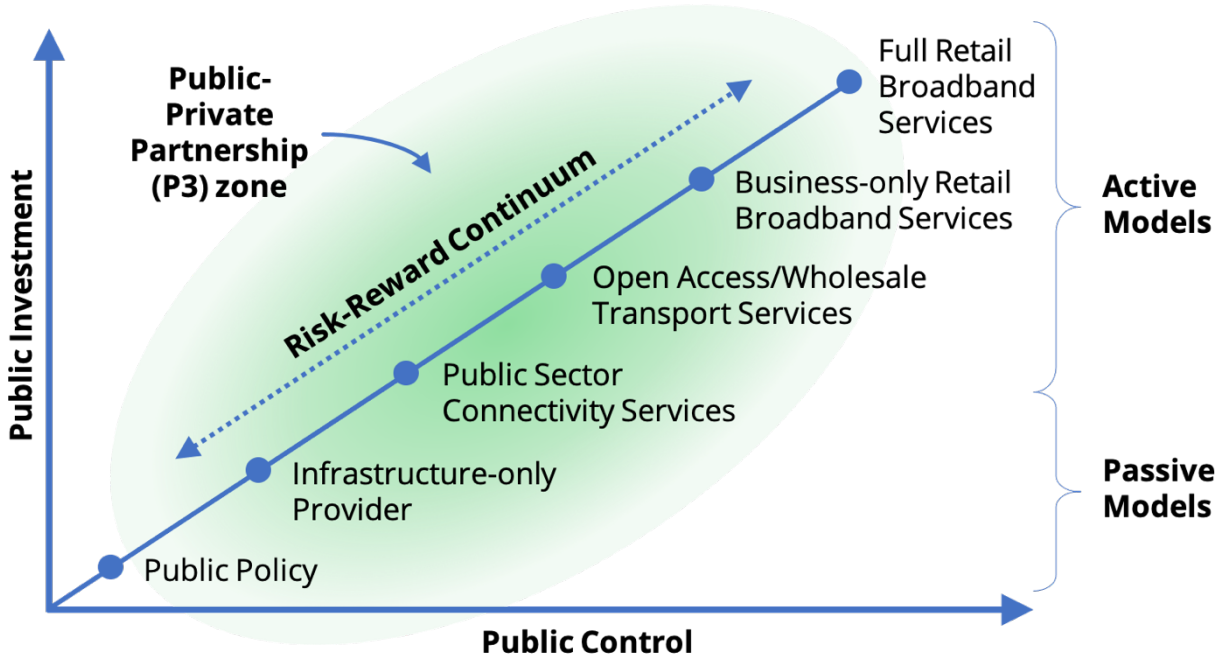


Figure 1: Risk Reward Model

If multiple private companies and other institutions literally buy into the network, a broadband enterprise could generate short-term capital investment and revenue, depending on how the business is structured. A broadband enterprise could generate revenue from services, too. As illustrated in Figure 1, the amount of investment involved increases with service offerings. The risk of buy-in depends on exactly where the infrastructure is deployed but also the level of effort put into selling physical connections and services. The County has relatively little capacity and doesn't have the culture for marketing and operating a broadband network.

Market Analysis

INTRODUCTION

To better understand the availability of broadband in Indian River County, a market analysis was completed assessing the options available to the County's residents and small and large businesses in various zip codes. The analysis focused on internet speeds and pricing from commercial service providers. This section summarizes the findings of this research and makes observations regarding the services currently offered in the service area. The assessment then addresses the state of competition and effects on costs, speeds and quality of service.

ASSUMPTIONS AND DEFINITIONS

For purposes of this analysis, "broadband" is defined as minimum speeds currently specified by the Federal Communications Commission (FCC). As of January 2015 (and reaffirmed in January 2018), the FCC defines "broadband" as a minimum of 25 megabits per second (Mbps) download speed, and 3 Mbps upload speed. (As an example, speeds in this report will be quoted as 25 down / 3 up (Mbps), or 25/3.) Gigabit speeds represent 1,000 megabits. (i.e. 1 Gbps = 1,000 Mbps.)

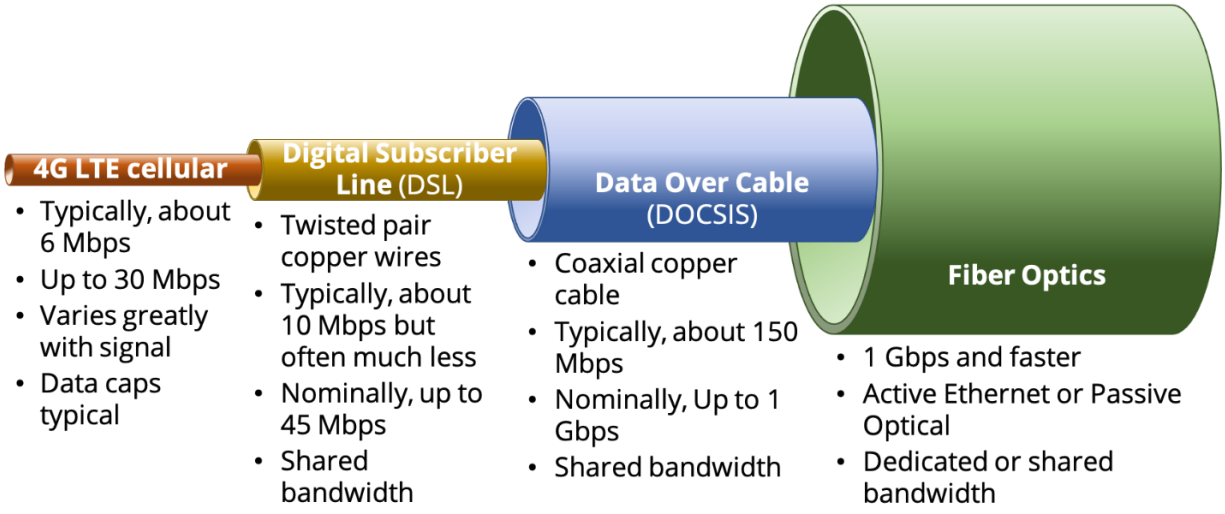


Figure 2. Speeds Associated with Internet Technologies

While the FCC has issued rough guidelines that suggest 25/3 Mbps service should meet the needs of a single user engaged in telecommuting or student activity, a Government Accountability Office (GAO) report released in July 2021 (GAO-21-494)

identified that small businesses require a minimum speed of 50 Mbps to operate point-of-sale terminals, manage inventory, and coordinate shipping. The GAO has recommended the FCC reexamine the benchmark for broadband. As shown in Figure 2, this would mean DSL (digital subscriber line which in most cases do not meet the speed requirements to be considered broadband) services, as well as 4G LTE cellular, would not qualify as broadband.

Identical download and upload speeds are termed "symmetric". But in most cases, Magellan finds that download speeds far exceed upload speeds (i.e., "asymmetric"), and typically, only download speeds are advertised. As businesses and consumers publish increasing amounts of data-rich web content (videos, photographs, and other social media), today's "slower" upload speeds will adversely affect the overall user experience; thus, demand for faster upload speeds and symmetric services will accelerate.

Where cited, costs will be classified as monthly recurring costs (MRC) or non-recurring costs (NRC). Monthly recurring costs are fees for service representing recurring payments which may or may not be part of a subscription toed to committed service term. Non-recurring costs are typically required up front for service installation. Quoted costs are exclusive of federal and local taxes, subscriber fees, Universal Service fees, and equipment rental costs. Often, the existing providers will also advertise teaser rates, good sometimes for only 6 months, then revert to their usual rates.

Much of the data represented here is self-reported by the incumbent internet service providers (ISPs) that serve Indian River County. These statistics measure availability based on the vendor's ability to service the region's businesses or residents as a percent of the total businesses or residences in the area.

BROADBAND AVAILABILITY

The major internet service provider for both residential and businesses in Indian River County is Comcast, which indicates cable broadband coverage for more than 88% of the county.[1] AT&T provides internet access via digital subscriber line (DSL), which is inherently slower but nominally able to cover more area. AT&T has fiber

[1] Source: BroadbandNow.com

with higher speed access in some areas of the County, however, this is quite limited.

FCC data on fixed broadband deployment shows 39.6% of rural Indian River County (population 11,917) have no 100/10 Mbps broadband service, and 43.6% are served by a single provider.

Other providers include EarthLink, Viasat, HughesNet, and Florida Broadband, which resell AT&T DSL, provide fixed wireless connections, or sell satellite service in the area. While plans that meet the minimum broadband definition 25/3 Mbps are available, this report focuses on speeds of 100/10 Mbps or greater, which is consistent with GAO findings for business requirements. These providers are listed for completeness, but detailed comparisons are omitted.

To gain an understanding of offerings and prices from service providers, multiple addresses covering 8 ZIP codes were researched for a representative sample of published services. The results of which are detailed in the charts below for each service provider.

Comcast/Xfinity: Xfinity is the retail broadband brand for Comcast. Comcast is the largest cable internet provider in the US. Xfinity offers internet plans as well as bundled TV/Internet/Phone service throughout much of Indian River County, but service is not available to southern and western addresses examined. Where service is available, Xfinity maintains the lowest MRC per MBPS.

Table 1:Comcast Xfinity's Published Residential Internet Service Offerings In Indian River County FL

Package	Speed[2]	MRC[3]	MRC per Mbps[4]	Notes
Performance Starter	50/5	$56	$1.02	discount available w/1-year contract
Performance	100/10	$76	$0.69	discount available w/1-year contract
Blast!	200/10	$86	$0.41	discount available w/1-year contract
Extreme	400/15	$96	$0.23	discount available w/1-year contract
Extreme Pro	800/20	$106	$0.13	discount available w/1-year contract
Gigabit	1200/35	$116	$0.09	discount available w/1-year contract

Table 2:Addresses Checked for Comcast/Xfinity Residential Internet Service Offerings In Indian River County FL

Address	Max Speed	Price	Notes
13075 81st St. Fellsmere, FL 32948	N/A	N/A	Not Serviceable

[2] Speeds are in megabits per second (Mbps) download over megabits per second upload. cited in this section are those advertised by providers and should be considered maximum possible speeds. Actual speeds are likely to be lower.

[3] MRC is "monthly recurring cost."

[4] This metric is the MRC divided by the total aggregate throughput, downstream plus upstream.

Address	Max Speed	Price	Notes
343 S Wimbrow Dr, Apt B, Sebastian, FL 32958	1,200 Mbps	$116	discount available
3605 16th St, Apt 4, Vero Beach, FL 32960	1,200 Mbps	$116	discount available
1170 17th St SW, Vero Beach, FL 32962	50 Mbps	$56	discount available
220 Park Shores Cir, Apt A, Vero Beach, FL 32963	50 Mbps	$56	discount available
12900 State Road 60, Vero Beach, FL 32966	N/A	N/A	Not Serviceable
3856 44th St, Vero Beach, FL 32967	1,200 Mbps	$116	discount available
7350 17th St SW, Vero Beach, FL 32968	N/A	N/A	Not Serviceable
8640 63rd Ave, Vero Beach, FL 32967	1,200 Mbps	$116	discount available
4281 5th Pl SW, Vero Beach, FL 32968	1,200 Mbps	$116	discount available

Table 3:Comcast's Published Business Internet Service Offerings In Indian River County FL

Package	Speed	MRC	MRC per Mbps	Notes
Business Internet 35	35/5	$80.00	$2.00	1-year contract
Business Internet 100	100/15	$159.95	$1.39	1-year contract
Business Internet 200	200/20	$259.95	$1.18	1-year contract

Package	Speed	MRC	MRC per Mbps	Notes
Business Internet 300	300/30	$309.95	$0.94	1-year contract
Business Internet 600	600/35	$359.95	$0.57	1-year contract
Business Internet 1 Gig	1,000/35	$499.95	$0.48	1-year contract

Table 4: Addresses Checked for Comcast's Published Business Internet Service Offerings In Indian River County FL

Address	Speeds	Price	Notes
22 S Lime St, Fellsmere, FL 32948	35-100-200-300-600-1000	$80.00 - $499.95	1-year contract
10290 130th Ave, Fellsmere, FL 32948	35-100-200-300-600-1000	$80.00 - $499.95	1-year contract
948 US Hwy 1, Sebastian, FL 32958	35-100-200-300-600-1000	$80.00 - $499.95	1-year contract
526 21st St, Vero Beach, FL 32960	35-100-200-300-600-1000	$80.00 - $499.95	1-year contract
805 11th Dr SW, Vero Beach, FL 32962	35-100-200-300-600-1000	$80.00 - $499.95	1-year contract
3418 Ocean Dr, Vero Beach, FL 32963	35-100-200-300-600-1000	$80.00 - $499.95	1-year contract
8525 20th St, Vero Beach, FL 32966	35-100-200-300-600-1000	$80.00 - $499.95	1-year contract
6880 US Hwy 1, Vero Beach, FL 32967	35-100-200-300-600-1000	$80.00 - $499.95	1-year contract

Address	Speeds	Price	Notes
65 43rd Ave, Vero Beach, FL 32968	35-100-200-300-600-1000	$80.00 - $499.95	1-year contract
8495 US Hwy 1, Vero Beach, FL 32967	35-100-200-300-600-1000	$80.00 - $499.95	1-year contract

AT&T: AT&T is the incumbent local exchange carrier (ILEC) throughout Indian River County Florida. AT&T is one of the world's largest providers of IP-based communications services for businesses, including Virtual Private Network (VPN) and Voice over IP (VoIP), and is well known for its wireless network.[5] AT&T has recently acquired DirecTV, and the FCC conditioned its approval of the transaction on AT&T extending fiber connections to some areas as well as offering gigabit connections to E-rate eligible schools and libraries.[6] While BroadbandNow.com states that AT&T provides services to 92% of Indian River County zip codes with speeds up to 100 Mbps, none of the residential or business addresses examined had greater than 75/20 Mbps capability.

Table 5. AT&T'S Published Residential Internet Service Offerings In Indian River County FL

Package	Speed	MRC	MRC per Mbps	Notes
Internet 100	Up to 100/20	$50.00	$0.42	requires AutoPay & paperless billing, + $10/month equipment, no contract

[5] http://www.att.com/gen/investor-relations?pid=5711

[6] In the Matter of Applications of AT&T Inc. and DIRECTV For Consent to Assign or Transfer Control of Licenses and Authorizations; MB Docket No. 14-90; Memorandum Opinion and Order; FCC 15-94, Released July 28, 2015, at page 148.

Table 6. Addresses Checked for AT&T'S Published Residential Internet Service Offerings In Indian River County FL

Address	Max Speed	Price	Notes
13075 81st St. Fellsmere, FL 32948	N/A	N/A	Not Serviceable
343 S Wimbrow Dr, Apt B, Sebastian, FL 32958	50/10 Mbps	$50	+$10/month equipment
3605 16th St, Apt 4, Vero Beach, FL 32960	25/5 Mbps	$50	+$10/month equipment
1170 17th St SW, Vero Beach, FL 32962	25/5 Mbps	$50	+$10/month equipment
220 Park Shores Cir, Apt A, Vero Beach, FL 32963	50/10 Mbps	$50	+$10/month equipment
12900 State Road 60, Vero Beach, FL 32966	N/A	N/A	Not Serviceable
3856 44th St, Vero Beach, FL 32967	18/1.5 Mbps	$50	+$10/month equipment
7350 17th St SW, Vero Beach, FL 32968	N/A	N/A	Not Serviceable
8640 63rd Ave, Vero Beach, FL 32967	50/10 Mbps	$50	+$10/month equipment
4281 5th Pl SW, Vero Beach, FL 32968	50/10 Mbps	$50	+$10/month equipment

Viasat: ViaSat is a satellite communications provider that covers the entire Indian River County market. It advertises speeds up to 100 Mbps download and 1 Mbps upload in select areas. Plans range from Bronze 12 Mbps with a 40 GB data cap for $99.99 to the Platinum plan of 30 Mbps service with 150 GB of data for $199.99 per month, all prices are after a 3-month introductory period at a lower price. Latency is

approximately .5 seconds for a round trip. This makes gaming difficult and could affect voice calls.

Table 7. Viasat's Published Residential Internet Service Offerings In Indian River County FL

Package	Speed	MRC	MRC per Mbps	Notes
Unlimited Platinum 30	Up to 30/3	$199.99	$6.06	requires 2-year contract, speed reduced after 150 GB data usage

HughesNet: HughesNet offers similar plans as ViaSat in the Indian River County market, but with lower speeds and data caps. All HughesNet plans are 25 Mbps download speed with different data caps. The plans range from 10 GB data cap for $59.99 after promo discount to 50 GB data cap for $149.99 per month. Offers are for a 2-year contract.

Table 8. Hughesnet's Published Residential Internet Service Offerings In Indian River County FL

Package	*Speed*[7]	*MRC*[8]	*MRC per Mbps*[9]	*Notes*
50 GB	25/3	$149.99	$5.36	requires 2-year contract, speed reduced after 50 GB data usage

Florida Broadband: Florida Broadband is a fixed wireless provider that offers services throughout Indian River County. It advertises residential speeds up to 8 Mbps download and 2 Mbps upload with bursts up to 12 Mbps download and 2.5

[7] Speeds are in megabits per second (Mbps) download over megabits per second upload. cited in this section are those advertised by providers and should be considered maximum possible speeds. Actual speeds are likely to be lower.

[8] MRC is "monthly recurring cost."

[9] This metric is the MRC divided by the total aggregate throughput, downstream plus upstream.

Mbps upload. Business internet service offerings range from .8 Mbps download for $45 per month to a call to order 800 Mbps download,

EarthLink: EarthLink, headquartered in Atlanta, GA offers internet access throughout the United States via partner relationships with several of the nation's largest providers. It advertises residential speeds up to 1 Gbps for areas served by fiber and 100 Mbps for DSL circuits. The fastest service found for any address examined in Indian River County was 45/6 Mbps at a cost of $69.95/month + $8.99/month equipment charge with an annual contract.

FIBER LOCATIONS

Multiple companies have fiber assets in Indian River County, primarily running north to south across the region, especially near the coast. Long-haul fiber, as shown in Figure 3, connects provider's points of presence (POP's) with effectively no physical access in between. Metro fiber, which has access at key locations on the routes, owned by Crown Castle and others are illustrated in Figure 4.

Long-Haul Routes

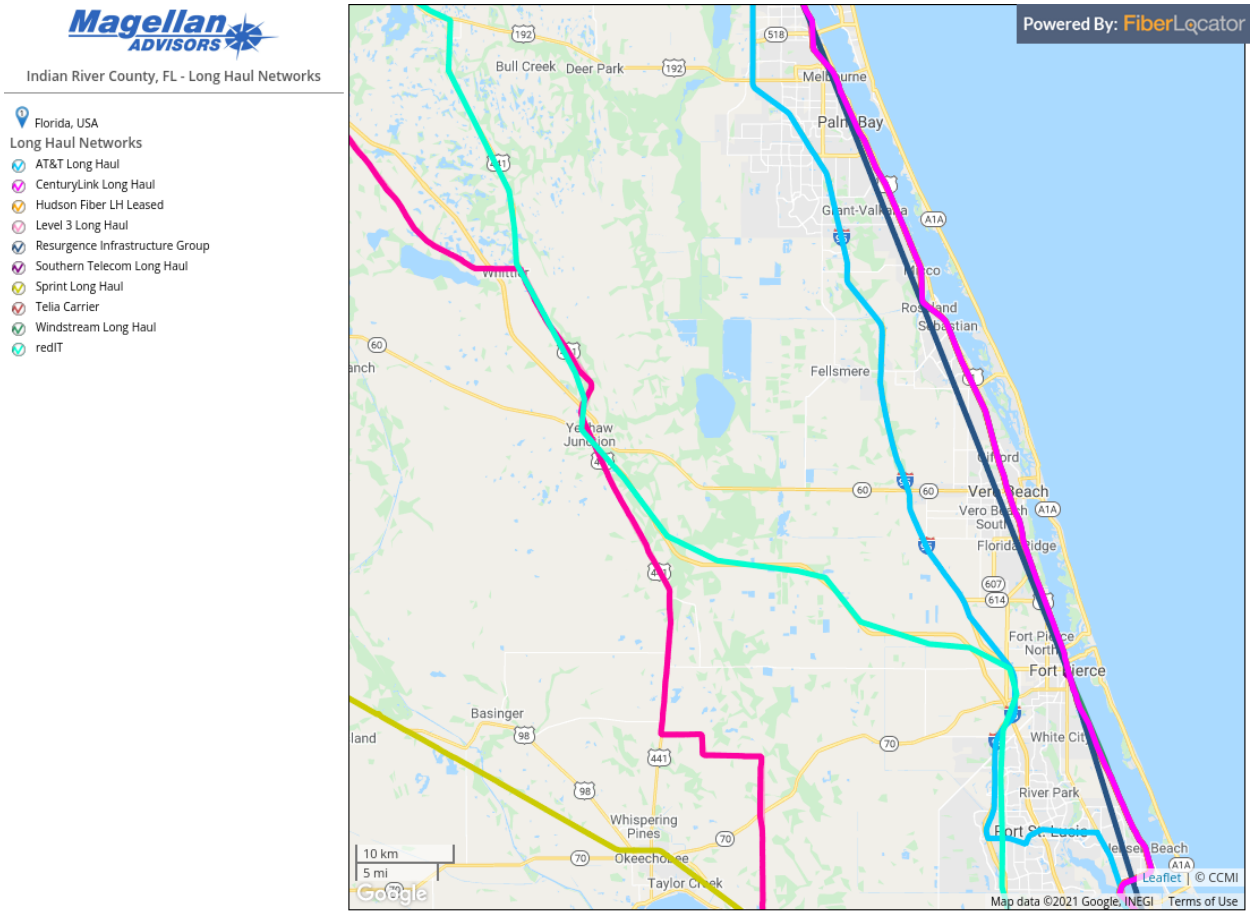


Figure 3: Long-Haul Fiber Routes

Metro Routes

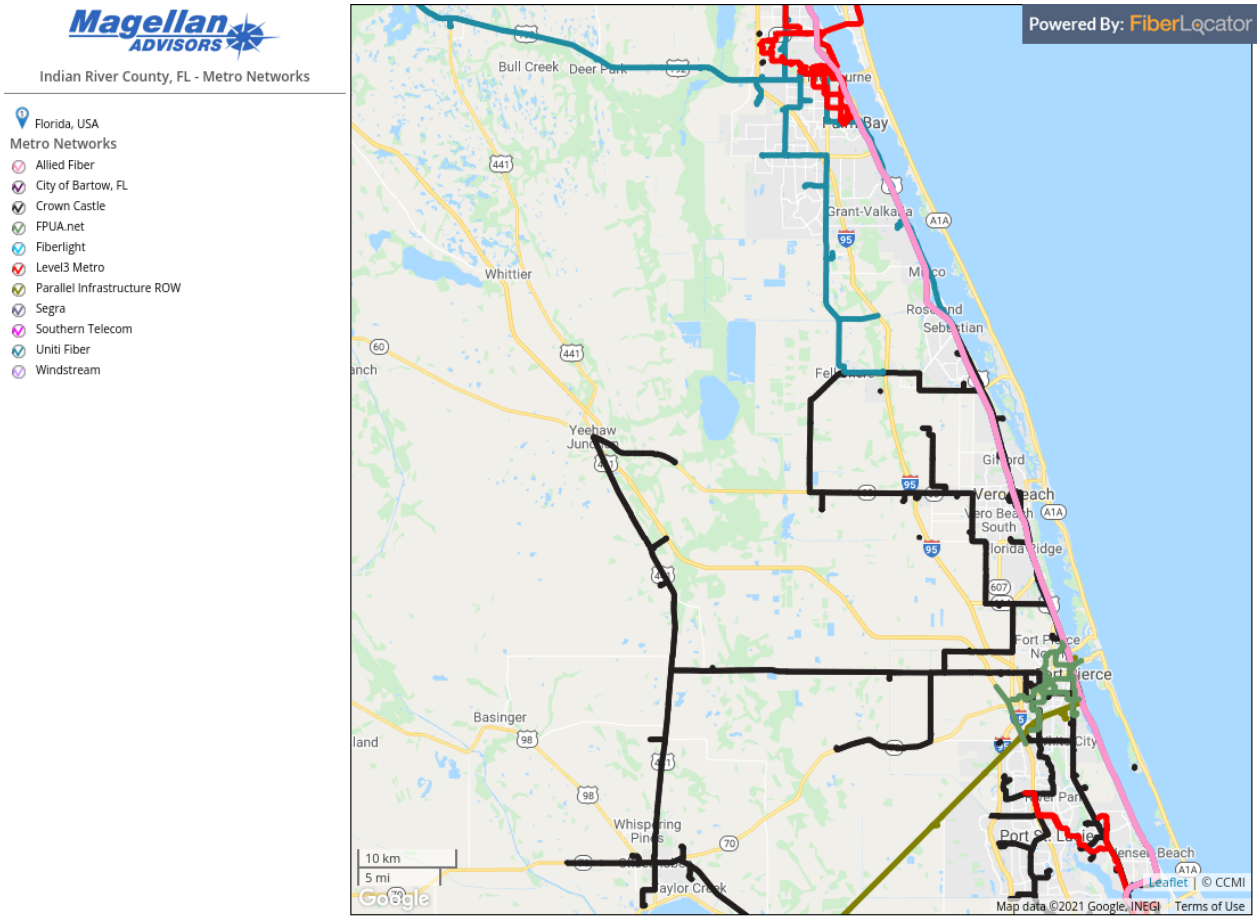


Figure 4: Metro Fiber Routes

The United States Department of Commerce, National Telecommunications and Information Administration (NTIA), uses data from multiple sources to provide information on broadband availability within the United States. The areas on this map colored in red represent areas of Indian River County where median Ookla speed test results were below 25/3 Mbps (e.g. the area west of SR-9), meaning effectively no broadband service.

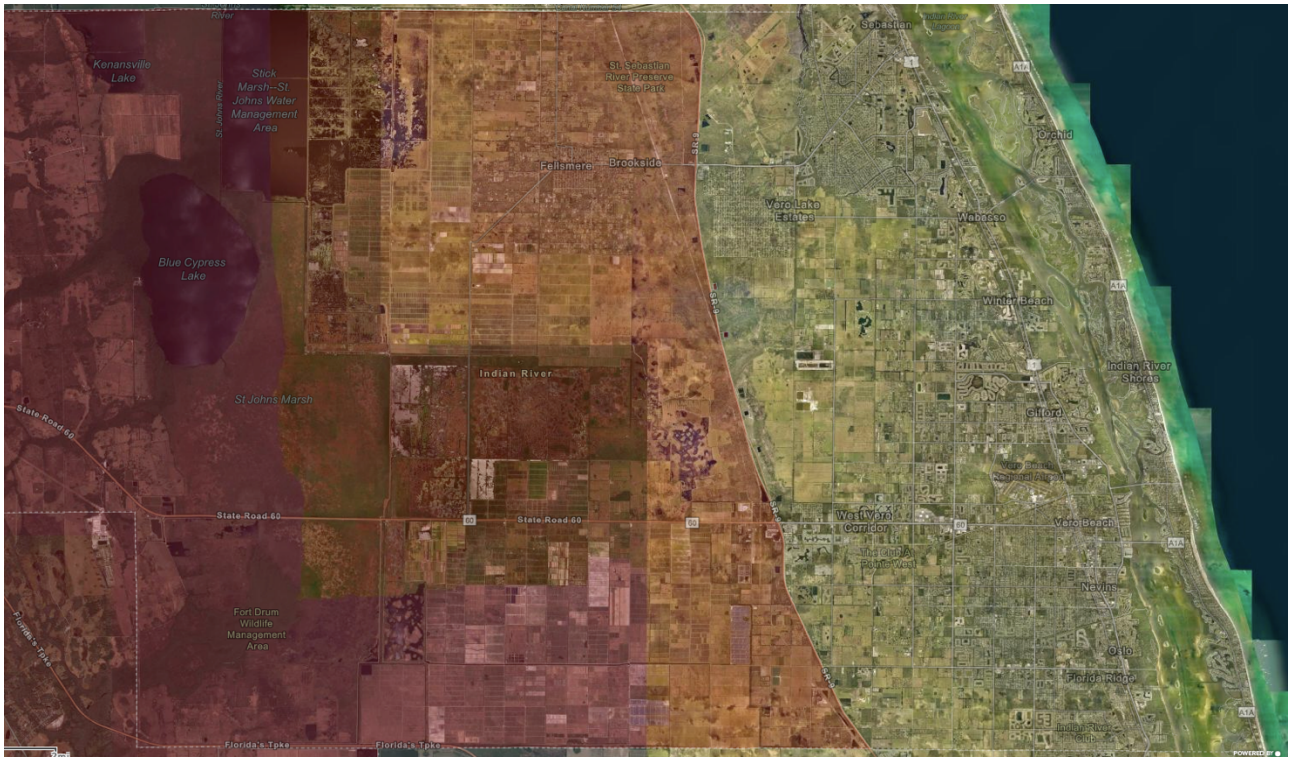


Figure 5: Indicators of Broadband Need

Comparing this region with U.S. Census Bureau 2020 population density for Indian River County we find most of the area with 15 persons per square mile, increasing to 64.5 persons per square mile in the Fellsmere census tract as seen in the figure below.

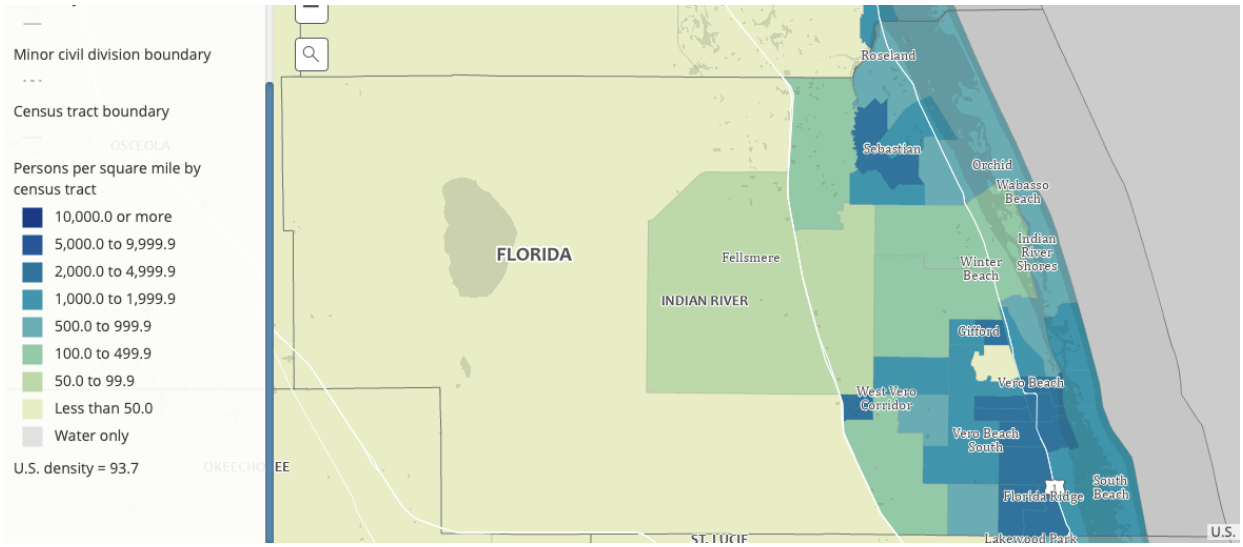


Figure 6: Population Density

Competition of broadband providers is limited, even in the more populous areas of the county. The Federal Communications Commission (FCC) data on fixed broadband reveals that few providers service even the eastern region of the county.

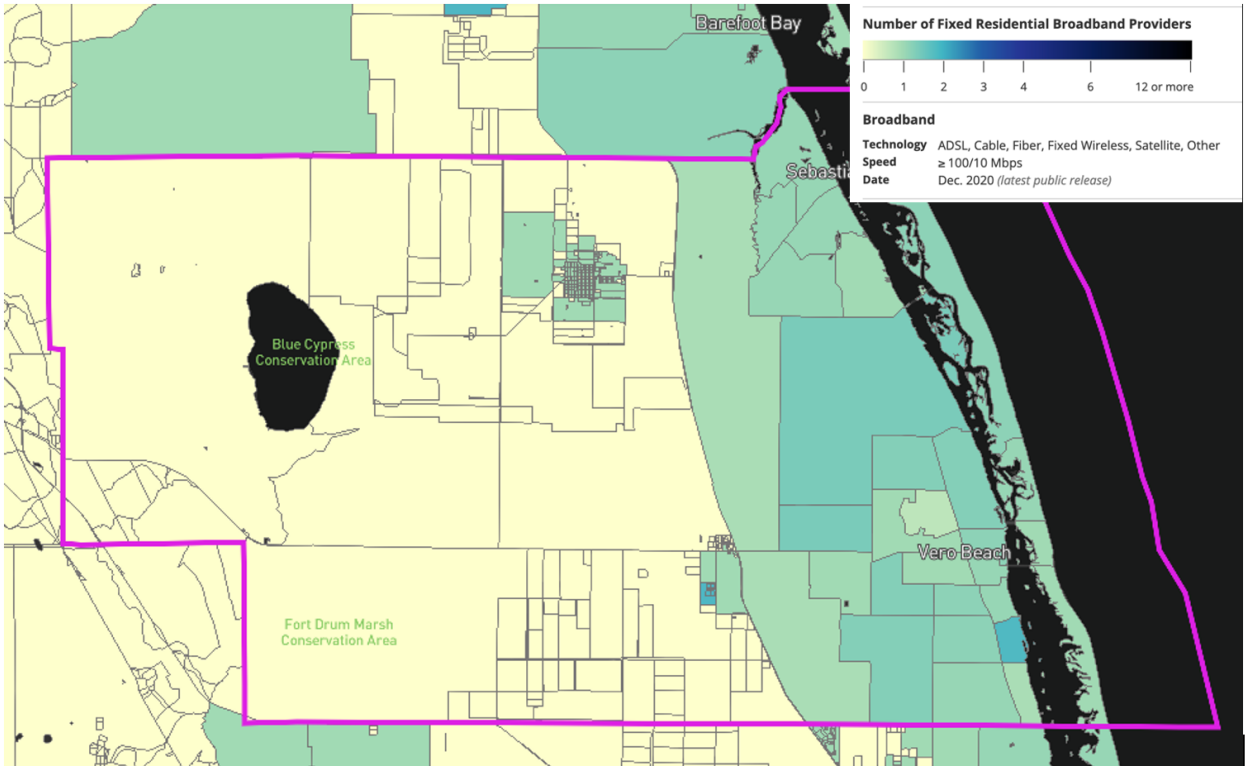


Figure 7: Number of Fixed Residential Broadband Providers

The data included in Figure 8 is for cable, fiber, fixed wireless, and satellite providers reporting speeds of 100/10 Mbps and above as of June 2020. The area in yellow represents NO providers while the light green areas are served by a single provider. The data clearly indicates that most of Indian River County's population has only a single (if any) choice of broadband provider, regardless of rural or urban location.

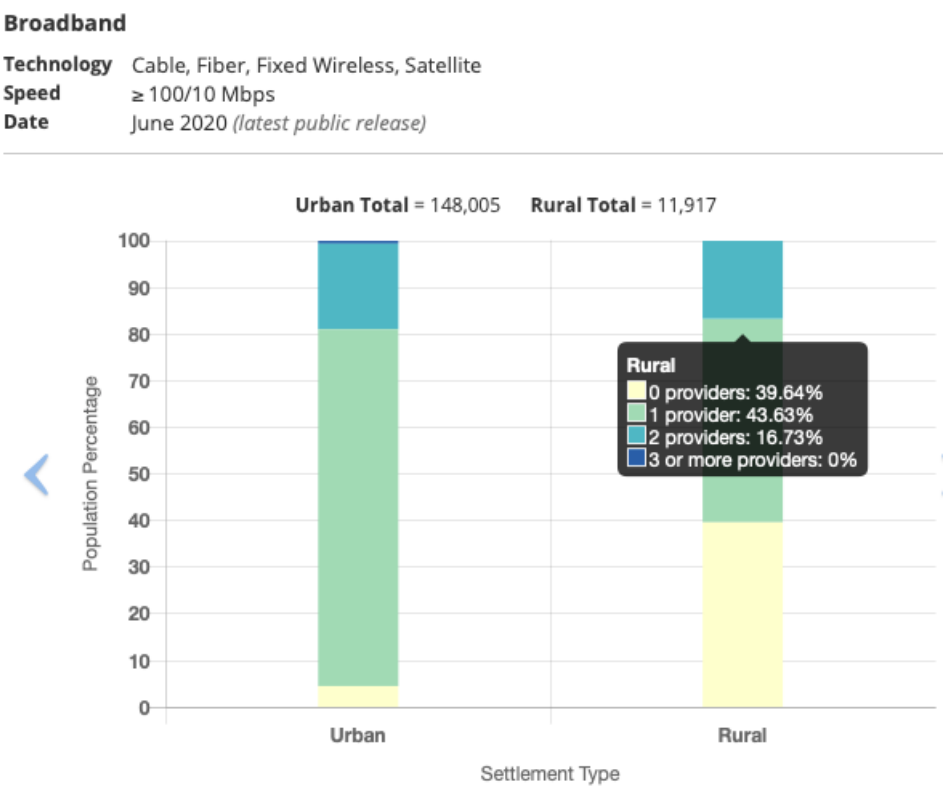


Figure 8: Urban vs Rural Providers

COMMUNITY SURVEY RESULTS

Markets are defined by demand and supply, and broadband is no exception. Demand can be measured as willingness to pay but it is based on expectations and requirements. In turn, activities and goals consumers want to do or accomplish, and their beliefs about how internet access can enable them, determine expectations and requirements.

Supply comes down to what consumers can get and how much they have to pay. Broadband needs are basically what is required minus what is available. Needs are the gap between the demand side of the local broadband market, what consumers do with broadband and are willing to pay for broadband, and the supply side, what is provided. It is important to look to the future because needs inevitably change but consumers plan based on the current state.

To understand the Indian River County broadband market, Magellan Advisors surveyed households and organizations about their broadband services, uses, and related issues. We gathered information about network infrastructure and service offerings by network service providers.

The survey resulted in a total of 596 responses, resulting in a 95% confidence interval with a 7% margin of error. Due to the response rate, the analysis will combine both residential and businesses/organizations. Only 22 of the surveyed respondents were businesses or organizations in Indian River County and therefore cannot be utilized as a true sample size or indicator of business needs.

Access to Broadband

Ninety-four percent of survey respondents had some access to internet at their address, however some of those are not connecting via a wired service – 85% of these respondents have internet access from a wired DSL, (DSL normally provides less speed than 25/3 and cannot be classified as broadband and under new federal funding requirements the minimum speed is 100/25) or cable service provider. Of those with internet access, the majority take service from Comcast (310 or 56.4%). Over a third of respondents had AT&T (200 or 36.4%). A few respondents (4) said they had Spectrum and small portion (36, 6.5%) indicated having other providers.

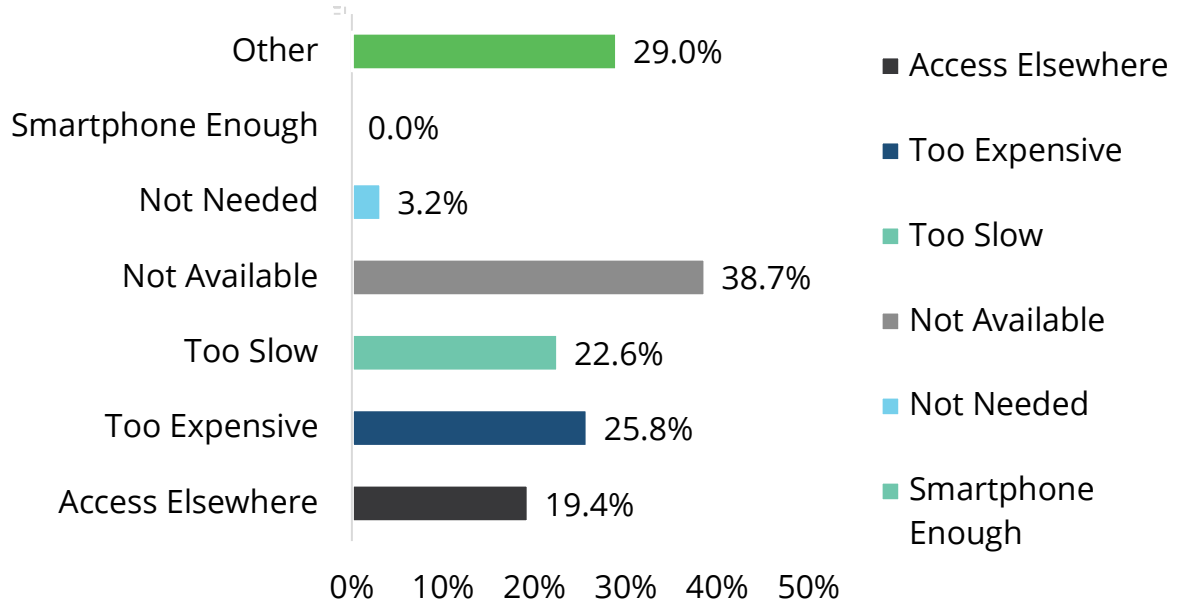


Figure 9. Indian River County Survey Results - Why No Internet as a Percentage of 31 respondents[10]

[10] Respondents were able to select multiple reasons for not having internet service therefore percentages for all items sums to greater than 100%.

Ninety-four respondents (15.7% of total responses) did not have broadband. Thirty-one respondents (5.2% of total responses) had no internet at their location. Of the respondents with no access to the Internet at their locations, illustrated in Figure 9, 12 (39%) indicated the reason was because broadband is not available to their location. About a quarter felt available services were too slow and unreliable to utilize, and that the services available are too expensive. Respondents were able to select multiple reasons for not having internet. One respondent indicated broadband was too expensive and slow as well as not available. Several indicated it was both too expensive and too slow.

Broadband Performance

Data from survey respondents' speed test results show the average speeds documented in and around Indian River County are 107.55 Mbps download and 29.19 Mbps upload. Although these are average speeds, and higher and lower speeds were documented, the average speeds reported by Indian River County survey respondents meet the FCC definition of broadband for download speeds (25 Mbps download) and the minimum for upload (3 Mbps). While the average speeds were quite high, it is important to note that 170 respondents encountered speed tests under 25 Mbps download and 353 respondents reported under 100 Mbps download. The locations of speed test results are shown in Figure 10. Therefore, there are significant areas within the county experiencing broadband issues.

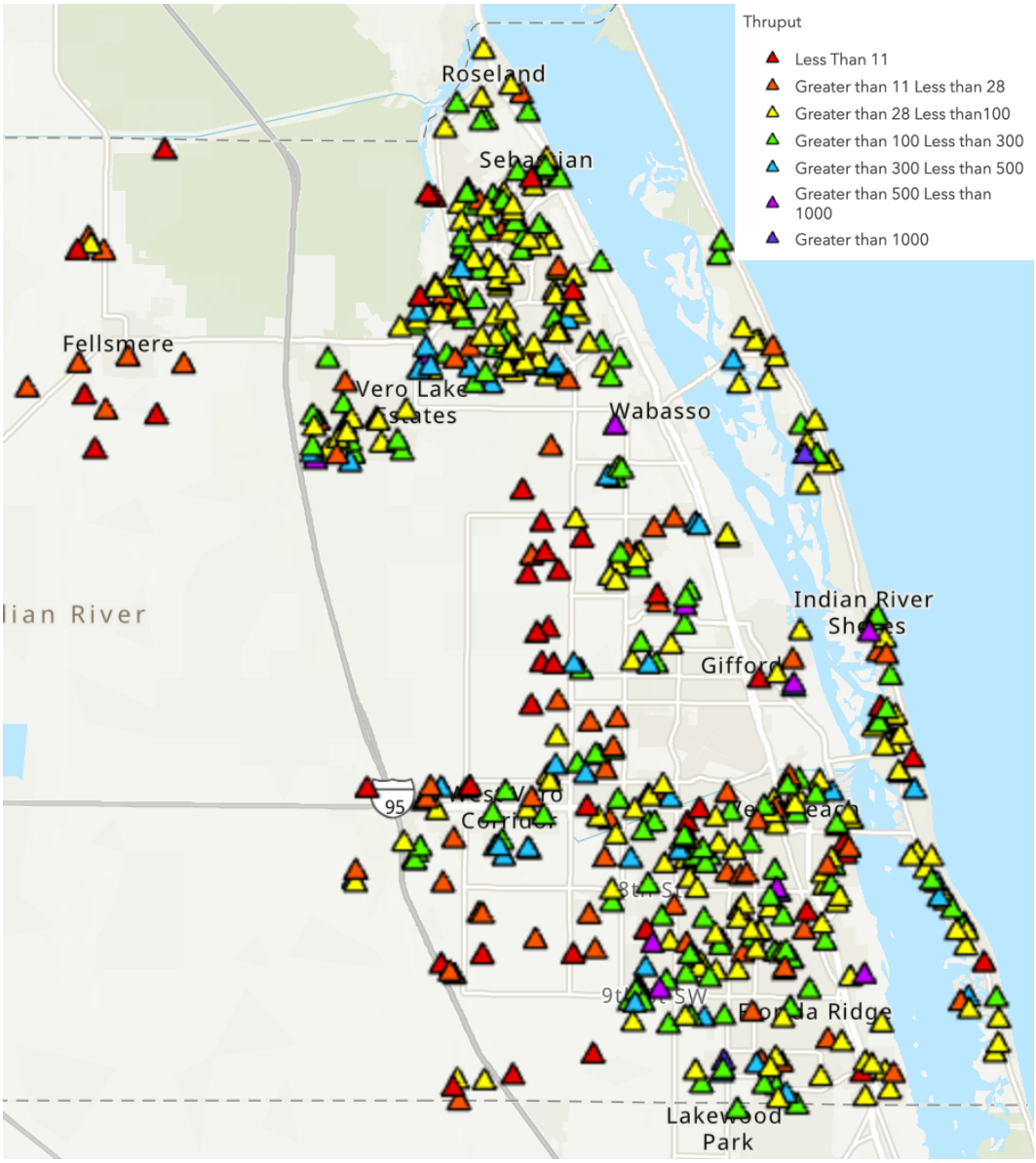


Figure 10. Indian River County Survey Results - Speed Tests by Address

Overall, the residents of Indian River County are fairly satisfied with their internet providers according to the survey respondents. Over half (58%) of residents in the county are satisfied with the internet services they currently receive, with only 34% of respondents saying they are very or somewhat dissatisfied with their service. In ranking areas of dissatisfaction respondents were most dissatisfied with price with 56% being somewhat or very dissatisfied and support (44%).

Residents in the county put a strong weight on the importance of internet in their homes, with 96% stating that Internet is extremely or very important, and only three respondents saying it was not important.

The residential survey responses found that Indian River County's broadband market is lacking competition, residents are relatively satisfied with their providers, and speeds received by respondents are well above the minimum requirements for broadband. However, it should be noted that 60% of respondents' education level was a bachelor's degree or higher, contrary to Indian River County's population of 68% having a high school education or less. Additionally, 48% of the respondents are retirees while the population's mean age is 33. These population statistics indicate that it is highly likely that most of the County's underserved population did not respond to the survey, which could possibly skew the total results.

Broadband Demand

The COVID-19 pandemic has exacerbated the need and demand for reliable, accessible high-speed internet access. Over 65% of survey respondents in Indian River County noted that their needs for internet have increased during the pandemic. As more and more education, remote work, telemedicine and everyday communication is moving online residents and businesses alike are realizing the increased needs.

Stakeholder Input

Magellan Advisors conducted a series of stakeholder interviews remotely in September and October 2021. We heard from other municipalities in Indian River County, chambers of commerce, public safety and internet service providers. All of these discussions yielded that high-speed, fiber-based Internet access will be essential to keeping up with and competing with other communities locally and across the nation. Given the recent COVID-19 pandemic, these issues are even more pronounced, as life has transitioned to working and learning remotely. While most had acceptable Internet services and no real complaints regarding internet services, few had outstanding services.

Cellular services are outside the focus of this study, but the poor quality of cellular services was consistent theme in community discussions. Participants complained about dead zones and unreliable connections. This is important because cellular services serve as a substitute for broadband where it is not available or is too costly or slow. T-Mobile is marketing their cellular services for home broadband. Other cellular providers are likely to push this as they expand their 5G services. Thus, poor cell coverage limits options for internet and points to opportunities for broadband development. Also, cellular towers require fiber connections, so cellular providers could be wholesale customers to anchor fiber investment in particular areas as well as provide additional services.

City of Vero Beach

Vero Beach is the County Seat of Indian River County and some of the County's buildings are located within Vero Beach city limits. Vero Beach is a full-service city with public works, an airport, a marina, parks and recreation, a cemetery, police, and water and sewer that covers outside of the city limits into Indian River Shores. The City has seven to ten government facility / buildings locations. Other than some roadway resurfacing projects, relocation of a wastewater plant near the airport, and a stormwater/irrigation project running to the barrier island. The City does not have any projects that include fiber or telecommunications on the horizon.

The City's Water Department does use meter readers and they have communications established between the lift stations and storage tanks. The Planning and Development Department have people collecting data in the field, however they upload data when they return to the office.

The airport area is primed for economic development. The City shared that Flight Safety had installed some fiber in between their buildings. While those on the call have not analyzed economic development issues, the downtown, banking, and beachside districts may have some future needs for broadband in the future.

The City has not heard of any residential complaints from those within the city limits regarding broadband. There have been complaints from those in the unincorporated areas of Indian River County, and more so for cellular related issues. One stakeholder on the call stated he lived 2 blocks outside of city limits and has to walk outside to get a cell signal on his phone. US1 and 18th Street is also known to be a dead zone for cellular service.

The City of Vero has some fiber that was set up by their previous electric system, substation to substation for an electrical grid. The City, County and Schools used this as a backbone and built out from there. The backbone is optical ground wire (OGW) and the County is not able to conduct maintenance on the fiber that is on FPL poles in the power space. The electric utility previously did the maintenance on the network, however when the electric utility was sold to FPL the County started helping with outages. The City has no interest in managing or maintaining the 30-year-old fiber network assets and have relied on the County for assistance with this.

City of Sebastian

Sebastian is a substantial city in northeast Indian River County. The City has six city facilities including City Hall, the Police Department, Airport, Old School House, the Senior Center, and the upcoming Public Works Compound by the airport. The Public Works complex will be connected to fiber. City Hall has WiFi and the Airport has cameras that are recorded and centrally monitored by the Police Department. The Police Department has laptops and air cards for connectivity.

Sebastian has very few areas for development. The City is currently building sewer to the Airport to attract businesses to the vacant, industrial lots nearby. The City is engaging in a Gap Analysis for economic development at the time of this report. They know the Brightline Service is looking to expand through Indian River County, however Sebastian does not have the acreage for it, they have heard that Stuart or Fort Pierce might be getting a station. Liberty Park and Blue Water Bay, which are part of the unincorporated area of the county, were mentioned as areas that the County should consider if building additional infrastructure. Today there are pasture lands there, but developers are eying this area for residential neighborhoods.

The City is serviced by AT&T and Comcast. They have 100 Mbps symmetrical from AT&T as their primary and a 50 Mbps backup connection from Comcast. These connections are to nearly all of the City facilities. The new complex is talking to Comcast for services and were negotiating the contract at the time of this report. The City does see some performance lags due to closed captioning, but all in all the services work well for them.

The City does not hear complaints from residents or businesses regarding broadband availability or services within the city limits. During the peak of COVID-19, many people were working remotely from home, Zoom was helpful and everyone had enough bandwidth in their homes to work remotely successfully. In addition, they did not hear issues from the schools within the city limits regarding issues with online or virtual learning for students.

Town of Indian River Shores

The Town of Indian River Shores, located on Orchid Island, includes Town Hall administrative offices next door to Public Safety administration. Unique at this campus is a Postal Center, operated by the Town under contract with the postal service, for maintaining PO boxes and facilitating mailings. Local Fire and Police rely on the County Sheriff for dispatch and record management services.

Maintaining less than seven miles of roadway, with the majority of streets controlled by HOA's, the Town's main infrastructure is devoted to stormwater. The Town is not connected to the County's fiber infrastructure, instead relying on redundant internet connections provided by Comcast and AT&T.

Town of Orchid

The Town of Orchid is one gated neighborhood on the barrier island. The demographics lean older but it is not a 55+ requirement community. The Town relies on the County for police and utilities, as the Town is largely administrative. The Town and community association manage the roads and streetlights and the golf club handles the parking lights by the club. The gated Town sits back from the beach, so there have not been any talks about smart streetlights as they aren't necessary for the turtles. Other than the golf club and some residents that work from home, the Town has no economic development activities or concerns.

The community has a part-time building clerk and an inspector. The inspector enjoys using an iPad due to digitization and the clerk prefers a paper and pen methodology. This Town has had a good experience with Comcast providing their

internet services, aside from an outage every now and again. The Town contracts for 25 Mbps / 3 Mbps services from Comcast. The HOA was approached by Hotwire Communications for fiber-based internet services, but the HOA turned it down due to the 10-year exclusive contract.

The residents of the Town are well served by AT&T and Comcast and the residents have had no complaints about speeds or services, even COVID-19. Cellular service is the major issue on the barrier island and increasing those services would be welcomed by the Town on Orchid.

Utilities

The County has water and sewer services throughout much of the county footprint. As stated previously, cellular service is poor throughout the county and this affects the County's utility operation. Verizon has had significant growth and is oversubscribed, which yields performance issues. The County has meter reading being completed through Android phones and hotspots through AT&T. The County's utility operations centers at 41st and 43rd Avenues which is in the center of the County. Many report that they have to leave the operations center for hotspots to work properly. Utilities use SCADA on a microwave secure network and use cellular for automated metering reading (AMR).

The Utilities were aware of where cellular works well and where it doesn't. They were able to identify some areas where they are aware of gaps in cellular availability: barrier islands, Windsor, some of the County parks, and Golden Sands have no cellular or broadband services. Utilities are considering Advanced Metering Infrastructure (AMI), which could address some of these coverage issues, but they are more than five years out on decisions on this.

Sebastian Chamber of Commerce

The Sebastian Chamber of Commerce has over 370 members ranging from big corporations, to waste management to small businesses. They have a lot of tourism, restaurants, hotels, small businesses, along with the Indian River Hospital and Sebastian Hospital.

While the contact that Magellan spoke with could not quote any specific complaints from businesses in the area, she did state that services are typically slow and services at her office go down more than they should. Comcast is the main player for businesses in Sebastian. Cellular service is the greater issue in Sebastian and

the County. There are many dead spots and friends/colleagues also complain of these issues.

It was mentioned that Sebastian may be undergrounding all electric, potentially through FPL. This could be a consideration for the County to consider for joint trench or dig once policy.

Public Safety

The County's Public Safety covers fire, EMS, 911 and animal control. Their primary means of communication is via 800 MHz "push to talk" land-mobile radio (LMR). They also make extensive use of cellular data and voice services provided by Verizon. While Verizon has the best service in the county, it is still very spotty, according to participants. The Emergency Operations Center (EOC) is a Cat 5 building and on a redundant fiber ring for connectivity.

Although EMS has a significant amount of continuous training, they have not heard of any issues accessing Target Solutions EMS/Fire. There are also two new fire stations on the horizon and they will be connected by coaxal cable as fiber is not currently located in these locations.

Libraries

Magellan had two separate meetings with the libraries, one with the Director of Library Services and one with IT. The library system consists of three branches, two smaller, and four vending machine libraries. The have Wi-Fi at every location and the vending machine locations can also provide Wi-Fi. The location at the college campus uses Wi-Fi provided by the college. They have 28-30 computers for adults and 6-8 for children at each location. The computers used to have waiting lists to get on and time limits for use, however they have seen computers more open over the last four years. They do not offer hot spots for rental; they had looked into it in the past but it never panned out. The majority of their users are self-sufficient, every once in a while, they will have users with digital literacy issues that need additional assistance. Most of their users are people that have a broken machine or they need to print something as they offer free printing.

The libraries are connected through AT&T and do not have a back-up provider. They recently upgraded from 100 Mbps to 300 Mbps for around $1,000, and the service is supposed to be symmetrical. No matter how much bandwidth the libraries add, the users eat it up with streaming services.

Education

During engagement for Fellsmere's Broadband Feasibility Study, Magellan spoke with Indian River Public Schools regarding broadband needs and issues of the schools and their students. Their schools are fairly well covered with two 10 Gigabit connections on a redundant fiber ring. They service 25 schools and 27 facilities through their Indian River Consortium. The Consortium fiber doesn't have alternate pathways, which leads to issues with redundancy for the system. Many of their schools are brick buildings, so they have some issues with cellular service not penetrating the buildings. At the time of this report, the district was not planning any school expansions as the demographics of Indian River County leans older than many other growing areas of Florida. The Consortium has also been fairly dormant in recent years and the County should seek to update agreements to clarify ownership of newly built infrastructure as they move forward.

During the pandemic the schools (specifically in Fellsmere) saw many students come sit on their steps to gain access to the Wi-Fi to complete assignments. Outside the fringes of town there isn't any AT&T or Comcast infrastructure, and Comcast Essentials is not available in all of the areas of need. The schools also handed out hot spots to students, however they received many calls that they didn't work well due to lack of cellular service. Their only solution was to place the hot spot near a window or on a porch to try to get better service.

Radio One[11]

Radio One is a Motorola partner in the LMR space that works with Disney, Advent Health, and other large enterprises to deploy artificial intelligence, video, and LTE[12] products. Motorola's expansion products help solve big picture problems, for instance they have been in the public safety communication space for 15 years. Motorola operates over CBRS-based private LTE as a service. They are purpose-built, open and on-go certified.

The company is targeting education with ARPA funding and they are seeing a lot of interest in distance learning and on premise for schools. Motorola offers Citizens Band Radio Service Device (CBSD) products provide approximately 800 users with

[11] https://radio1cbrs.com/

[12] LTE stands for Long-Term Evolution and is a data communication protocol most used for 4G cellular. Many CBRS solutions uses LTE as it allows devices to be interoperable between vendors.

100-200 Mbps symmetrical over a 1.5-mile radius from a 140-foot monopole tower. The platform is very flexible so they are looking outside distance learning for applications their system might support.

Data Center LLC

Magellan Advisors spoke with Data Center LLC's chairman and technical resource. The company is building a data center in Fort Piece which will be a 4th or 5th vertical to connect other data centers. They are working with FPUAnet Communications, Fort Pierce Utility Authority's internet service, on a coop arrangement. Data Center LLC does not want to be in the telecom business. Rather, Data Center LLC wants to rent space to ISPs through a maintenance contract or public/private partnership which could help expand broadband services throughout the county and region. Data Center LLC sees providing co-location services as a way of lowering transport and operations cost for local ISP's. Data Center LLC also has some interest in an open access wireless network, with multiple players and multiple spectrums. If they had enough towers in place, they could cover a one-hundred-mile radius rather quickly. They have finished the permitting process with St. Lucie County and have discussed a county consortium project. They see a potential partnership with the counties with the objective to get the counties to give a commitment of presence.

Service Providers

Various service providers were interviewed in order to understand current infrastructure, expansion plans and opportunities to support higher-speed and more reliable broadband options for Indian River County residents and businesses in partnership with the with the County.

AT&T

Magellan Advisors met with representatives from AT&T in August of 2021. During the conversation with AT&T representatives, AT&T shared that they are migrating away from all DSL products and this should be complete by 2023. They are pushing fiber deployments. They noted that they needed to speak with their External Affairs group prior to sharing any proprietary mapping or expansion information. Since the previous conversation, Magellan has not had responses from AT&T.

Verizon

Magellan Advisors met with representatives from Verizon in August of 2021. Many things have stalled for Verizon during COVID, but their emphasis is 5G at this point.

They are planning to extend a wide band of 5G into other markets, then phases 2 and 3 will move into more rural markets. This 5G Nationwide/Seaband project will roll out over the course of a three-year period.

Verizon feels that the Federal money that is coming out helps to put band aids on areas with digital divide or digital equity issues, but this doesn't always solve long term issues. Verizon presented ideas of Wi-Fi on the buses to Indian River County Schools and to put buses in parks or other areas so students could utilize Wi-Fi outside of school.

Next City Networks

NextCity is a wholly owned subsidiary (unregulated of NextEra), looking to come in as owner/operator of fiber networks. They have a combination of lit and dark services. They are not looking to be ISP, rather an open access network to allow for competition.

NextCity approached Indian River County regarding Gifford as an area of need. IRC relayed concern for Fellsmere and Wabasso. Wabasso has so few residents, it would not be part of phase 1.

They were in the process of uploading documents for grant application ($9M) at the time of the discussion. Fellsmere would be included as being identified as an area for future expansion. End-user service is part of plan. One of their ISP partners identified is Hotwire. They have also engaged Jacobs Engineering for construction.

IRC committed to submitting grant application. NextCity will slightly overbuild, providing the County with a limited number of strands.

Recommended Broadband Initiatives

OPTIONS

1. Consider partnering with the City of Fellsmere and potentially help fund Fellsmere's broadband plan which will bring broadband services to the underserved in western rural IRC. Specifically, the Fellsmere plan calls for fiber backhaul from Wireless Tower locations in unincorporated parts of IRC. These towers will be equipped with CBRS radio gear that would provide internet access to the unincorporated areas around Fellsmere. Fellsmere proposes to build a conduit system underground to be used by both ISP and WISP broadband providers. The entire Fellsmere plan is about 2.7 million dollars. Please see attached Fellsmere plan, maps and cost.
2. Consider extending the county's existing or proposed fiber network to the Gifford area and work with ISPs to use this connectivity to extend the ISP's last mile to underserved areas of Gifford. If unable to forge a partnership with an ISP to serve the Gifford area's underserved, consider working with a WISP (Wireless ISP provider) to build a low cost CBRS wireless network that would serve the Gifford underserved areas. A recent grant application estimates that a retail fiber network would cost about 11 million dollars to construct. IRC could consider a split cost model (fiber build) with an ISP to serve the Gifford community. A much less expensive alternative is a complete wireless broadband network with fiber backhaul to the wireless tower positions. The details of providing a low-cost high output wireless broadband network are these:

   A CBRS wireless broadband network study has been prepared for the Gifford area. The network is designed as a fixed network meaning the receiving locations are buildings, public places or residences that are not in motion. Public assets (water tower and EOC tower) are proposed as base station sites. Both are on the conceptual fiber connection plan that Magellan prepared for Indian River County and as outlined in this report. Each location will have a 4-sector base station located on the tower. This will provide good coverage and capacity for the area. Towers close to airports have height restrictions and must be lighted. The tower assets used for this design are existing structures. The height is not raised by the addition of the CBRS equipment. The existing registration with FAA will not be changed by this installation. Much has been made in the news about 5G interfering with

Aircraft Altimeter Instruments. These instruments operate in the 4 GHz band. The issue is question is interference by the new C band that was recently auctioned by the FCC. The C band operates in the 3.7 to 4.2GHz Band. The airline officials complained that this was too close to the Altimeter band of 4.2-4.4 GHz. The CBRS band, proposed for the Gifford system, is 3.55-3.7 GHz so is well below the band that could interfere with Aircraft altimeters. Public assets are proposed for CBRS installation no commercial tower rental should be incurred. Each location will require 4 sector devices and a ruggedized switch to connect them to the fiber at the locations. Below is a cost estimate for the base station CAPEX for equipment and installation. See capital cost assumptions below. This financial estimate is based on Telrad CBRS equipment. Cost may vary for different manufacturers of equipment. This is a "middle of the road" type estimate of functional equipment. The number of CPE (Customer Premises Equipment, residential and business customers equipment) required is not known at this time. The CPE can be either a Mi-FI type device that would require no installation, or a CPE mounted receiver outside the business or residence and a cable run inside to a switch or Wi-Fi access point. Approximately $700-$900 should be budgeted for each CPE device (connected customer). The CPE cost would be the responsibility of the WISP partner who would provide all retail services and operations and maintenance services. The EPC access fee of $35.00 per customer is a one-time charge and would also be the responsibility of the WISP partner. The operations cost for this network would be exceptionally low. The towers are public assets and have fiber connections, so tower rent or backhaul costs may not be required. Power consumption for the base stations is low and will not adversely affect the EOC or Water tower. One possibility is for the county to allocate approximately two million dollars in support of the Wireless network to serve the Gifford community. This would cover the capital cost required to serve about 2,500 homes. The goal would be to get a WISP partner to match the county's investment and provide the capital cost to serve 5,000 homes.

3. Use current ARPA funds, pursue additional grant funding and develop a multi-year CIP budget dedicated to expanding broadband services to the underserved to provide broadband assets in a multi-year phased approach. In addition, IRC should continue to monitor and apply for Grant funding opportunities. The federal government has allocated 400 million dollars to Florida to expand broadband. The latest information from the state broadband office is that no timetable nor procedure has been established

but they estimate it will be about two years before actual funding will be distributed.

OPTION 1 – FELLSMERE WIRELESS BROADBAND NETWORK

It should also be noted that the far western part of the network could easily connect to the Town of Fellsmere proposed conduit network that is outlined in detail in the Fellsmere Study and Business Plan provided by Magellan. The Fellsmere study and Business Plan lays out a plan that includes a combination of both fiber and wireless technologies that when implemented will provide broadband services to the underserved unincorporated areas of IRC around Fellsmere. Magellan recommends that by joint funding and partnering with the Town of Fellsmere a large portion of the counties underserved could be served.

*Fellsmere estimated capital cost to serve broadband for the underserved. Wireless broadband average 100/50 Mbps per user. Does not include CPE or licenses which will be provided by WISP partner.

Table 9: Estimated Cost for Fellsmere network

Category	Cost
Fiber Network – Conduit Only	$2,300,000.
Optional – 288 Count Dark Fiber	$400,000.
Wireless Electronics	$380,000
Total Capital Costs – Conduit & Fiber	$3,080,000

OPTION 2 – GIFFORD WIRELESS BROADBAND NETWORK

Table 10: Estimated Cost of Gifford Wireless Network

Category	Cost
Base Stations (Installed)	$124,000.
Outdoor Routers	$2,000.00
Engineering and Project MGNT	$18,900.00
Total Capital Costs	$144,900.00

OPTION 3 – INDIAN RIVER COUNTY FIBER NETWORK

Indian River's proposed feeder and distribution network, as the name suggests, feeds the fiber from the backbone throughout the service area and to county facilities. The network, displayed below in Figure 11, is created with multiple rings to create redundancy in the network. The conceptual design is based on providing a high-capacity fiber backbone that could easily serve connectivity opportunities over the next 20-30 years. The County should build what it needs today, while preparing for needs in the future. The rest of the conceptual design can be added in phases as grant opportunities arise.

The detailed network design prepared for the County provides precise routing of fiber cables across the service area. Moreover, the design provides an accurate estimate of the costs of components that, in aggregate, constitute a significant amount of capital investment in the project. All specific fiber network design and construction specifications are included in Appendix A of this report.

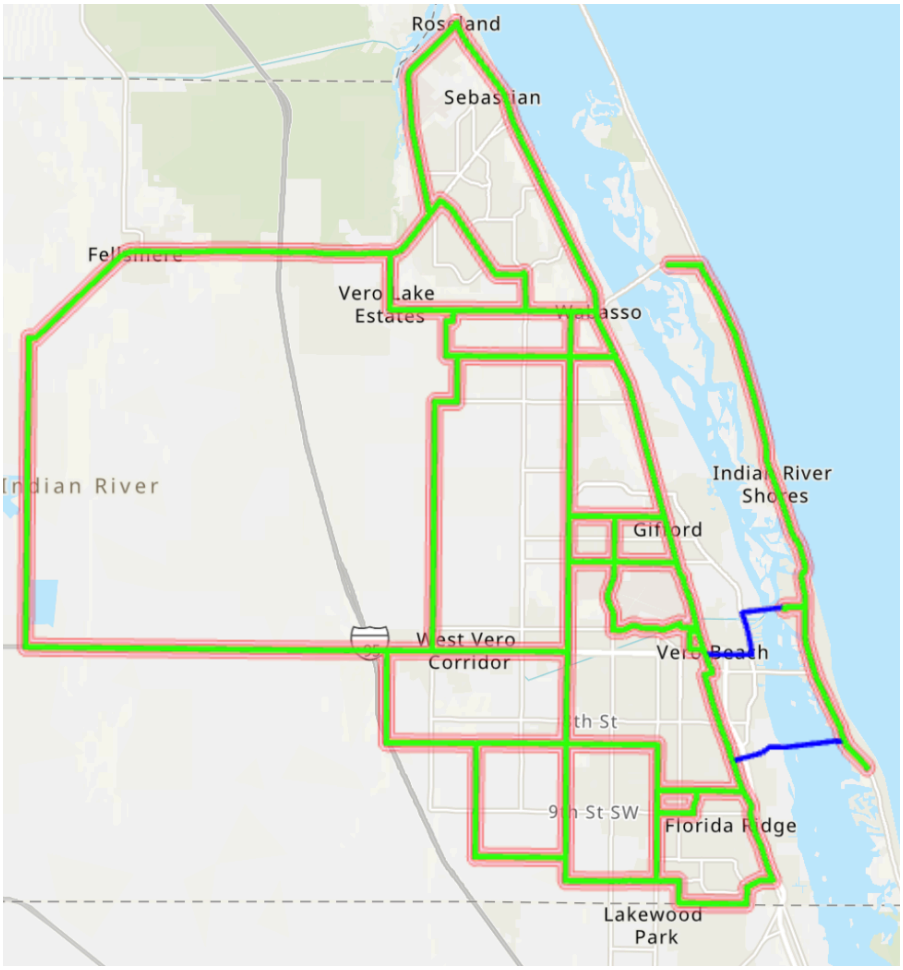


Figure 11: Indian River County Fiber Network Conceptual Design

BACKBONE ROUTES

The fiber backbone would serve several important purposes in the operations of the overall County fiber-optic network. For one, the backbone routes are the most direct network routes into and out of the County fiber network. These are critical paths for internet connectivity, and these backbone routes would have redundant paths to and from the County from multiple internet "backhaul" service providers.

The County would have an active backbone layer to connect each county office. These locations connect the fiber-optic feeder and distribution network between the substations and the County households and businesses via ISP's. The backbone is comprised of (2) 144 strand fibers; half of which could be dedicated for the County's purposes while the other half could be dedicated to serve the needs of

homes and businesses by ISPs. The backbone routes also serve as the critical connections between the County offices to enable smart community benefits.

The County network is connected to the internet backbone at transport centers across the service area. The connection points serve as network nodes, with networking equipment securely housed in a field cabinet or huts inside the County. Depending on complexity of each transport center, it can simply be a fiber connection point, or it can function as a data center through an assortment of devices to relay data between the internet and customers on the network.

Magellan created a buffer analysis which demonstrates how many address points the County could reach within 500 and 1000 feet of the network.

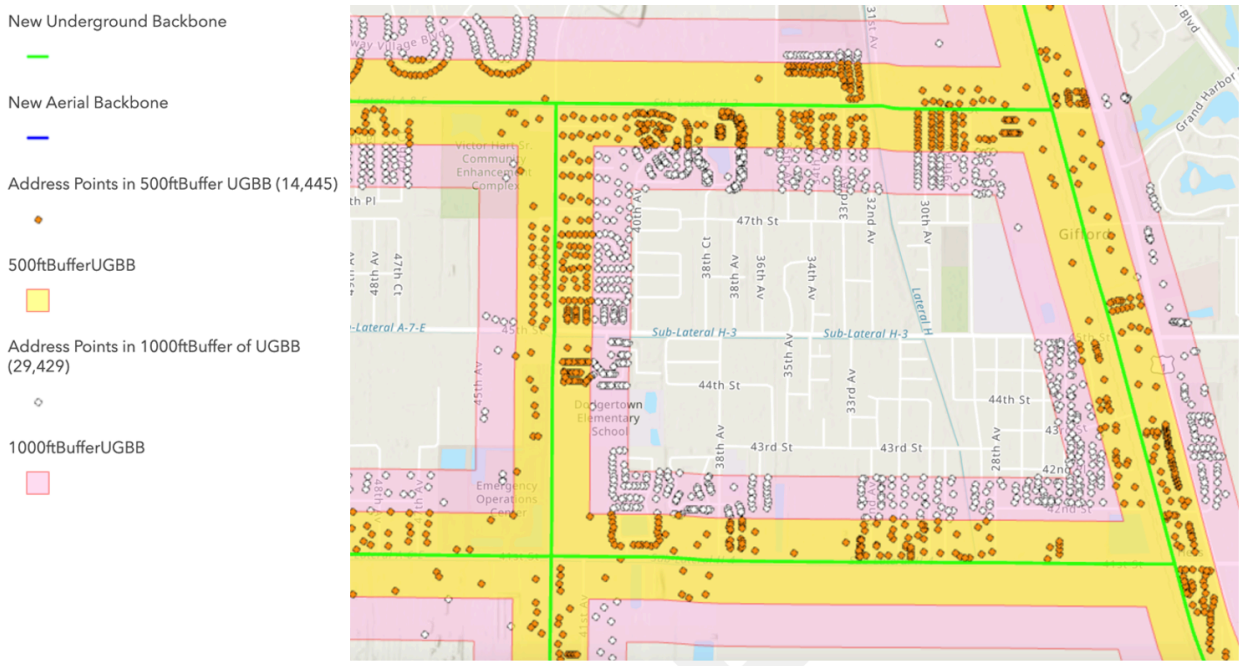


Figure 12: Address Points Within 500ft/1000ft Buffers

Components of the outside plant design include:

- Aerial and underground placement requirements
- Fiber-optic routes in established ROW and easement with distance and slack
- Location of vaults, hand-holes and pedestals, along with their sizes and quantities
- Placement of fiber distribution hubs, sizes and quantities
- Splitter configuration and density within fiber distribution hubs
- Fiber-optic splice points and splice cases
- Fiber-optic termination locations, sizes and quantities

- Equipment locations and requirements

Detailed breakdown of comprehensive county fiber underground broadband network option. Estimated cost based on current conceptional design and construction cost:

- Total Fiber Mileage Backbone and Laterals 144 miles of underground and 6 miles of aerial for an estimated total of 150 miles of 288 fiber.
- Current Estimated Construction Cost $25.42M
- Estimated Network Cost Breakdown:
    - PM/CM Services 18 months build $1.1M
    - Design/Engineering $870K
    - Construction Labor $15.7M
    - Additional 4" empty conduit for future use $1.15M (Optional)
    - Materials and Miscellaneous $6.25M
    - Core and Edge Electronics and Facilities $1.5M
    - New Data Center $500K Building Only (Optional)
    - Total Estimated Network Cost with Options $27.07M

BUSINESS STRATEGY- OPTION 3

1. Build a high-capacity IRC Intranet backbone that would serve connectivity to all of the IRC facilities.
2. The network would be 99% underground and hardened inside of conduit.
3. The network would have redundant rings and diverse routes for high reliability.
4. The network would be a high-count fiber strands which would provide lots of capacity beyond the county's current needs.
5. This access Dark Fiber backbone would be offered to lease to ISP's or an RFP could be issued to select an ISP partner that could either co-invest or agree to fund the laterals to reach any underserved parts of the county as part of an overall agreement.
6. Funding would be a combination of ARPA and state and federal grant opportunities.
7. The network could be built in phases based on funding available.

Indian River could create an infrastructure to support new entrants in an area with underserved broadband demand. The business strategy will define the IRFN's value proposition in the broadband infrastructure market. The core strategy will be to

focus on superior products and maintain community orientation while creating partnerships.

The broadband survey responses indicate that Indian River area households and businesses demand new entrants and better service and speed. A County investment in Infrastructure that partners with a provider will have demand from both organizations and residents in Indian River under the right conditions. IRFN and its partner would need to offer high-speed internet in competitive market tiers for prices that are equal to or less than consumers are currently paying today.

GENERAL BROADBAND STRATEGY

To be a successful fiber infrastructure provider, IRFN must build an organization with the competence to thrive in a competitive environment while maintaining its mission of serving the community first. A number of key items should be considered as Indian River plans to deploy services, including:

- Utilize the strong local brand known for reliability and customer service to introduce IRFN's infrastructure to community and public and private partners.
- Utilize shared resources to reduce the cost of deployment and increase the flexibility in which Indian River Fiber Network deploys services.
- Build an organization with the same culture of providing excellence in quality and customer service that Indian River departments provide today.
- Recognize that the broadband enterprise must partner with companies that excel in the competitive environment with leadership that has a strong competitive orientation and prior experience in delivering broadband services.
- Focus on delivering benefits to customers rather than features.
- Use the County's existing relationships with the residential and business communities to help their partners connect more customers.
- Focus on attracting major employers, employment centers, and commercial corridors to utilize IRFN's services; and
- Partner with municipal governments, county governments, school districts and other public organizations to support their needs through IRFN's dark fiber.

PRODUCTS AND SERVICES

Dark Fiber Leasing

The Indian River County could lease dark fiber to public entities, anchors, businesses, cellular and broadband service providers that need access within their community. The County could lease the fiber per strand mile, meaning that each strand of fiber is available for lease and the customer pays a set amount per mile of fiber utilized.

Many communities across the state of Florida and the US have created successful leased dark fiber networks including the City of Lakeland. In 2021, the City of Lakeland had revenues of over $800,000 a year from nine dark fiber leases. They began a partnership with Summit Broadband in 2020 to expand that to include fiber to the home broadband.

Business Model - Option 3 Build/Operate

The below analysis lays out the options and ways to monetize the County network assets with discussions around cost and operations, and benefits and risk of various models and the final Magellan recommended model.

The original intent of the feasibility study was to help identify the underserved population and to put together a plan that would provide services to this population as quickly and as responsibly as possible. In order to achieve this goal, it requires the County to build and provide the infrastructure that would allow service providers (ISPs) to have access and overcome the financial challenges that have been a roadblock for ISPs to provide services. Because a logical extension of this goal is to use the network to provide the required County connectivity. It makes sense for the County to establish an organization that is needed to support the County's own network requirements.

The County has determined that it has no interest in being an ISP especially in the retail marketplace but wants to be a facilitator for ISPs to expand and extend services. There are a few different ways to provide those facilities and assets for an ISP's use. The County will "light" parts of the network fiber to provide its own services and will support and provide operational support either through outsourcing, in-sourcing or a possible combination for these services. The County should also make the determination if it prefers to provide ISPs with "lit" services or

"dark" fiber services. And the County also must decide what type of financial model or monetization model it prefers.

The options are:

1. Dark fiber monthly or annual leasing based on a per fiber mile basis
2. Lit circuits
3. Fiber capital leases also known as IRUs (Indefeasible Right of Use)
4. Revenue share

Option 1 is a very common revenue model and requires less O&M from the County but also may produce less revenue.

Option 2 is more often a model used by network operators who look to maximize revenue potential and are willing to take more responsibility for O&M support to and for ISPs.

Option 3 is the model preferred by much larger ISPs because they can carry it as an asset on their books and also has less cost for ISPs over time, this also requires less O&M services for the County but produces the least revenue for the County.

Option 4, revenue share has become more common in the last several years and is based on a success and a win-win type basis and more of a partnership type structure. An example of this is Huntsville, AL and West Des Moines, IA where Google is paying five dollars per month per "customer passed" for use of the community owned fiber network. This option can provide enhanced revenue and less O&M cost for the County if structured properly.

Estimated Financials - Option 3

The Indian River network has an opportunity to increase broadband availability, bridge the digital divide and lower cost for consumers. Being that the network is to be paid for by grant funding enables Indian River to provide facilities that will spur competition by lowering the cost of entry into the market for ISPs wishing to serve the Indian River market. The network is a hybrid fiber/wireless network providing high capacity. The network will consist of 288 count dark fiber, almost all underground and spanning a total of about 150 miles of fiber network. The backbone fiber is capable of 1 gigabit to 40 gigabit and beyond depending on the electronics deployed on the network. The fiber network is designed to connect all County facilities, is a foundation for expanding broadband services and provides backhaul for the wireless towers.

Indian River has no interest in operating an ISP nor operating or maintaining the network. In this regard, an RFP could be issued for an ISP partner that would provide the needed electronics for the fiber network and lease the dark network from Indian River and would operate and maintain the network assets.

Operations and Maintenance – Option 3

Table 11 below illustrates the estimates for expenditures for Indian River County Intranet's annual O&M Cost. The network is 144 miles of underground fiber and about 6 miles of aerial fiber with fiber counts of 288, 96, and 48 strands serving County facilities, and providing a fiber superhighway across the county which is state-of-the-art and securely hardened.

Table 11: Operations And Maintenance

Cost Category Annual	Cost
Outside Network Maintenance	$60,000
Network Electronics (Fix/Replace)	$50,000
2 Fulltime Personnel (loaded costs)	$140,000
Reserves and Replacements	$40,000
Transport (2 diverse providers)	$60,000
Utilities	$15,000
Outsourced NOC services 24/7 (EPB for example) is 24/7 is desired Optional	$60,000
Miscellaneous Expenses	$60,000
Estimated Total Annual Network O&M Expense	$485K

Dark Fiber Leasing Revenue Model - Open Access

The revenue estimates are projected based on both dark fiber leasing opportunities to encourage ISPs to better serve areas and encourage new ISPs to consider moving into Indian River County and create more competition. The revenue estimates also include corporate point-to-point dark fiber leasing opportunities. The County should consider widely releasing an RFQ describing the opportunity and request feedback from potential users of the conceptual network.

Table 12:Dark Fiber Leasing

Additional Outside Network Maintenance	**$60,000**
Dark Fiber Revenue	$2,400 per fiber strand mile / minimum four strands
Estimated Net Annual Revenue (Based on 100 miles of 4 strands of fiber leased)	$900,000

LIT Fiber Revenue Model - Open Access

Table 13: Lit Fiber Revenue Model - Open Access

Cost Category	Cost
Additional Outside Network Maintenance	$126,000
2 Additional Network Personnel (loaded cost)	$160,000
Annual Estimated Revenue	$5,000 per fiber strand mile / minimum four strands
Estimated Annual Gross Revenue (Based on 100 miles of fiber leased) $2M	Net Revenue $1.7 Million

Revenue Share Model- Annual Estimated

Table 14:Revenue Share Model

Cost Category	Cost
Additional Outside Network Maintenance	$266,000
Estimated Revenue	$60 annually per passing / estimated 20,000 passings
Estimated Annual Net Revenue	$ 900,000

The Business Plan if the full network build/own is selected.

It encompasses two forms of monetizing the network investment which will maximize the revenue and leverage the necessary fixed cost of operating the network. In this business plan the County would own and operate its own network infrastructure to provide its own broadband services to all identified County facilities. The County would also lease dark fiber to ISPs in an open access model as referenced above.

There are a wide range of funding sources that Indian River County should be prepared to consider preparing an application for. The American Rescue Plan Act (ARPA) has allocated funding for broadband, and the larger pending infrastructure bill has almost $65B in funding expected for broadband over the course of the next few years once passed by congress. Allocations from ARPA have been delivered to states and localities, as well as federal agencies that are now and will continue to roll out funding sources for communities, tribes, utilities, and service providers that can prove shovel ready projects that solve the digital divide and close gaps in unserved and underserved communities – namely those lacking speeds ranging from 25Mbps/3Mbps to 100Mbps/100Mbps.

Each funding source will have different scoring metrics, and funding windows will be short so the County will need a business and engineering plan prepared for these opportunities. Magellan's team tracks all funding opportunities and will update the County when new announcements and Notice of Funding Availability

(NOFA) are announced on eligible opportunities. A list of funding agencies that Indian River County may submit to in coming rounds includes:

- Rural Utilities Service (RUS)
- National Telecommunications and Information Administration (NTIA)
- Economic Development Administration (EDA)
- Federal Communications Commission (FCC)
- State of Florida

Appendix A: Fiber Network Design and Construction Specifications

INTRODUCTION

The purpose of this document is to describe the guidelines and methods by which the physical components for the County of Indian River fiber networks will be designed and installed. Completed construction projects will follow the guidelines and principles outlined in this document, in addition to local rules, regulations, and specifications as they apply. Contractors will adhere to industry standard quality installation principles and provide quality installation services to ensure that the most reliable and cost-effective network is built.

All fiber routes will be installed to fall within the public right-of-way (ROW), existing utility easements, or other property to which the County has legal access.

Any changes to this document will be provided in writing and a revised version will be disseminated to all stakeholders upon approval.

Issue	Revision Date	Change Description	Authors
20211122	11/22/21	Initial Revision	John Williams

GENERAL GUIDELINES

These guidelines identify and define the County of Indian River's requirements and policies for designing and installing broadband infrastructure and substructure for the County. Use of, and compliance with these guidelines is mandatory for architects, engineers, and installation contractors including all subcontractors working on the County of Indian River's Network Infrastructure upgrades, moves, maintenance and restoration projects.

The County Infrastructure Standards are based upon the code requirements and telecommunications industry standards contained in the following guidelines. These guidelines will not duplicate the information contained in those references, except where necessary to provide guidance, clarification or direction. Installers shall use sound judgement in order to comply with the requirements of the codes

and standards in references and standards.

(a) License

Contractor shall possess any and all contractor licenses, in form and class as required by any and all applicable laws with respect to any and all work to be performed under this contract; in accordance with the provisions of the Contractor's License Law in the State of Florida and rules and regulation adopted pursuant thereto.

(b) Insurance

The Contractor shall not commence work under this contract until he has obtained all insurance required per the contract with the County. Nor shall the Contractor allow any subcontractor to commence work on his subcontract until all insurance required of the subcontractor has been obtained. The Contractor shall take out and maintain at all time during the life of the contract. The following policies of insurance: policies as required by the County of Indian River.

(c) Laws and Regulations

Installation contractor including all subcontractors shall follow all Federal, State, and local laws and regulations for the installation and maintenance in which the contractor has been hired to perform.

(d) Materials

The Contractor will be responsible for providing materials necessary to complete all work described in the work order to deliver a complete and working system. Contractor shall provide cut sheets with material specifications to the County for all materials for approval prior to ordering.

(e) Permitting

Contractor shall always have a copy of approved permit and associated plans on the jobsite. The County will provide copies of approved permits to the Contractor prior to any installation work proceeding. It is the Contractor’s responsibility to coordinate notice of commencement, and coordinate with the permitting authority having jurisdiction on any requirements given as a conditional approval of the

permitting.

All fiber-optic network systems shall meet or exceed the latest requirements of all national, state, county, municipal, and other authorities exercising jurisdiction over the telecommunications systems and the Project.

Contractor agrees to furnish any additional labor or material required to comply with all local and other agencies having jurisdiction at no additional cost.

Contractor shall obtain certificates of inspection and approval from all authorities having jurisdiction, and forward copies of the same to the County prior to request for Project acceptance inspections, final completion inspections, substantial completion inspections, and acceptance testing/demonstrations.

All required permits and inspection certificates shall be made available at the completion of the fiber-optic system installation and commissioning.

Any portion of the fiber network which is not subject to the requirements of an electric code published by a specific authority having jurisdiction shall be governed by the National Electrical Code and other applicable sections of the National Fire Code, as published by the National Fire Protection Association (NFPA).

Installation procedures, methods and conditions shall comply with the latest requirements of the Federal Occupational Safety and Health Administration (OSHA).

(f) Traffic Control

It is the responsibility of the Contractor to provide adequate temporary traffic control to ensure traffic safety during construction activities. Therefore, the Contractor shall submit a traffic control plan to the appropriate public works department and have the plan approved prior to starting any work in the right-of-way.

(g) Warranties

The Contractor shall guarantee the entire work constructed by him under the contract to be free of defects in materials and workmanship for a period of one year following the date of acceptance of the work by the County. The Contractor shall agree to make, at his own expense, any repairs or replacements made necessary by defects in materials or workmanship, which become evident within

the warranty period. The Contractor shall further agree to indemnify and save harmless the County and Engineer, and their officers, agents and employees, against and from all claims and liability arising from damage and injury due to said defects. The Contractor shall make all repairs and replacements promptly upon receipt of written order from the Engineer. If the Contractor fails to make the repairs and replacements promptly, the County may do the work and the Contractor, and his surety shall be liable to the County for the cost of the work.

Manufacturers' warranties, guarantees, instruction sheets and parts lists, which are furnished with certain articles of materials incorporated in the work, shall be delivered to the Engineer before acceptance of the contracts.

(h) Change orders

No change orders will be paid for unless preapproved by the County. Any deviations or discrepancies in the plans or field conditions that result in a change of installed billable quantities shall be submitted for approval prior to commencement of work.

(i) Restoration

All work performed under the responsibility of the Contractor shall include full restoration of any disturbed area to like new condition. This includes, but is not limited to; asphalt, concrete, pavers, earthwork, compaction requirements, sod, plants, trees, landscaping, signage, irrigation systems, and all existing utilities.

All work and materials within the FDOT Right-of-Way shall be in accordance with the Florida Road and Bridge Standards, latest edition.

(j) Testing

All systems shall be tested as defined within this document to include, conduit proofing, cabling continuity and splice loss, compaction of disturbed earth, and any additional requirements set forth as a conditional approval of permitting or as directed by permitting authority and the County of **Indian River**.

(k) Craftsmanship

All work, which is defective in its construction or deficient in any of the requirements of the plans and specifications, shall be remedied or removed and replaced by the Contractor in an acceptable manner at his own expense. No compensation will be allowed for any work done beyond the lines and grades shown on the plans or established by the Engineer. Upon failure on the part of the Contractor to comply with any order of the Engineer made under the provisions of this article, the Engineer and County may cause the defective work to be remedied or removed and replaced at the expense of the Contractor.

Any unauthorized or defective work, defective material or workmanship or any unfaithful or imperfect work that may be discovered before final acceptance of work by the board shall be corrected immediately with no extra charge even though it may have been overlooked in previous inspections and estimates or may have been caused due to failure to inspect the work.

All cable and equipment shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the contract documents shall be subject to the control and approval of the Owner.

Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where “approved equal” is stated or a substitution is requested, equipment shall be equivalent in every way to that of the equipment specified. All substitutions are subject to the control and approval of the owner or the owner representative.

Strictly adhere to all Telecommunications Industry Association (TIA) and BICSI recommended installation practices and manufacturer’s guidelines when installing communications components.

(l) Safety

Payment for performing all work necessary to provide safety measures or compliance with the provisions of the safety orders and all other laws, ordinances, and regulations shall be included in Contractor’s pricing.

The Contractor shall be responsible for providing adequate safeguards, safety devices, protective equipment, confined space protections, flaggers, and any other

needed actions to protect the life, health, and safety of the public and to protect property in connection with the performance of work covered by the contract. Any work within the traveled right-of-way that may interrupt normal traffic flow shall require a traffic control plan approved by FDOT, and the County or County public works. All sections of the FDOT Standard Specifications, Traffic Control, and the Manual of Uniform Traffic Control Devices (MUTCD) shall apply.

(m) Protection of Public

Whenever the construction occurs within a developed residential area and/or through a school site, the Contractor shall take all necessary precautions to protect the public, especially children, from the hazards of open excavations. Trenches shall either be covered or adequately fenced at night and on weekends or whenever operations are not in actual process.

Unusual conditions may arise on the project, which will require that immediate and unusual provision be made to protect the public from danger or loss or damage to life and property, due directly or indirectly to the progression of the work. It is part of the service required of the Contractor to make such provisions and to furnish such protection.

The Contractor shall use such foresight and shall take such steps and precautions as the operations make necessary to protect the public from danger or damage, or loss of life or property, which would result from the interruption or contamination of public water supply, irrigation or other public service or from the failure of partly completed work.

Whenever, in the opinion of the County, an emergency exists against which the Contractor has not taken sufficient precaution for the safety of the public or the protection of utilities or of adjacent structures or property or if immediate action shall be considered necessary in order to protect public or private personnel or property interest, or prevent likely loss of human life or damage on account of the operations under the contract, then and in that event the County may provide suitable protection to said interest by causing such work to be done and material to be furnished, as, in the opinion of the County may seem reasonable and necessary.

The cost and expense of said labor and material together with the cost and expense of such repairs as may be deemed necessary shall be borne by the Contractor, and if he shall not pay said cost and expense upon presentation of the

bills therefore, duly certified by the Engineer, then said costs and expense will be paid by the County and shall thereafter be deducted from any amounts due, or which may become due said Contractor. Failure of the County, however, to take such precautionary measure, shall not relieve the Contractor of his full responsibility for public safety.

(n) Storage of Equipment and Materials in Public Streets

Construction materials shall not be stored in streets, roads, or highways for more than five days after unloading. All materials or equipment not installed or used in construction within five days after unloading, shall be stored elsewhere by the Contractor at their expense unless authorized additional storage time.

Construction equipment shall not be stored at the work site before its actual use on the work or for more than five days after it is no longer needed. Time necessary for repair or assembly of equipment may be authorized by the Engineer.

Excavated material, except that which is to be used as backfill in the adjacent trench, shall not be stored in public streets unless otherwise permitted. After placing backfill, all excess material shall be removed immediately from the site.

The foregoing provisions are in addition to and not in limitation of any other rights or remedies available to the County.

(o) Discrepancies

If a discrepancy or inconsistency is discovered in the plans, drawings, specifications or contract for the work in relation to any such law, ordinance, regulation, order or decree, the Contractor shall forthwith report the same to the Engineer in writing.

FIBER-OPTIC CABLE

(a) General Guidelines

All cable, unless specifically called out, for shall be single-mode cable, rated for the environment in which it is installed. Installations shall be OSP rated dielectric.

- Pre-Approved Product Sets The following product sets are pre-approved for this project. Except as noted, all others will require a substitution request to be completed and approved as per these documents. Indian River will not

consider product sets that have not been pre- approved or accepted as per the substitution request process.

- Fiber-optic cable and connection/termination products shall be manufactured by one of the following:
    1. Optical Cable Corporation
    2. Corning
    3. CommScope
    4. OFS
    5. Or approved alternate

(b) Fiber Optic Cable

All cables shall be loose tube or ribbon fiber. If ribbon fiber is to be used it shall be approved by the engineer before ordering.

(c) Bend Radius

The main risk of damage to the fiber-optic cable is by overlooking the minimum-bend radius. It is important to know that the damage occurs more easily when the cable is bent under tension, so when the installation is in process be sure to allow for at least the minimum-bend radius. The number of 90-degree turns on a pull shall not exceed four (4).

(d) Reel Placement

Have the reel set adjacent to the hand hole and use a fiber-optic manhole pulling block assembly from Sherman & Reilly (or similar).

(e) Cable Slack

Coil a minimum of 50 feet of cable at each hand hole location.

(f) Cable Tags

All cables shall be tagged and labeled at each splice location, fiber termination panel and building entrance. Tags shall read cable size, count and origin.

(g) Strength

The fibers in the cable will shatter under considerable impact, pressure or if pulling tensions exceed 600 lb., although not apparent from the outside of the cable. With fiber-optic cable the jacket of the cable and the Kevlar layer directly beneath give the cable its strength, note and repair all nicks and cuts.

(h) Installation

During installation, use a swivel eye for pulling the fiber-optic cable and conduit system including use of a 600 lb. breakaway.

(i) Precautions

Review the manufacturer's installation instructions prior to commencing with the installation. If any questions arise during installation, refer to the manufacturer's installation instructions or notify the project Engineer.

All fibers in the cables shall be usable fibers and shall be free of surface imperfections and occlusions, in order to meet or exceed all the optical, mechanical, and environmental requirements contained in this specification.

All cables shall be free of material or manufacturing defects and dimensional non-uniformity that would:

- Interfere with the cable installation employing accepted cable installation practices.
- Degrade the transmission performance and environmental resistance after installation.
- Inhibit proper connection to interfacing elements.
- Otherwise yield an inferior product.
- Each fiber optic outside plant cable for this project shall be all-dielectric, dry water-blocking material, duct type, with loose buffer tubes, and shall conform to these special conditions.

Fiber-optic cables shall be supplied in the configurations shown on the plans and specified in these special conditions.

The optical fibers shall be contained within buffer tubes. The buffer tubes shall be stranded around an all-dielectric central member. Aramid yarn and/or fiberglass

shall be used as a primary strength member and a medium or high-density polyethylene outside jacket shall provide for overall protection.

All fiber-optic cable on this project shall be from the same manufacturer who is regularly engaged in the production of optical fiber material.

The cable shall be qualified as compliant with Chapter XVII, of Title 7, Part 1755.900 of the Code of Federal Regulations, “REA Specification for Filled Fiber Optic Cables.”

(j) Cable Marking

The optical fiber cable outer jacket shall be marked with manufacturer's name, the month and year of manufacture, the words "Optical Cable," telecommunications handset symbol as required by Section 350G of the National Electrical Safety Code (NESC®), fiber count, fiber type and sequential meter marks. The markings shall be repeated every two feet. The actual length of the cable shall be within -0/+1% of the length marking. The marking shall be in a contrasting color to the cable jacket. The marking shall be approximately –0/+1% of the actual length of the cable in height and must be permanent and weatherproof.

The fiber-optic cable shall consist of, but not be limited to, the following components:

- Single-mode optical fiber
- Buffer tubes
- Central member
- Filler rods (as needed per cable type)
- Stranding
- Dry-filled, water blocking tape and water blocking yarn
- Tensile strength member
- Ripcord
- Outer jacket

(k) Single-Mode Optical Fiber

Each optical fiber shall be glass and consist of a doped silica core surrounded by concentric silica cladding. All fibers in the buffer tube shall be usable fibers and shall be sufficiently free of surface imperfections and occlusions to meet the

optical, mechanical, and environmental requirements of these specifications. The coating shall be a dual layered, UV cured acrylate. The coating shall be mechanically or chemically strippable without damaging the fiber.

(l) Buffer Tubes

The loose buffer tubes shall be single or dual layered in construction. For single layer, use polypropylene. For dual layer, the inner layer shall be made of polycarbonate and the outer layer shall be made of polyester. Buffer tubes shall provide clearance between the fibers and the inside of the tube to allow for expansion without constraining the fiber. The fibers shall be loose or suspended within the tubes and shall not adhere to the inside of the tube. Each buffer tube shall contain 12 fibers based upon the total fiber count in the cable and the fiber assignment table as shown on the plans and these special conditions. No individual fiber tube shall contain more than 12 fibers. The number of buffer tubes for the fiber-optic cable shall be approved by the Engineer before ordering.

The loose buffer tubes shall be extruded from a material having a coefficient of friction sufficiently low to allow free movement of the fibers. The material shall be tough and abrasion resistant to provide mechanical and environmental protection of the fibers yet designed to permit safe intentional "scoring" and breakout, without damaging or degrading the internal fibers.

Buffer tube filling compound shall be a homogenous, hydrocarbon-based gel with anti-oxidant additives. It shall be used to prevent water intrusion and migration. The filling compound shall be non-toxic and dermatologically safe to exposed skin. It shall be chemically and mechanically compatible with all cable components, non-nutritive to fungus, non-hygroscopic and electrically non-conductive. The filling compound shall be free from dirt and foreign matter and shall be readily removable with conventional, nontoxic, solvents.

Buffer tubes shall be stranded around a central member by a method such as the reverse oscillation stranding process that will prevent stress on the fibers when the cable jacket is placed under strain.

Each buffer tube shall be distinguishable from other buffer tubes in the cable by using the same color coding as specified for fibers elsewhere in this document.

(m) Central Member

The central member, which functions as an anti-buckling element, shall be a glass reinforced plastic rod with similar expansion and contraction characteristics as the optical fibers and buffer tubes. To provide the proper spacing between buffer tubes during stranding, a symmetrical, linear, overcoat of polyethylene may be applied to the central member to achieve the optimum diameter.

(n) Filler rods

Fillers may be included in the cable cross-section. Filler rods shall be solid medium or high-density polyethylene. The diameter of filler rods shall be the same as the outer diameter of the buffer tubes.

(o) Stranding

The buffer tubes shall be helically wrapped using the reverse lay stranding process around the central member in order to decouple the buffer tubes and optical fibers from the mechanical forces experienced during installation.

Completed buffer tubes shall be stranded around the central member using stranding methods, lay lengths, and positioning such that the cable shall meet mechanical, environmental, and performance specifications. A polyester binding shall be applied over the stranded buffer tubes to hold them in place. Binders shall be applied with sufficient tension to secure the buffer tubes to the central member without crushing the buffer tubes. The binders shall be non-hygroscopic, non-wicking, and dielectric with low shrinkage.

(p) Core and Cable Water-Block Material

The cable core shall use a dry, water-blocking material to block the ingress and migration of water. The water-blocking performance shall be equivalent to flooded optical cables when tested in accordance with industry standards (ICEA, RUS). Dry, water-blocking material is used in optical cables to enhance the ease of handleability while maintaining reliable water-blocking performance.

(q) Tensile Strength Member

Tensile strength shall be provided by high tensile strength Aramid yarns and/or fiberglass which shall be helically stranded evenly around the cable core and shall not adhere to other cable components.

(r) Ripcord

The cable shall contain at least one ripcord under the jacket for easy sheath removal.

Outer Jacket

The all-dielectric cables (no armoring) shall be sheathed with medium or high-density polyethylene. The minimum nominal jacket thickness shall be 1.4 mm. Jacketing material shall be applied directly over the tensile strength members and shall not adhere to the Aramid strength material. The polyethylene shall contain carbon black to provide ultra-violet light protection, and it shall not promote the growth of fungus. The jacket shall be free of holes, splits and blisters. The cable jacket shall contain no metal elements and shall be of a consistent thickness.

The jacket or sheath shall be marked with the manufacturer's name, the words "Optical Cable", the number of fibers, fiber type, month and year of manufacture, and sequential measurement markings every meter. The actual length of the cable shall be within ±1 percent of the length marking. The marking shall be in a contrasting color to the cable jacket. The print height of the marking shall be approximately 2.5 mm and must be permanent and weatherproof. The cable shall contain at least one ripcord under the sheath for easy sheath removal.

(s) Quality Assurance

The manufacturer(s) of supplied optical cable, optical cable assemblies and hardware shall be TL 9000 registered.

(t) Fiber Characteristics

One hundred percent (100%) of the optical fibers shall meet or exceed the requirements contained in this specification.

The cable shall be tested in accordance with TIA/EIA-455-3A (FOTP-3), "Procedure to

Measure Temperature Cycling Effects on Optical Fiber, Optical Cable, and Other Passive Fiber-Optic Components." The average change in attenuation at extreme operational temperatures (-40°C to +70°C) will not exceed 0.05 dB/km at 1550 nm. The magnitude of the maximum attenuation change of each individual fiber will not be greater than 0.15 dB/km at 1550 nm. This figure includes an allowance of up to 0.05 dB/km for measurement repeatability. All fibers within the finished cable shall be composed primarily of silica and shall have a matched clad index of refraction profile as well as the physical and performance characteristics that shall meet the requirements in the following table:

Table 15: Field Characteristics

Parameters	Value
Mode	Single
Type	Corning SMF-28 or approved equal
Core diameter	8.3 µm (nominal)
Cladding diameter	125 µm ± 1.0 µm
Core to Cladding Offset	≤ 0.8 µm
Coating Diameter	245 µm ±10 µm
Cladding Non-circularity defined as: [1- (min. cladding dia ÷ max. cladding dia.)]x100	≤ 1.0%
Proof/Tensile Test	100 kpsi, min.
Attenuation:	
@ 1310 nm	≤ 0.4 dB/km
@ 1550 nm	≤ 0.3 dB/km
Attenuation Uniformity	No point discontinuity greater than 0.1 dB at either 1300 nm or 1550 nm
Attenuation at the Water Peak	≤ 2.1 dB/km @ 1383 ±3 nm
Attenuation at Extreme Operational Temperatures	≤ +0.05 dB @ 1310 nm or 1550 nm
Chromatic Dispersion:	

Parameters	Value
Zero Dispersion Wavelength (λ_o)	$1301.5 \leq \lambda_o \leq 1321.5$ nm
Zero Dispersion Slope	≤ 0.092 spy/(nm^2•km)
Maximum Dispersion:	≤ 3.5 peso/(nm•km) for 1285 - 1330 nm ≤ 18 spy/(nm•km) for 1550 nm
Cut-Off Wavelength	<1260 nm
Mode Field Diameter (Petermann II)	9.3 ± 0.5 µm at 1310 nm 10.5 ± 1.0 µm at 1550 nm

(u)Color Coding

Optical fibers shall be distinguishable from others in the same buffer tube by means of color-coding according to the following:

1. Blue (BL)
2. Orange (OR)
3. Green (GR)
4. Brown (BR)
5. Slate (SL)
6. White (WT)
7. Red (RD)
8. Black (BK)
9. Yellow (YL)
10. Violet (VL)
11. Rose (RS)
12. Aqua (AQ)

The colors shall be targeted in accordance with the Munsell color shades and shall meet TIA/EIA-598B "Color Coding of Fiber Optic Cables" and RUS 7 CFR 1755.900.

The color formulation shall be compatible with the fiber coating and the buffer tube filling compound and be heat stable. It shall not fade or smear or be susceptible to migration, it shall not affect the transmission characteristics of the optical fibers and shall not cause fibers to stick together.

(v) General Cable Performance Specifications

The fiber-optic cable shall withstand water penetration when tested with a one-meter static head or equivalent continuous pressure applied at one end of a one-meter length of filled cable for one hour, no water shall leak through the open cable end. Testing shall be done in accordance with TIA/EIA-455-82 (FOTP-82), "Fluid Penetration Test for Fluid-Blocked Fiber Optic Cable."

The cable shall exhibit no flow (drip or leak) for 24 hours at 80°C. The weight of any compound that drips from the sample shall be less than 0.05 grams (0.002 ounce). A representative sample of cable shall be tested in accordance with TIA/EIA-455-81B (FOTP-81), "Compound Flow [Drip] Test for Filled Fiber Optic Cable". The test sample shall be prepared in accordance with method A.

Crush resistance of the finished fiber-optic cables shall be 220 N/cm applied uniformly over the length of the cable without showing evidence of cracking or splitting when tested in accordance with TIA/EIA-455-41 (FOTP-41), "Compressive Loading Resistance of Fiber Optic Cables." The 220 N/cm (125 lbf/in) load shall be applied at a rate of 2.5 mm (0.1 in) per minute. The load shall be maintained for a period of 1 minute. The load shall then be decreased to 110 N/cm (63 lbf/in). Alternatively, it is acceptable to remove the 220 N/cm (125 lbf/in) load entirely and apply the 110 N/cm (63 lbf/in) load within five minutes at a rate of 2.5 mm (0.1 in) per minute. The 110 N/cm (63 lbf/in) load shall be maintained for a period of 10 minutes. Attenuation measurements shall be performed before release of the 110 N/cm (63 lbf/in) load. The change in attenuation shall not exceed 0.4 dB during loading at 1550 nm for single-mode fibers and 1.0 dB during loading at 1300 nm for multimode fiber. The repeatability of the measurement system is typically 0.05 dB or less. No fibers shall exhibit a measurable change in attenuation after load removal.

The cable shall withstand 25 cycles of mechanical flexing at a rate of 30 ±1 cycles/minute with a sheave diameter not greater than 20 times the cable diameter. The cable shall be tested in accordance with Test Conditions I and III of TIA/EIA-455-104A (FOTP-104), “Fiber Optic Cable Cyclic Flexing Test.” The magnitude of the attenuation change will be within the repeatability of the measurement system for 90% of the test fibers. The remaining 10% of the fibers will not experience an attenuation change greater than 0.1 dB at 1550 nm. The repeatability of the measurement system is typically ± 0.05 dB or less. The cable jacket will exhibit no cracking or splitting when observed under 5X magnification.

Impact testing shall be conducted in accordance with TIA/EIA-455-25B (FOTP-25) "Repeated Impact Testing of Fiber Optic Cables and Cable Assemblies." The cable shall withstand 20 impact cycles. The magnitude of the attenuation change will be within the repeatability of the measurement system for 90% of the test fibers. The remaining 10% of the fibers will not experience an attenuation change greater than 0.1 dB at 1550 nm. The repeatability of the measurement system is typically ± 0.05 dB or less. The cable jacket will not exhibit evidence of cracking or splitting at the completion of the test.

Using a maximum mandrel and sheave diameter of 560 mm, the finished cable shall withstand a longitudinal tensile load of 2700 N (608 lbs.) applied for one hour (using "Test Condition II" of the test plan). The test shall be conducted in accordance with TIA/EIA-455-33 (FOTP-33), "Fiber Optic Cable Tensile Loading and Bending Test." The measured fiber tensile strain shall be $\leq$ 60% of the fiber proof strain. The cable will not experience a measurable increase in attenuation when subjected to the rated residual tensile load, 890 N (200 lbf). The repeatability of the measurement system is typically ± 0.05 dB or less.

The cable shall be capable of withstanding a bending radius of 15 times the cable diameter under tensile loading and 10 times the cable diameter under a no-load condition

SPLICING

(a) General Guidelines

This section describes minimum requirements for splicing and connecting of the specified optical fiber cables.

Fiber-optic cable shall be installed without splices except where specifically allowed on the plans or described in these special conditions. The single-mode fiber-optic cables used for distribution shall be spliced in pull boxes as shown on the plans or at aerial slack locations as shown on drawings. When splicing into a distribution cable, only those fibers associated with the count transferring onto the distribution cable shall be severed. All other fibers shall remain intact. The Engineer may allow additional splices between these specified locations.

At no point shall cables be severed out of the convenience of the installation contractor. Splices shall only be performed at planned locations. Any situation

where this can be accomplished shall be pre-approved prior to adding any additional splices to the network.

(b) Labeling

All splice cases, trays and fiber termination panels shall be properly labeled as to identify cable size, fiber count and routing of each fiber strand.

(c) Splicing

Optical fibers shall be spliced using the fusion splice method and the insertion loss shall not exceed 0.20 dB of loss per splice when tested using a bi-directional average.

All closures shall include all necessary hardware items to support the cable adjacent to the closure and to terminate the lashing wire (if aerial). The fiber organizer trays shall be supplied as part of the Splice Case Closure.

Cable closures shall be installed in accordance with the manufacturer's instructions. Splicing shall be performed in accordance with RUS Splicing Standard Bulletin 1753F-401 (PC-2).

Field splicing is permitted for the following:

- Connection of cable reel sections.
- Connection of a mainline service distribution cable to a service drop cable or a breakout cable.
- Connection of service drop cable or breakout cable to an optical fiber pigtail at cabinets or the patch panels.
- Connection of the backbone cable to an optical fiber pigtail at a hub patch panel.

The Contractor shall not exceed the maximum number of field splices permitted as shown in the plans. Completed splices shall be placed in a splice tray. The splice tray shall then be placed in a water tight splice enclosure. Field splices shall be conducted only at locations as shown in the plans as an approved splice location.

All splicing equipment shall be in good working order, properly calibrated with calibration certificate showing proof of calibration within the past 12 months.

Craftmanship shall meet all industry standards and safety regulations. Cable preparation, closure installation and splicing shall be accomplished in accordance with accepted and approved industry standards.

All splices shall be protected with a thermal shrink sleeve. All fibers shall be labeled in the splice tray with permanent vinyl markers. Pigtail ends shall also be labeled to identify the destination of the fiber. Pigtail ends shall also be labeled to identify the destination of the fiber.

Upon completion of the splicing operation, all waste material shall be deposited in suitable containers, removed from the job site and disposed of in an environmentally acceptable manner.

(d) Splice Cases

All splice cases used on this project shall be CommScope FOSC 450 Gel sealed fiber-optic splice closure or approved equal. The following sizes shall be used:

- FOSC 450A – Holds up to 96 fiber splices
- FOSC 450B – Holds up to 144 fiber splices
- FOSC 450C – Holds up to 192 fiber splices
- FOSC 450D – Holds up to 576 fiber splices

All cases shall be sized to accommodate cable sizes that are housed in the splice case. Contractor shall include splice trays, label all fiber coming in and out of splice case, and protect each fusion splice with heat shrink protectors.

(e) Photos

Contractor shall take a photo of each splice tray and document as part of the deliverables with the test results. All photos shall be labeled with location, date, tech name, company and description of the completed splice.

(f) Fiber-Optic Cable Termination Assemblies

Cable termination assemblies (connectors, pigtails and couplers) shall be products of the same manufacturer. The cable used for cable assemblies shall be made of

fiber meeting the performance requirements of these special conditions for the F/O cable being connected, except that the operating temperature shall be modified to -20°C to +70°C.

Manufacturer's attenuation test results shall be provided for all cable assemblies.

(g) Optical Fiber Connectors

All optical fiber termination components shall meet or exceed the applicable provisions of TIA/EIA-455-B, Standard Test Procedure for Fiber-Optic Fibers, Cables, Transducers, Sensors, Connecting and Terminating Devices, and Other Fiber-Optic Components.

All optical fiber connectors shall be of industry standard LC Angled polished APC, type for single-mode optical fiber and shall meet or exceed the applicable provisions of TIA/EIA-455-2C (FOTP-2), Impact Test Measurements for Fiber-Optic Devices, TIA/EIA-455-5B (FOTP-5), Humidity Test Procedure for Fiber-Optic Components, and TIA/EIA-455-34A (FOTP-34), Interconnection Device Insertion Loss Test. When tested in accordance with FOTP –2, the connector assembly will be subjected to ten impact cycles by being dropped from a height of 1.5 m. The maximum insertion loss measured before and after the impacts shall be < 0.50 dB. The mean insertion loss of the before and after impacts shall be < 0.30 dB. The insertion loss increase measured before and after the impacts shall be < 0.30 dB. The maximum reflectance measured before and after the impacts shall be < - 40 dB. When tested in accordance with FOTP – 5, the connector assembly will be subjected to test conditions of 75 °C and 95% relative humidity for 7 days. Measurements of loss and reflectance will be made at the beginning of the test, at a minimum of six-hour intervals during the test, and at the end of the test. The maximum insertion loss measured before, during or after the test shall be < 0.50 dB. The mean insertion loss of the before, during or after the test shall be < 0.30 dB. The insertion loss increase measured before, during or after the test shall be < 0.30 dB. The maximum reflectance measured before, during or after the test shall be < - 40 dB.

Optical fiber connectors shall satisfy all interface parameters of equipment components as may be defined by the transmission equipment specifications. All optical fiber connector assemblies shall be machine angle polished for low back-reflection and low insertion losses at both 1310 nm and 1550 nm wavelengths.

Single-mode pigtails shall be provided with factory pre-connectorized single-mode connectors of the "LC Angle-PC" type. Connectors shall have maximum insertion loss of 0.5 dB or better. Connectors shall have a composite barrel with a “push-pull” connection design, ceramic (zirconia) ferrule. Each connector shall be capable of 200 repeated matings with a total maximum additional increase in insertion loss after 200 matings limited to 0.30 dB.

Each connector shall have a return loss (back reflection) equal to or better than .50 dB.

All connectors shall be factory-assembled and tested. There shall be no fabrication of connectors in the field.

All unmated connectors shall have protective caps installed.

(h) Couplers

Couplers shall be made of nickel-plated zinc or a glass reinforced polymer that is consistent with the material forming the associated lC connector body. The design mechanism for mounting the coupler to the connector panel may be flanged or threaded but shall coincide with the connector panel punch-outs. All coupler sleeves shall be ceramic of the split clamshell or clover leaf design. The temperature operating range for couplers shall be the same as that specified for the SC connectors.

(i) Pigtails

Pigtails shall be of simplex (one fiber) construction, in 900 μm tight-buffer form, surrounded by Aramid for strength, with a connector on one end. The outer jacket shall be yellow PVC with a nominal diameter of 3 mm, marked with the manufacturer’s identification information. All pigtails shall be of adequate length for the intended connection purpose, but not less than two meters in length. Pigtails installed in conduit shall follow the installation procedures outlined for fiber-optic cables, except that the pulling tension shall not exceed 500 N (110 lbf.).

(j) Fiber Termination Panels

Fiber terminations shall be housed in a rack mounted fiber termination panel, sized appropriately for the cable size installed. All materials including fiber panel housing,

pigtails, splice cassettes, trays, connector panels and all other materials required for a complete working system shall be provided by the Contractors and shall be included in Contractor pricing.

(k) Testing

The contractor shall perform fiber testing on 100% of all fiber strands installed. Testing shall be completed using the following standards using equipment calibrated within the past 12 months.

(i) Reel Testing

All fiber shall be tested on the reel prior to installation utilizing an OTDR. Testing shall be completed to verify continuity of length consistent with the length of the reel documented. OTDR reel test shall be completed in one direction at 1550nm. Raw OTDR traces as well as .pdf copies of reel test shall be provided to the County as a project deliverable. Traces shall be performed long enough to provide a clean trace and show beginning and end of fiber. Any issues in fiber continuity or defects discovered shall be brought to the attention of the County and shall not be installed until the issue is rectified.

Post Installation Testing

All fiber strands shall be tested once they are in their final configuration. Test documentations shall be provided to the County as part of the project deliverables. Acceptance testing shall be completed utilizing two wavelengths of 1310 and 1550nm. Acceptance testing shall utilize both OTDR and Power Meter testing. OTDR test shall be delivered to the County in both raw trace format as well as .pdf copies. Power Meter test shall be documented and delivered on a Power meter test form.

All field splicing shall have a bi-directional dB loss no greater than -.20dB. All connectors shall have a dB loss no greater than -.50dB.

In the event any fiber splice or termination test with a dB loss higher than the maximum loss, fiber splices shall be broken and re-spliced until allowable dB loss can be achieved. In the event a fiber stand has been re-spliced three different times and cannot meet these standards, an exception document shall be provided identifying the fiber, splice locations, and documentation showing the three attempts of re-splicing.

UNDERGROUND CONSTRUCTION

(a) General Guidelines

Governing Florida Department of Transportation indexes and regulations will be used as well as all applicable codes in force.

No construction shall begin without authorization or permit from the authority having jurisdiction.

(b) Locates

Contractor shall follow all state laws pertaining to the Locates rules and regulations.

Contractor shall call 811 at least two business days and not more than 10 business days prior to excavations. Notification can be completed by utilizing one of the following methods:

1. Call 811
2. www.callbeforeyoudig.com

Contractor shall utilize sound judgement when completing underground utility excavations and installations. No guess work as to where existing utilities are located. All practical means necessary shall be utilized to locate existing utilities to include locates, soft digs and spot holes, and ground penetrating radar shall be considered to avoid conflicts. Contractor's pricing shall include these in their pricing as a cost of doing business.

(c) Special Considerations

All bore pits shall be compacted to 95% density in roadways, roadway shoulders, roadway prism and driveways and 85% density in unpaved areas.

The Contractor's trench safety system shall be a protective system designed and maintained by a competent person and shall meet accepted engineering requirements or practices. This trench safety system may require the use of a support system in locations not designated in the contract as requiring a support system.

(d) Conduit Placement

The standard quantity for the County's Backbone Network shall use existing conduits. The conduit shall be placed as shown on the construction documents. A new conduit shall be placed to feed some sites on County property. Existing conduit along the streets shall be used. All new and existing conduit is shown on plans.

Warning Tape shall be required for all buried cable installation process except when directional boring operation are used and shall be as follows:

1. Extra Stretch terra tape
2. Minimum of six inches (6") wide
3. Orange in color with black lettering which reads "Caution Buried Fiber Optic Cable Below"
4. Placed in the Trench a minimum of twelve inches (12") above all conduit/ fiber

(e) Depth of Placement

Unless otherwise specified by the Contractor's project engineer above the depth of buried cable or wire placed, measured from the top of the cable or wire to the surface of ground or rock must be as listed below:

1. Minimum depth in soil (Mainline) - 36 inch
2. Minimum depth at ditch crossings 36 inch
3. Minimum depth in rock 24-inch (152 mm) Rock to surface.

Note: FDOT or other authority having jurisdiction may require a deeper requirement for minimum depth. In the event of conflicting requirements, the more stringent depth requirement shall be used.

In the case of a layer of soil over rock, either the minimum depth in rock, measured to the surface of the rock, or the minimum depth in soil, measured to the surface of the soil, may be used at the Contractor's Project Engineer's option.

When rock excavating is required, width and depth requirements of the trench must be:

Trench Width	Trench Depth
10” (or greater)	24”

Either the minimum depth in rock must be achieved or some other method may be employed by the Contractor to provide adequate protection to the cable or wire as agreed to by the AHJ, e.g. concrete cap.

(f) Grade Away from Buildings/Structures

The conduit shall be placed in such a way to as to maintain a gradual grade down away from buildings and other major structures.

(g) Conduit Type

(i) Directional Boring/Plowing

Conduit for directional boring shall be HDPE with a minimum rating of SDR 11 type.

Trenching

Conduit type for open trench shall be PVC with a minimum rating of Schedule 40.

Innerduct

Inner duct, where required, shall be of the corrugated type and orange in color. Inner duct requirements (size and amount) will be determined by the Project Engineer.

(h) Conduit Turns and Transitions

All conduit turns shall be made with 45-degree bends or sweeps. At no time shall 90-degree bends be utilized in the outside plant arena, unless it is already existing conduit, and approved by the County.

(i) Conduit Proofing

All conduit installed shall be proofed utilizing a mandrel and shall include the installation of a continuous, jet-line pull-string. Duct proofing shall ensure new conduit is continuous, free from dirt and debris and conduit is in good usable

condition.

(j) Duct plugs

All conduit ends shall be properly sealed with mechanical duct plugs. Duct plugs shall be Jack-moon type or equal.

(k) Trace Wire

A #12 AWG insulated solid trace wire shall be placed along with all conduit put in place. This trace wire shall maintain continuity from end station to end station. It is acceptable to use vaults/hand holds for joining the trace wire, while keeping these joints visible and out of the way of the fiber cable.

(l) Marker Posts

Easily visible, marked, HDPE orange dome fiber-optic marker posts shall be placed above the conduit at all major transitions to said conduit (turns greater than 25 degrees, etc.). Fink plated marker posts are required where necessary. Marker posts will display the County of **Indian River** logo and will be marked "Underground Fiber Cable." Fink test locations shall be installed and properly grounded at every splice location.

(m) Conduit Entering Hand Holes/Man Holes

All conduits shall be stubbed up underneath the bottom of each manhole/hand hole leaving at least 8" but no more than 12" of visible conduit exposed. Conduit and inner ducts shall be capped until use. After use they shall be plugged appropriately to maintain the integrity of the conduit/inner duct from dirt and water.

(n) Locate Information

All splice points, vaults, hand hole/manhole, and conduit turns of 45-degrees or greater shall receive a GPS coordinate that is marked and labeled back onto the as-built drawings.

(o) Building Entrances

All building entrances should be checked and approved with The County of **Indian River** Project Engineer or liaison. Preference is given in the following order (but dictated by the facility itself): use of existing entrance conduit, core drilling and bringing conduit up the outside of a facility, attaching a pull-box to the exterior of said building and entering through the wall of the building.

(p) Box Sizing

All boxes utilized MUST meet the FDOT applicable indexes and be on the FDOT approved equipment list. Handholes shall be polymer composite Quazite brand or approved equal with a minimum tier 15, 20k load rating. The following sizes are to be used unless specifically called out for in the design:

- 17x30x24 (20K Load)
- 24x24x24 (20K Load)
- 24x36x24 (20K Load)
- 30x48x24 (20K Load)

(q) Box Spacing

Hand holes and vault spacing on backbone shall be installed as designed. If any adjustments in location of hand holes needs to be made, new location needs to be pre-approved by the County or County representative authorized to approve any adjustments.

As an overall guideline, hand hole spacing on the backbone shall be held to a maximum distance of 1,500’ between handholes to assist in pulling and access to the network. Any 90-degree turn, major intersection of place of future connectivity or splice locations will also require a hand hole or vault to be placed.

(r) Box Placement

All hand holes and vaults shall be installed flush with the existing grade unless otherwise specifically directed. Box installation shall include a 6” base or crushed stone or gravel for drainage purposes. Any earth disturbed in the immediate area

surrounding the box shall be compacted to avoid any future wash outs. All box, hand holes, vault installations shall include all restoration. Box pricing shall also include placement of all bolts to secure lid.

Have all boxes approved prior to purchasing/installation of said boxes per the material submittal requirements.

Appendix B: Option 2 – Gifford Wireless Broadband Network

A CBRS wireless broadband network study has been prepared for the Gifford area. The network is designed as a fixed network meaning the receiving locations are buildings, public places or residences that are not in motion. City assets (water tower and EOC tower) are proposed as base station sites. Both are on the conceptual fiber connection plan that Magellan prepared for Indian River and as outlined in this report.

Each location will have a 4-sector base station located on the tower. This will provide good coverage and capacity for the area. Below is the estimated coverage obtained by using these sites.

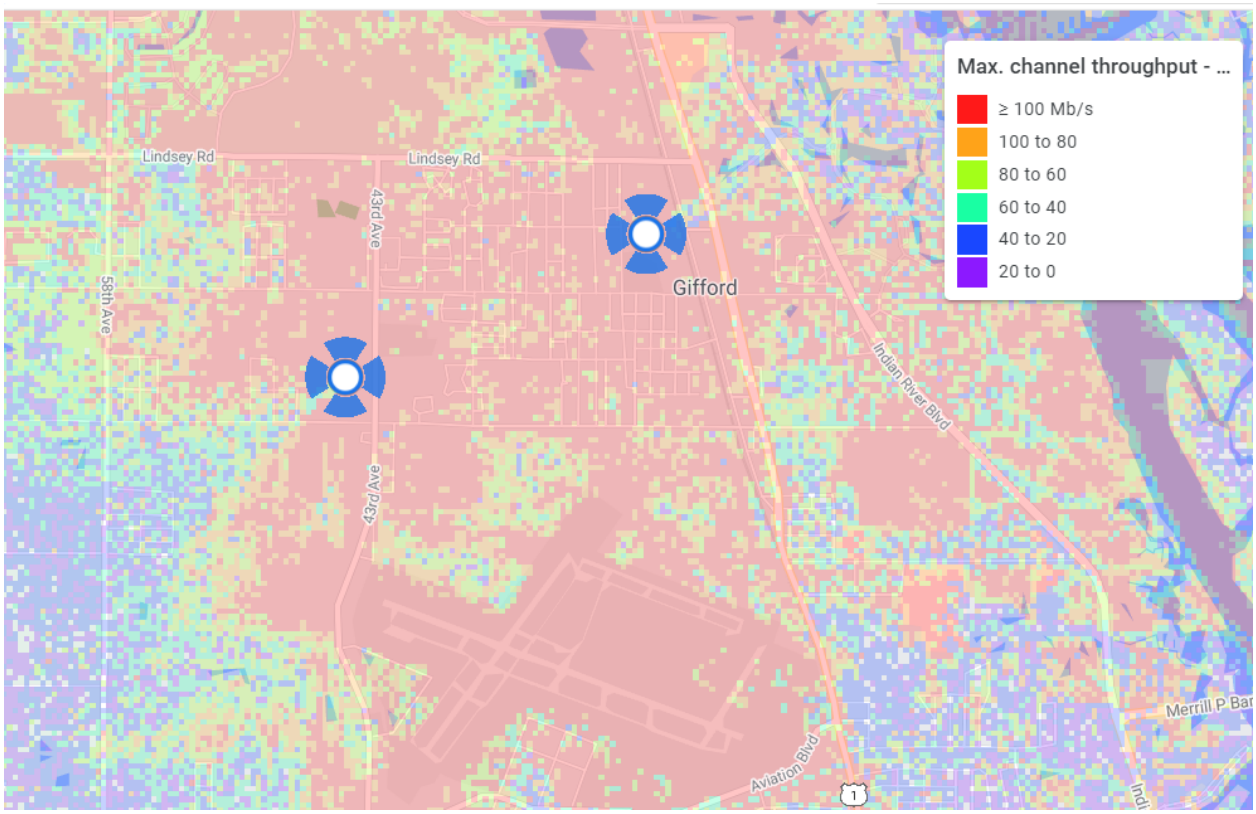


Figure 13: CBRS Propagation Estimate

AIRPORT PROXIMITY ISSUES

Towers close to airports have height restrictions and must be lighted. The tower assets used for this design are existing structures. The height is not raised by the addition of the CBRS equipment. The existing registration with FAA will not be changed by this installation.

Much has been made in the news about 5G interfering with Aircraft Altimeter Instruments. These instruments operate in the 4 GHz band. The issue is question is interference by the new C band that was recently auctioned by the FCC. The C band operates in the 3.7 to 4.2GHz Band. The airline officials complained that this was too close to the Altimeter band of 4.2-4.4 GHz. The CBRS band, proposed for the Gifford system, is 3.55-3.7 GHz so is well below the band that could interfere with Aircraft altimeters.

COST ESTIMATE FOR CBRS

Public assets are proposed for CBRS installation, therefore no commercial tower rental will be incurred. Each location will require 4 sector devices and a ruggedized switch to connect them to the fiber at the locations. Below is a cost estimate for the base station CAPEX for equipment and installation.

Table 16: Gifford Estimated CBRS Wireless Overlay Cost-CAPEX

Gifford Estimated CBRS Wireless Overlay Cost-CAPEX			
Item	Cost	Units	Total Cost
County Owned Towers/Water Tanks	$ -	2	$ -
Base Station Cost	$ 15,000	8	$ 120,000
Base Station Installation 2 Sites	$ 2,000	2	$ 4,000
Outdoor Router	$ 1,000	2	$ 2,000
CPE cost ($356 equipment, $350 labor)	$ 706	-	$ -
EPC Access Fee Per CPE	$ 35	-	$ -
Subtotal			$ 126,000
Engineering, Project & Construction Mgmt	15%		$ 18,900
Total Estimated Capex Cost			**$ 144,900**

This estimate is based on Telrad CBRS equipment. Price may vary for different manufacturers of equipment. This is a “middle of the road” type estimate of functional equipment. The number of CPE required is not known at this time. The CPE can be either a Mi-FI type device that would require no installation, or a CPE mounted outside the business or residence and a cable run inside to a switch or WiFi access point. Approximately $700-$900 should be budgeted for each CPE

device the CPE cost would be the responsibility of the WISP partner who would provide all retail services and O&M services. The EPC access fee per each CPE is a one-time charge and would also be the responsibility of the WISP partner.

The Opex cost for this network would be very low. The towers are city assets and have fiber connections, so tower rent or backhaul costs are not needed. Power consumption for the base stations is low and will not adversely affect the EOC or Water tower.

Appendix C: Fellsmere Plan

THE FELLSMERE FIBER-OPTIC NETWORK

The City's detailed design provides precise routing of fiber cables across the service area. Moreover, the design provides an accurate estimate of the costs of components that, in aggregate, constitute a significant amount of capital investment in the project.

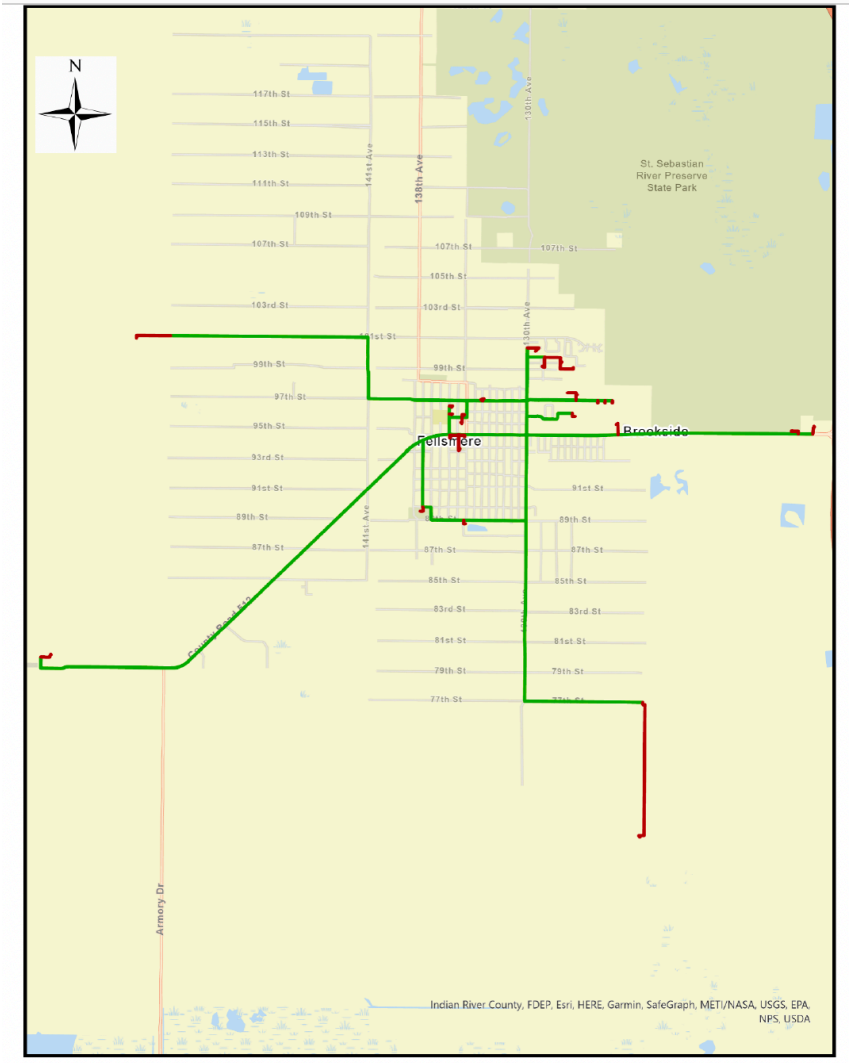
Components of the outside plant design include:

- Aerial and underground placement requirements
- Fiber-optic routes in established ROW and easement with distance and slack
- Location of vaults, hand-holes and pedestals, along with their sizes and quantities
- Placement of fiber distribution hubs, sizes and quantities
- Splitter configuration and density within fiber distribution hubs
- Fiber-optic splice points and splice cases
- Fiber-optic termination locations, sizes and quantities
- Equipment locations and requirements

BACKBONE ROUTES

The fiber backbone will serve several important purposes in the operations of the overall City fiber-optic network. For one, the backbone routes are the most direct network routes into and out of the City fiber network. These are critical paths for internet connectivity, and these backbone routes will have redundant paths to and from the City from multiple internet "backhaul" service providers. The City will have an active backbone layer to connect each Central Office. These Central Office locations connect the fiber-optic feeder and distribution network between the substations and the City households and businesses via ISPs. The backbone routes also serve as the critical connections between the City offices to enable smart community benefits. The image in Figure 1 below details the City of Fellsmere's backbone network.

Figure 14: Fiber backbone routes



The City network is connected to the internet backbone at Central Offices across the service area, depending on the geographic route of the specific backhaul provider. The connection points serve as network nodes, with networking equipment securely housed in a field cabinet or hut inside the City. Depending on complexity of each Central Office, it can simply be a fiber connection point, or it can function as a data center through an assortment of devices to relay data between the internet and customers on the network.

FEEDER AND DISTRIBUTION ROUTES

Fellsmere's feeder and distribution network, as the name suggests, feeds the fiber from the backbone throughout the service area to wireless towers. The wireless towers will be utilized to reach customers in rural Fellsmere with a high-speed network supporting small to medium businesses and residents.

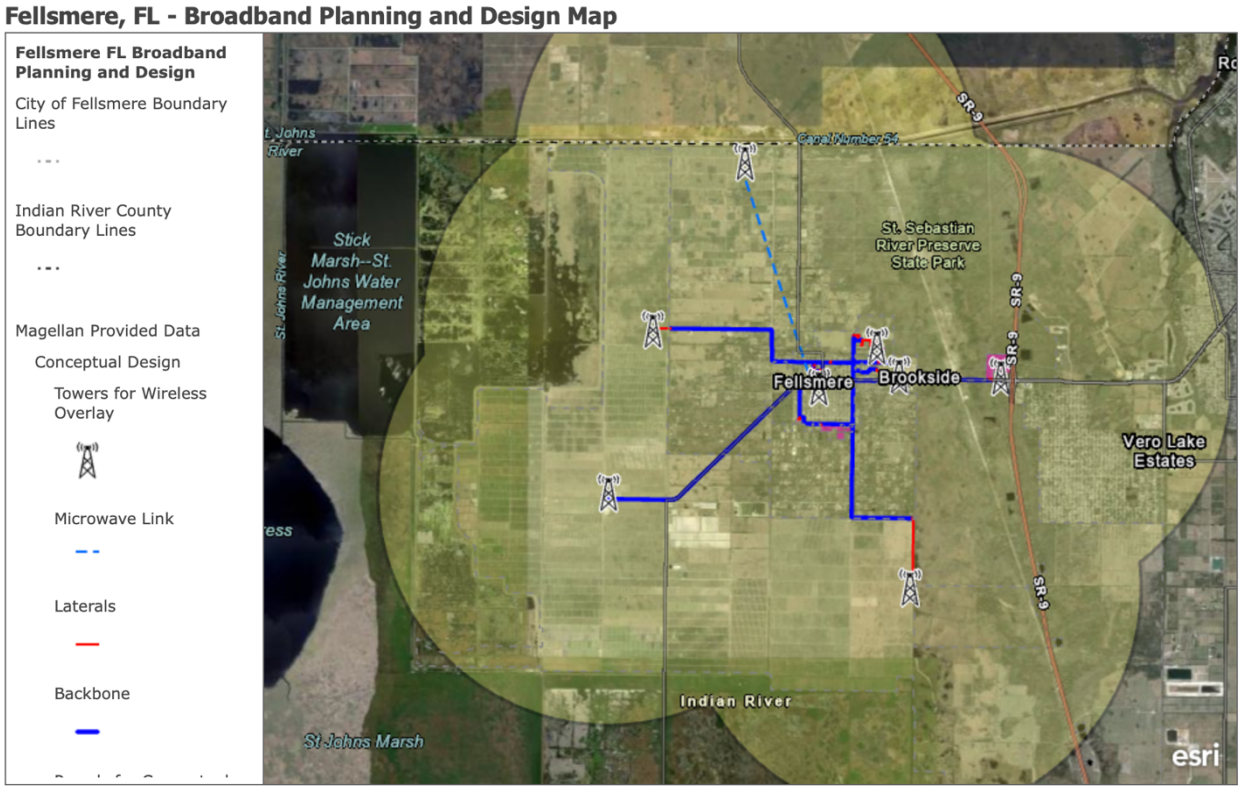


Figure 15: Fellsmere Design and Towers for Wireless Network

Financial Plan

The Fellsmere network is an opportunity to increase broadband availability, bridge the digital divide and lower costs for consumers. Potential grant funding may enable Fellsmere to provide facilities that will spur competition by lowering the cost of entry into the market for ISPs wishing to serve the Fellsmere market. The network is a hybrid fiber/wireless network providing high capacity 288 count dark fiber, all underground and spanning 23.2 miles. The backbone fiber is capable of 1 gigabit to 40 gigabit and beyond depending on the electronics deployed on the network. The wireless network is deployed over the majority of the Fellsmere market and can deliver 150Mbps to up to 3,000 endpoints depending on electronics deployed. The wireless elements use CBRS unlicensed spectrum generated from 8 towers. The fiber network is designed to connect all city facilities, is a foundation for expanding broadband services and provides backhaul for the wireless towers.

Fellsmere has no interest in operating an ISP nor operating nor maintaining the network. In this regard an RFP will be issued for an ISP partner that will provide the needed electronics for the fiber network and lease the dark network from Fellsmere and will operate and maintain the network assets. The RFP could also include the requirement to provide all city facilities broadband connectivity as part of the overall agreement.

CAPITAL COSTS

Table 17 below illustrates estimates capital expenditures for the fiber and wireless network.

Table 17: Fellsmere Capital Costs

Cost Category	Cost
City Fiber Network – Conduit Only	$2,300,000
City Fiber Network – 288 Count Dark Fiber	$2,700,000

Cost Category	Cost
	$380,000
Total Capital Costs – Conduit Only	**$ 2,680,000**
Total Capital Costs – Conduit & Fiber	**$3,080,000**

ESTIMATED ANNUAL NETWORK OPERATIONS COSTS

Expected annual operating costs are shown below. Costs have an annual adjustment ranging from 2%-4% for staffing and sales to 1%-2% for other items.

Table 18: Operating Expenses

Cost of Services	Base Cost	Annual Increase
Fiber Network	$24,000	2%
Conduit Only Maintenance	$10,000	2%
Wireless Network	$80,000	2%
Network IP Transport	$9,000	2%
Total Estimated Annual Network Operations Costs	**$113,000**	

ESTIMATED ANNUAL REVENUE FROM ISP PARTNERS

The below tables show how much annual revenue the City can expect from leasing its network to ISP partners. Expected annual operating costs are shown below. Costs have an annual adjustment ranging from 2%-4% for staffing and sales to 1%-2% for other items.

Table 19: Operating Expenses

Revenue Opportunities	Annual Revenue
Conduit Only Lease (23.2 Miles)	$55,200
Conduit and Dark Fiber Per Strand Mile (23.2 Miles)*	$83,500

* ISP will have to lease 2 strands.

Appendix D: Glossary of Terms

3G – Third Generation	The third generation of mobile broadband technology, used by smart phones, tablets, and other mobile devices to access the web.
4G – Fourth Generation	The fourth generation of mobile broadband technology, used by smart phones, tablets, and other mobile devices to access the web.
5G – Fifth Generation	The fifth generation of mobile broadband technology, used by smart phones, tablets, and other mobile devices to access the web. It is believed that this technology will significantly increase bandwidth to users, up to 1 Gig.
ADSL – Asymmetric Digital Subscriber Line	DSL service with a larger portion of the capacity devoted to downstream communications, less to upstream. Typically thought of as a residential service.
ADSS – All-Dieletric Self-Supporting	A type of optical fiber cable that contains no conductive metal elements.
AMR/AMI – Automatic Meter Reading/Advanced Metering Infrastructure	Electrical meters that measure more than simple consumption and an associated communication network to report the measurements.
ATM – Asynchronous Transfer Mode	A data service offering that can be used for interconnection of customer's LAN. ATM provides service from 1 Mbps to 145 Mbps utilizing Cell Relay Packets.
Bandwidth	The amount of data transmitted in a given amount of time; usually measured in bits per second, kilobits per second (kbps), and Megabits per second (Mbps).

Bit	A single unit of data, either a one or a zero. In the world of broadband, bits are used to refer to the amount of transmitted data. A kilobit (Kb) is approximately 1,000 bits. A Megabit (Mb) is approximately 1,000,000 bits. There are 8 bits in a byte (which is the unit used to measure storage space), therefore a 1 Mbps connection takes about 8 seconds to transfer 1 megabyte of data (about the size of a typical digital camera photo).
BPL – Broadband over Powerline	A technology that provides broadband service over existing electrical power lines.
BPON – Broadband Passive Optical Network	BPON is a point-to-multipoint fiber-lean architecture network system which uses passive splitters to deliver signals to multiple users. Instead of running a separate strand of fiber from the CO to every customer, BPON uses a single strand of fiber to serve up to 32 subscribers.
Broadband	A descriptive term for evolving digital technologies that provide consumers with integrated access to voice, high-speed data service, video-demand services, and interactive delivery services (e.g. DSL, Cable Internet).
CAD – Computer Aided Design	The use of computer systems to assist in the creation, modification, analysis, or optimization of a design.

CAI – Community Anchor Institutions	The National Telecommunications and Information Administration defined CAIs in its SBDD program as "Schools, libraries, medical and healthcare providers, public safety entities, community colleges and other institutions of higher education, and other community support organizations and entities." Universities, colleges, community colleges, K-12 schools, libraries, health care facilities, social service providers, public safety entities, government and municipal offices are all community anchor institutions.
CAP – Competitive Access Provider	(or "Bypass Carrier") A Company that provides network links between the customer and the Inter-Exchange Carrier or even directly to the Internet Service Provider. CAPs operate private networks independent of Local Exchange Carriers.
Cellular	A mobile communications system that uses a combination of radio transmission and conventional telephone switching to permit telephone communications to and from mobile users within a specified area.
CLEC – Competitive Local Exchange Carrier	Wireline service provider that is authorized under state and Federal rules to compete with ILECs to provide local telephone service. CLECs provide telephone services in one of three ways or a combination thereof: 1) by building or rebuilding telecommunications facilities of their own, 2) by leasing capacity from another local telephone company (typically an ILEC) and reselling it, and 3) by leasing discrete parts of the ILEC network referred to as UNEs.
CO – Central Office	A circuit switch where the phone lines in a geographical area come together, usually housed in a small building.

Coaxial Cable	A type of cable that can carry large amounts of bandwidth over long distances. Cable TV and cable modem service both utilize this technology.
CPE – Customer Premise Equipment	Any terminal and associated equipment located at a subscriber's premises and connected with a carrier's telecommunication channel at the demarcation point ("demarc").
CWDM – Coarse Wavelength Division Multiplexing	A technology similar to DWDM only utilizing less wavelengths in a more customer-facing application whereby less bandwidth is required per fiber.
Demarcation Point (“demarc”)	The point at which the public switched telephone network ends and connects with the customer's on-premises wiring.
Dial-Up	A technology that provides customers with access to the Internet over an existing telephone line.
DLEC – Data Local Exchange Carrier	DLECs deliver high-speed access to the Internet, not voice. Examples of DLECs include Covad, Northpoint and Rhythms.
Downstream	Data flowing from the Internet to a computer (Surfing the net, getting E-mail, downloading a file).
DSL – Digital Subscriber Line	The use of a copper telephone line to deliver “always on” broadband Internet service.
DSLAM – Digital Subscriber Line Access Multiplier	A piece of technology installed at a telephone company’s Central Office (CO) and connects the carrier to the subscriber loop (and ultimately the customer’s PC).

DWDM – Dense Wavelength Division Multiplexing	An optical technology used to increase bandwidth over existing fiber-optic networks. DWDM works by combining and transmitting multiple signals simultaneously at different wavelengths on the same fiber. In effect, one fiber is transformed into multiple virtual fibers.
E-Rate	A Federal program that provides subsidy for voice and data circuits as well as internal network connections to qualified schools and libraries. The subsidy is based on a percentage designated by the FCC.
EON – Ethernet Optical Network	The use of Ethernet LAN packets running over a fiber network.
EvDO – Evolution Data Only	EvDO is a wireless technology that provides data connections that are 10 times as fast as a traditional modem. This has been overtaken by 4G LTE.
FCC – Federal Communications Commission	A Federal regulatory agency that is responsible for regulating interstate and international communications by radio, television, wire, satellite and cable in all 50 states, the District of Rock Falls, and U.S. territories.
FDH – Fiber Distribution Hub	A connection and distribution point for optical fiber cables.
FTTN – Fiber to the Neighborhood	A hybrid network architecture involving optical fiber from the carrier network, terminating in a neighborhood cabinet which converts the signal from optical to electrical.
FTTP – Fiber to the premise (or FTTB – Fiber to the building)	A fiber-optic system that connects directly from the carrier network to the user premises.

FTTx – Fiber to the X	All fiber optic topologies from a provider to its customers, based on the location of the fiber's termination point
GIS – Geographic Information Systems	A system designed to capture, store, manipulate, analyze, manage, and present all types of geographical data.
GPON- Gigabit-Capable Passive Optical Network	Similar to BPON, GPON allows for greater bandwidth through the use of a faster approach (up to 2.5 Gbps in current products) than BPON.
GPS – Global Positioning System	a space-based satellite navigation system that provides location and time information in all weather conditions, anywhere on or near the Earth where there is an unobstructed line of sight to four or more GPS satellites.
GSM – Global System for Mobile Communications	This is the current radio/telephone standard developed in Europe and implemented globally except in Japan and South Korea.
HD – High Definition (Video)	Video of substantially higher resolution than standard definition.
HFC – Hybrid Fiber Coaxial	An outside plant distribution cabling concept employing both fiber-optic and coaxial cable.
ICT – Information and Communications Technology	Often used as an extended synonym for information technology (IT), but it is more specific term that stresses the role of unified communications and the integration of telecommunications, computers as well as necessary enterprise software, middleware, storage, and audio-visual systems, which enable users to access, store, transmit, and manipulate information.
IEEE – Institute of Electrical Engineers	A professional association headquartered in New York City that is dedicated to advancing technological innovation and excellence.

ILEC – Incumbent Local Exchange Carrier	The traditional wireline telephone service providers within defined geographic areas. Prior to 1996, ILECs operated as monopolies having exclusive right and responsibility for providing local and local toll telephone service within LATAs.
IP-VPN – Internet Protocol-Virtual Private Network	A software-defined network offering the appearance, functionality, and usefulness of a dedicated private network.
ISDN – Integrated Services Digital Network	An alternative method to simultaneously carry voice, data, and other traffic, using the switched telephone network.
ISP – Internet Service Provider	A company providing Internet access to consumers and businesses, acting as a bridge between customer (end-user) and infrastructure owners for dial-up, cable modem and DSL services.
ITS – Intelligent Traffic System	Advanced applications which, without embodying intelligence as such, aim to provide innovative services relating to different modes of transport and traffic management and enable various users to be better informed and make safer, more coordinated, and 'smarter' use of transport networks.
Kbps – Kilobits per second	1,000 bits per second. A measure of how fast data can be transmitted.
LAN – Local Area Network	A geographically localized network consisting of both hardware and software. The network can link workstations within a building or multiple computers with a single wireless Internet connection.

LATA – Local Access and Transport Areas	A geographic area within a divested Regional Bell Operating Company is permitted to offer exchange telecommunications and exchange access service. Calls between LATAs are often thought of as long distance service. Calls within a LATA (IntraLATA) typically include local and local toll services.
Local Loop	A generic term for the connection between the customer's premises (home, office, etc.) and the provider's serving central office. Historically, this has been a copper wire connection; but in many areas it has transitioned to fiber optic. Also, wireless options are increasingly available for local loop capacity.
MAN – Metropolitan Area Network	A high-speed intra-city network that links multiple locations with a campus, city or LATA. A MAN typically extends as far as 30 miles.
Mbps – Megabits per second	1,000,000 bits per second. A measure of how fast data can be transmitted.
Middle Mile Network	Middle mile is a term most often referring to the network connection between the last mile and greater Internet. For instance, in a rural area, the middle mile would likely connect the town's network to a larger metropolitan area where it interconnects with major carriers.
MPLS – Multiprotocol Label Switching	A mechanism in high-performance telecommunications networks that directs data from one network node to the next based on short path labels rather than long network addresses, avoiding complex lookups in a routing table.

ONT – Optical Network Terminal	Used to terminate the fiber-optic line, demultiplex the signal into its component parts (voice telephone, television, and Internet), and provide power to customer telephones.
Overbuilding	The practice of building excess capacity. In this context, it involves investment in additional infrastructure projects to provide competition.
OVS – Open Video Systems	OVS is a new option for those looking to offer cable television service outside the current framework of traditional regulation. It would allow more flexibility in providing service by reducing the build out requirements of new carriers.
PON – Passive Optical Network	A Passive Optical Network consists of an optical line terminator located at the Central Office and a set of associated optical network terminals located at the customer's premise. Between them lies the optical distribution network comprised of fibers and passive splitters or couplers. In a PON network, a single piece of fiber can be run from the serving exchange out to a subdivision or office park, and then individual fiber strands to each building or serving equipment can be split from the main fiber using passive splitters / couplers. This allows for an expensive piece of fiber cable from the exchange to the customer to be shared among many customers, thereby dramatically lowering the overall costs of deployment for fiber to the business (FTTB) or fiber to the home (FTTH) applications.
PPP – Public-Private Partnership	A Public–Private Partnership (PPP) is a government service or private business venture that is funded and operated through a collaborative partnership between a government and one or more private sector organizations. In addition to being referred to as a PPP, they are sometimes called a P3, or P^3.

QOS – Quality of Service	QoS (Quality of Service) refers to a broad collection of networking technologies and techniques. The goal of QoS is to provide guarantees on the ability of a network to deliver predictable results, which are reflected in Service Level Agreements or SLAs. Elements of network performance within the scope of QoS often include availability (uptime), bandwidth (throughput), latency (delay), and error rate. QoS involves prioritization of network traffic.
RF – Radio Frequency	a rate of oscillation in the range of about 3 kHz to 300 GHz, which corresponds to the frequency of radio waves, and the alternating currents which carry radio signals.
Right-of-Way	A legal right of passage over land owned by another. Carriers and service providers must obtain right-of-way to dig trenches or plant poles for cable systems, and to place wireless antennas.
RMS – Resource Management System	A system used to track telecommunications assets.
RPR – Resilient Packet Ring	Also known as IEEE 802.17, is a protocol standard designed for the optimized transport of data traffic over optical fiber ring networks.
RUS – Rural Utility Service	A division of the United States Department of Agriculture, it promotes universal service in unserved and underserved areas of the country with grants, loans, and financing. Formerly known as “REA” or the Rural Electrification Administration.
SCADA – Supervisory Control and Data Acquisition	A type of industrial control system (ICS). Industrial control systems are computer controlled systems that monitor and control industrial processes that exist in the physical world.

SNMP – Simple Network Management Protocol	An Internet-standard protocol for managing devices on IP networks.
SONET – Synchronous Optical Network	A family of fiber-optic transmission rates.
Streaming	Streamed data is any information/data delivered from a server to a host where the data represents information that must be delivered in real time. This could be video, audio, graphics, slide shows, web tours, combinations of these, or any other real time application.
Subscribership	Subscribership is how many customers have subscribed for a particular telecommunications service.
Submarine Network	Submarine networking is the process by which data is carried on subsea cables to connect continents. Submarine networks carry 95 percent of the world's intercontinental electronic communications traffic.
Switched Network	A domestic telecommunications network usually accessed by telephone, key telephone systems, private branch exchange trunks, and data arrangements.
T-1 – Trunk Level 1	A digital transmission link with a total signaling speed of 1.544 Mbps. It is a standard for digital transmission in North America.
T-3 – Trunk Level 3	28 T1 lines or 44.736 Mbps.
UNE – Unbundled Network Element	Leased portions of a carrier's (typically an ILEC's) network used by another carrier to provide service to customers. Over time, the obligation to provide UNEs has been greatly narrowed, such that the most common UNE now is the UNE-Loop.

Universal Service	The idea of providing every home in the United States with basic telephone service.
Upstream	Data flowing from your computer to the Internet (sending E-mail, uploading a file).
UPS – Uninterruptable Power Supply	An electrical apparatus that provides emergency power to a load when the input power source, typically main power, fails.
USAC – Universal Service Administrative Company	An independent American nonprofit corporation designated as the administrator of the Federal Universal Service Fund (USF) by the Federal Communications Commission.
VDSL – Very High Data Rate Digital Subscriber Line	A developing digital subscriber line (DSL) technology providing data transmission faster than ADSL over a single flat untwisted or twisted pair of copper wires (up to 52 Mbit/s downstream and 16 Mbit/s upstream), and on coaxial cable (up to 85 Mbit/s down and upstream); using the frequency band from 25 kHz to 12 MHz.
Video on Demand	A service that allows users to remotely choose a movie from a digital library whenever they like and be able to pause, fast-forward, and rewind their selection.
VLAN – Virtual Local Area Network	In computer networking, a single layer-2 network may be partitioned to create multiple distinct broadcast domains, which are mutually isolated so that packets can only pass between them via one or more routers; such a domain is referred to as a Virtual Local Area Network, Virtual LAN or VLAN.
VoIP – Voice over Internet Protocol	An application that employs a data network (using a broadband connection) to transmit voice conversations using Internet Protocol.

VPN – Virtual Private Network	A virtual private network (VPN) extends a private network across a public network, such as the Internet. It enables a computer to send and receive data across shared or public networks as if it were directly connected to the private network, while benefitting from the functionality, security and management policies of the private network. This is done by establishing a virtual point-to-point connection through the use of dedicated connections, encryption, or a combination of the two.
WAN – Wide Area Network	A network that covers a broad area (i.e., any telecommunications network that links across metropolitan, regional, or national boundaries) using private or public network transports.
WiFi	WiFi is a popular technology that allows an electronic device to exchange data or connect to the Internet wirelessly using radio waves. The WiFi Alliance defines WiFi as any "wireless local area network (WLAN) products that are based on the Institute of Electrical and Electronics Engineers' (IEEE) 802.11 standards".
WiMAX	WiMAX is a wireless technology that provides high-throughput broadband connections over long distances. WiMAX can be used for a number of applications, including “last mile” broadband connections, hotspot and cellular backhaul, and high speed enterprise connectivity for businesses.
Wireless	Telephone service transmitted via cellular, PCS, satellite, or other technologies that do not require the telephone to be connected to a land-based line.
Wireless Internet	1) Internet applications and access using mobile devices such as cell phones and palm devices. 2) Broadband Internet service provided via wireless connection, such as satellite or tower transmitters.

Wireline	Service based on infrastructure on or near the ground, such as copper telephone wires or coaxial cable underground or on telephone poles.