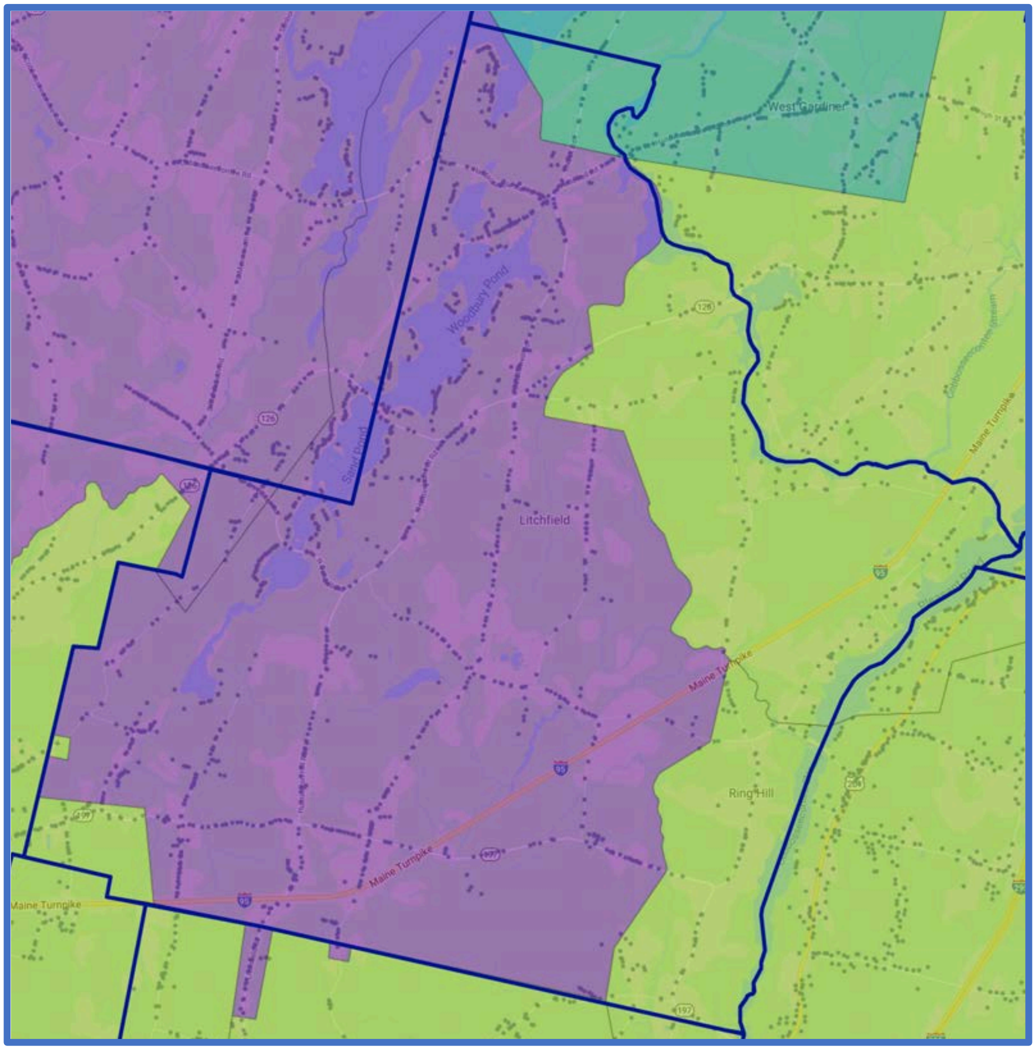
Casco Bay Advisors, LLC
Broadband/Telecom Consulting

Town of Litchfield

Broadband Planning Report



Casco Bay Advisors, LLC

November 2020

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Cover Image

The Town of Litchfield was originally served in part by three (3) different local telephone companies. The following color key identifies the geography of each.

Purple *= Community Service Telephone Co. d/b/a Consolidated Communications* ***Light Green*** *= FairPoint Communications f/n/a Verizon d/b/a/ Consolidated Communications* ***Dark Green*** *= Cobbosseecontee Tel. & Tel. Co d/b/a TDS of Maine*

Disclaimer

It is important to understand this report contains high level costs and projections based on the information readily available and should not be interpreted as providing the level of detail required for investing purposes.

All costs contained in the report are estimates based upon high-level desk-top engineering designs, our estimates of construction costs for various providers, and our knowledge of costs for similar types of projects. In order to develop precise costs, a detailed engineering analysis will need to be performed and actual construction costs determined.

All service providers declined to provide mapping or data to illustrate the location of their assets. In the absence of service provider data, we performed a detailed field audit the week of August 17, 2020 to visually capture and note the location of existing phone company fiber optic cables, remote terminals and central offices. At the same time, we visually captured and noted the location of the hybrid fiber/coax infrastructure of the cable TV company. We believe the process used to visually capture the presence of infrastructure is 98% accurate.

Finally, we utilized 911 location data and parcel boundary data filed with the State of Maine by the Town of Litchfield. Not every potential subscriber location has been uploaded into the State of Maine 911 systems and the majority of those that have been uploaded are not spatially accurate. As such, we examined Google Earth imagery to discover potential subscriber locations present at the time the aerial imagery was captured on May 4, 2018. New construction since that date is not necessarily included in this analysis.

1 Executive Summary

Casco Bay Advisors, LLC (Casco Bay) is pleased to present this Broadband Planning Report (Report) to the Town of Litchfield (Town), examining existing high-speed broadband assets within the Town limits, where gaps in coverage may exist, potential solutions and costs to fill those gaps and recommendations for next steps.

This Report begins with an overview of the various technologies capable of providing Internet access and the differences in the capability of each. We recommend reviewing this section first in order to easily interpret and digest the remainder of the Report.

The foundation of our research efforts included contacts with each of the land-line based service providers currently serving the Town and reviewing and incorporating any mapping data provided by the service providers. We then conducted a field audit of every public and private roadway, including long driveways to verify the accuracy of the data provided and to acquire data where sufficiently detailed mapping was not provided. This information was then incorporated into a Geospatial Information System (GIS), along with 911 addressing data, parcel data and aerial imagery, to facilitate analysis and presentation of the data collected.

Our research has determined that 88% of potential subscribers across the study area have access to cable modem service provided by Charter (Spectrum) with minimum advertised download speeds of 100Mbps and minimum advertised upload speeds of 10Mbps.

The Town is widely served by lower speed DSL Internet from Consolidated Communications. Overall, there is no DSL service available to 7% of the study area and 78% of potential DSL subscribers cannot be served by a minimum 25Mbps/3Mbps DSL service.

The Report includes an estimation of the overall cost to extend the Charter (Spectrum) cable modem service to the remaining areas of the Town not currently served. The cost to extend cable system coverage is estimated to be $795,147, although we anticipate the final costs will be lower by negotiation of a cost sharing arrangement with Charter (Spectrum). These figures do not include the cost of extending service from the street to subscribers at the end of driveways longer than approximately 250 feet from the roadway, which is typically borne by the subscriber.

As an alternative to the existing providers, we have estimated a cost of $5,618,505 to overbuild the Town with a new Fiber-to-the-Home (FTTH) network under municipal ownership or in partnership with a service provider. We believe this cost could be reduced by up to 50% in a partnership arrangement with a willing service provider.

Consolidated Communications is another alternative who would have a lower cost to deploy a FTTH network by virtue of the fact they are already attached to the utility poles with their twisted-pair copper network and they have existing central offices. Fiber could be over-lashed to this existing infrastructure, eliminating the utility pole make-ready process and cost, reducing the cost to approximately $4,112,032.

With this Report in hand and the data now transparently available, we recommend the Town develop a vision and set of goals to guide its efforts going forward and to engage both the incumbent service providers and other potential alternative service providers to expand the availability, capacity and competitive options for the provision of affordable, reliable high-speed Internet.

As has been demonstrated this year of 2020, unrestricted access to robust, universally available, affordable and reliable Internet is a critical infrastructure required to participate in the increasingly global economy, especially in the areas of healthcare, education, entertainment, financial services, consumer goods and services, and global commerce.

We applaud the Town for taking this initiative to better understand its current resources and to set the stage for ensuring all of your citizens are well positioned to take advantage of the introduction of new Internet enabled services.

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2 Internet Access and Broadband Definition

The terms "Internet access" and "broadband" are often used interchangeably. There is frequently confusion between the two, especially as the definitions evolve with technology changes.

Internet access connects individual computer terminals, computers, mobile devices, and computer networks to the Internet, enabling users to access Internet services such as email, applications and information delivered via the World Wide Web. Internet service providers (ISPs) offer Internet access through various technologies that offer a wide range of data signaling rates (speeds).

Consumer use of the Internet first became popular through dial-up Internet access in the 1990s. By the first decade of the 21st century, many consumers in developed nations used faster, broadband Internet access technologies.

Broadband is a generic term representing any wide-bandwidth data transmission method with the ability to transport multiple signals and traffic types simultaneously. This data can be transmitted using coaxial cable, optical fiber, radio or twisted pair copper. In the context of Internet access, broadband is used much more loosely to mean any high-speed Internet access that is always on and faster than traditional dial-up access. Different governing authorities have developed inconsistent definitions of what constitutes broadband service based on access speed.

In January 2015, the Federal Communications Commission (FCC) voted to define broadband as Internet service with at least 25 Mbps (megabits per second) download and 3 Mbps upload. Their definition affects policy decisions and the FCC's annual assessment of whether broadband is being deployed to all Americans quickly enough. In Maine, the ConnectMaine Authority Board[1] currently defines effective broadband network capacity as speeds equal to or greater than 25Mbps/3Mbps, and anything less as "unserved."

For those rural and high-cost areas served by Consolidated Communications, Inc. (CCI) where CCI has accepted subsidies through the Connect America Fund – Phase II (CAF-II), the FCC has adopted a minimum speed standard of 10Mbps/1Mbps.

[1] In recognition of the critical importance of modern technology for education, health care, and business success in Maine, the Legislature created the ConnectME Authority (Authority) in 2006 as an independent state agency to develop and implement broadband strategy for Maine. The Authority is governed by a board which is comprised of members appointed by the Governor or specifically identified and designated by statute.

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3 Internet Access Technology Overview

In this section, we present an overview of different Internet access technology, including digital subscriber line, cable modem, fixed wireless, 4G/LTE Advanced, 5G, satellite, and Fiber-to-the-Premise.

3.1 DSL

Digital subscriber line (DSL) is a technology most frequently used by traditional telephone system operators such as Consolidated Communications, Inc. (CCI) and TDS to deliver advanced services *(high-speed data and potentially video)* over twisted pair copper telephone wires. This technology has lower data carrying capacity than the hybrid fiber coaxial network deployed by cable system operators like Charter Communications (Spectrum). Data speeds are range-limited by the length of the copper cable serving the premise, the wire gauge of the copper conductors and the condition of the copper.

DSL service can be delivered simultaneously with wired telephone service on the same telephone line. This is possible because DSL uses higher frequency bands for data transmission than are required for the voice service transmission. On the customer premises, a DSL filter on each non-DSL outlet blocks any high-frequency interference to enable simultaneous use of the voice and DSL services.

The bit rate of consumer DSL services can range from 256 Kbps *(kilobits per second)* to over 100 Mbps in the direction of the service provider to the customer (downstream), depending on the DSL technology, line conditions, and the length of the copper loop. Until recently, the most commonly installed DSL technology for Internet access has been asymmetric digital subscriber line (ADSL). With ADSL, the data throughput in the upstream direction *(the direction from the consumer to the service provider)* is lower, hence the designation of asymmetric service.

At the central office, a digital subscriber line access multiplexer (DSLAM) terminates the DSL circuits and aggregates them, where they are handed off to other networking transport equipment. The DSLAM terminates all connections and recovers the original digital information. For locations beyond the maximum distance from the central office for the particular type of DSL technology deployed (7,000 – 12,000 feet), DSLAMs can be deployed in the field in outside plant cabinets *(remote terminals)* and connected to the central office by fiber optic cables. A shorter distance from the subscriber premise to the DSLAM results in greater bandwidth *(speed and/or capacity)* for the connected users.

The customer end of the connection consists of a terminal adaptor or "DSL modem." This converts data between the digital signals used by computers and the voltage signal of a suitable frequency range which is then applied to the phone line.

There are additional formats of DSL technologies that can enhance the capacity of the network. ADSL2+ extends the capability of basic ADSL by doubling the number of downstream channels,

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increasing the frequency from 1.1 Mhz to 2.2 Mhz. The data rates can be as high as 24 Mbps downstream and up to 1.4 Mbps upstream, depending on the distance from the DSLAM to the subscriber's premises. Like the previous standards, ADSL2+ will degrade from its peak bit rate after a certain distance.

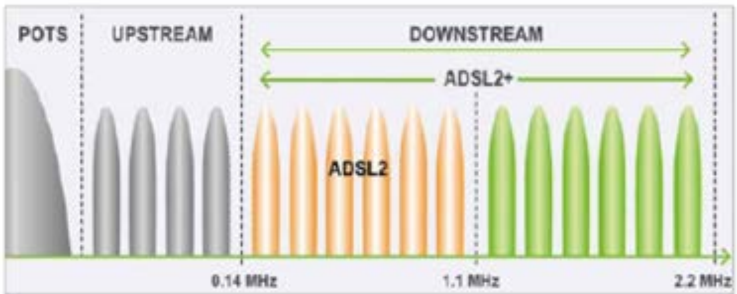

Figure 1: ADSL2+ Frequency Utilization

ADSL2+ allows port bonding, where multiple ports are physically provisioned to the end user and the total bandwidth is equal to the sum of all provisioned ports. When two lines capable of 24 Mbps are bonded, the end result is a connection capable of 48 Mbps download and twice the original upload speed.

Very-high-bit-rate digital subscriber line 2 (VDSL2+) permits the transmission of asymmetric and symmetric aggregate data rates up to 200 Mbps downstream and upstream on twisted pairs using a bandwidth up to 30 Mhz. It deteriorates quickly from a theoretical maximum of 250 Mbps at the source to 100 Mbps at 1,600 feet and 50 Mbps at 3,300 feet but degrades at a much slower rate from there. Starting from one mile, its performance is similar to ADSL2+. Bonding may be used to combine multiple wire pairs to increase available capacity or extend the copper network's reach.

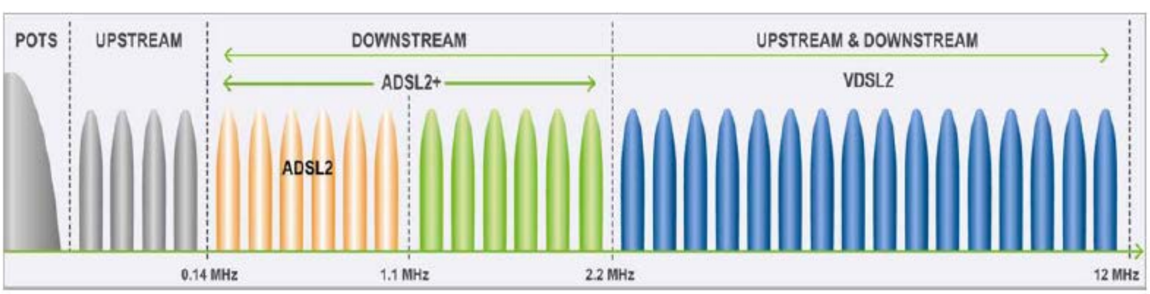

Figure 2: VDSL2+ Frequency Utilization

All new DSL deployments for CCI and TDS utilize VDSL2+ equipment.

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3.2 Cable Modem

Cable modem Internet access is provided over a hybrid fiber coaxial (HFC) broadband network. It has been employed globally by cable television operators since the early 1990s and is the network architecture utilized by Spectrum. In an HFC cable system, the television channels are sent from the cable system's distribution facility, the headend, to local communities through optical fiber trunk lines. The fiber-optic trunk lines provide adequate bandwidth to allow future expansion for bandwidth-intensive services. At the local community, an optical node translates the signal from a light beam to an electrical signal and sends it over coaxial cable lines for distribution to potential subscribers.

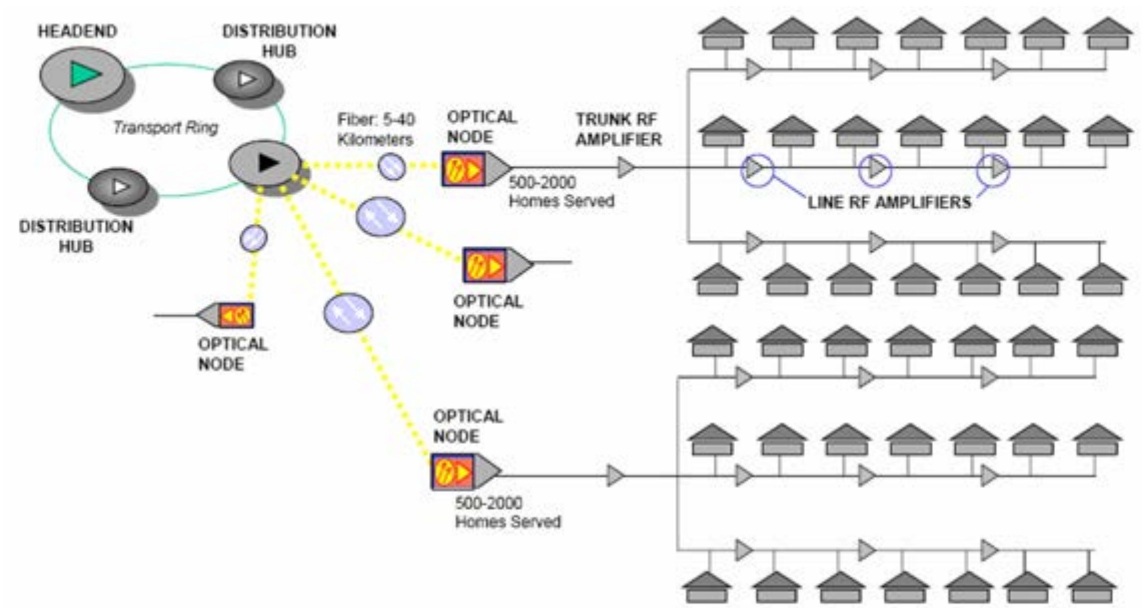

Figure 3: Hybrid Fiber/Coax Network Architecture Diagram

The coaxial portion of the network connects 25–2,000 homes in a tree-and-branch configuration off the node. RF amplifiers are used at intervals to overcome cable attenuation and passive losses of the electrical signals caused by splitting or "tapping" the coaxial cable.

The HFC broadband network is typically operated bi-directionally, meaning that signals are carried in both directions on the same network from the headend/hub office to the home, and from the home to the headend/hub office. The forward-path or downstream signals carry information such as video content, voice and data. The return-path or upstream signals carry information such as video control signals to order a movie or Internet data to send an email. The forward-path and the return-path are carried over the same coaxial cable in both directions between the optical node and the home.

Data Over Cable Service Interface Specification (DOCSIS) is an international telecommunications standard that permits the addition of high-bandwidth data transfer to an existing cable TV (CATV) system. DOCSIS 3.1 has been deployed by Spectrum to provide Internet access over their existing HFC infrastructure. The DOCSIS 3.1 standard is capable of supporting Internet speeds of up to 10 Gbps *(gigabits per second),* but most providers are currently offering speeds of 1 Gbps or less service for residential users.

3.3 Fixed Wireless

Fixed wireless broadband is the operation of wireless devices or systems used to connect two fixed locations *(e.g., building to building or tower to building*) with a radio or other wireless link. Fixed wireless data (FWD) links are often a cost-effective alternative to leasing fiber or installing cables between the buildings. The point-to-point signal transmissions occur through the air over a terrestrial microwave platform. The advantages of fixed wireless include the ability to connect with users in remote areas without the need for laying new cables and the capacity for broad bandwidth that is not impeded by fiber or cable capacities. Fixed wireless services typically use a directional radio antenna on each end of the signal. These antennas are generally larger than those seen in Wi-Fi setups and are designed for outdoor use. They are typically designed to be used in the unlicensed Industrial, Scientific, and Medical (ISM) radio frequency bands (900 MHz, 1.8 GHz, 2.4 GHz and 5 GHz). However, in many commercial installations licensed frequencies may be used to ensure quality of service (QoS) or to provide higher connection speeds.

To receive this type of Internet connection, consumers mount a small dish to the roof of their home or office and point it to the transmitter. Line-of-sight is usually necessary for Wireless Internet Service Providers (WISPs) operating in the 2.4 and 5 GHz bands. The 900 MHz band offers better non-line-of-sight (NLOS) performance. Providers of unlicensed fixed wireless broadband services typically provide equipment to customers and install a small antenna or dish somewhere on the roof. This equipment is usually deployed and maintained by the company providing that service.

3.4 4G/LTE Advanced Broadband

4G/LTE Advanced is wireless technology being deployed by cellular telephone providers such as AT&T, Verizon Wireless, US Cellular, Sprint and T-Mobile for traditional mobile phone and data services. The latest standard incorporates two new technologies - Carrier Aggregation, and Multiple Input Multiple Output (MIMO), in order to provide speeds in excess of 100 Mbps, and eventually up to 1 Gbps and beyond. While standard data connections use one antenna and one signal at any given time, 4G LTE Advanced has the capability of utilizing multiple signals and multiple antennas.

Mobile LTE wireless service uses MIMO technology to combine multiple antennas on both the transmitter and the receiver. A 2×2 MIMO configuration has two antennas on the transmitter and two on the receiver, but the technology is not limited to 2x2. More antennas could theoretically operate at faster speeds as the data streams can travel more efficiently. The signal is then combined with "carrier

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aggregation," which allows a device to receive multiple 4G signals at once. The received signals don't have to be on the same frequency; one could receive an 1800 MHz and an 800 MHz signal at the same time, which is not possible with standard 4G. Up to five different 20 MHz signals can be combined to create a data pipe of up to 100 MHz of bandwidth.

3.5 5G Wireless[2]

Fifth-generation wireless (5G) is the latest iteration of cellular technology, engineered to greatly increase the speed and responsiveness of wireless networks. With 5G, data transmitted over wireless broadband connections could travel at rates as high as 20 Gbps by some estimates -- exceeding wireline network speeds -- as well as offer latency of 1 millisecond or lower for uses that require real-time feedback. 5G will also enable a sharp increase in the amount of data transmitted over wireless systems due to more available bandwidth and advanced antenna technology.

In addition to improvements in speed, capacity and latency, 5G offers network management features, among them network slicing, which allows mobile operators to create multiple virtual networks within a single physical 5G network. This capability will enable wireless network connections to support specific uses or business cases and could be sold on an as-a-service basis. A self-driving car, for example, would require a network slice that offers extremely fast, low-latency connections so a vehicle could navigate in real time. A home appliance, however, could be connected via a lower-power, slower connection because high performance isn't crucial.

5G networks and services will be deployed in stages over the next several years to accommodate the increasing reliance on mobile and internet-enabled devices. Overall, 5G is expected to generate a variety of new applications, uses and business cases as the technology is rolled out.

How 5G works - Wireless networks are composed of cell sites divided into sectors that send data through radio waves. Fourth generation (4G) Long-Term Evolution (LTE) wireless technology provides the foundation for 5G. Unlike 4G, which requires large, high-power cell towers to radiate signals over longer distances, 5G wireless signals will be transmitted via large numbers of small cell stations located in places like light poles or building roofs. The use of multiple small cells is necessary because the millimeter wave spectrum -- the band of spectrum between 30 GHz and 300 GHz that most 5G implementations rely on to generate high speeds -- can only travel over short distances (500 - 1,000 feet) and is subject to interference from weather and physical obstacles, like buildings[3].

[2] https://searchnetworking.techtarget.com/definition/5G

[3] T-Moble is reportedly deploying 5G in the 600Mhz spectrum that can travel over much longer distances (3 - 5 miles) and will not require line-of-sight, but the bandwidth available will be much less than that provided in the higher spectrum ranges.

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Previous generations of wireless technology have used lower-frequency bands of spectrum. To offset millimeter wave challenges relating to distance and interference, the wireless industry is also considering the use of lower-frequency spectrum for 5G networks so network operators could use spectrum they already own to build out their new networks. Lower-frequency spectrum reaches greater distances but has lower speed and capacity than millimeter wave.

3.6 Satellite

Satellite Internet is available to virtually the entire lower 48 states, with some coverage in Alaska, Hawaii and Puerto Rico. The satellites are positioned more than 22,000 miles above the equator. These satellites are geostationary, which means they are always above a specific point on the earth as it rotates. The first Internet satellites successfully brought the Internet to a larger audience, but the rates were incredibly slow. Modern satellites use more advanced technology to transmit information which provides faster Internet access, but this is still much slower than landline-based Internet and terrestrial wireless Internet services.

When a consumer subscribes to satellite Internet, the company installs household equipment, which consists of an antenna dish and a modem. The antenna is located outside of the house and is generally two or three feet in diameter. The antenna must have an unobstructed view of the sky, called the line-of-sight, in order to communicate with the satellite. The antenna is connected to a modem, which connects to a computer with an Ethernet cable.

To manage bandwidth quality for all users, each plan comes with a cap on the data you can transmit or consume per month. The amount of data allotted depends on the subscriber’s plan. Plans typically range from 5 GB to 50 GB of data transmission per month with use limits prescribed. If you exceed the allotted data amount, Internet speeds will be throttled back until the next month. However, some companies allow subscribers to pay for more data capacity once the threshold is met, resetting normal operation levels.

Looking forward, at least a dozen companies, including Boeing, Amazon, SpaceX, OneWEb and Telesat are deploying, or planning to deploy thousands of Low Earth Orbit (LEO) satellites in massive constellations to provide Internet service to unserved and underserved regions of the world. The benefit of LEO satellites includes greater bandwidth and less latency, with the reported potential of displacing traditional land-line based Internet service. SpaceX and others have begun deploying LEO satellites and are in the process of testing the service to demonstrate their viability.

Satellite industry proponents say that now, unlike decades ago when Teledesic and the earlier iteration of Iridium failed to develop successful businesses, technology advancements are enabling satellite service to be offered more affordably and efficiently.

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3.7 Fiber-to-the-Home (FTTH)

Fiber-to-the-Home (FTTH) or Fiber-to-the-Premise (FTTP) is a network utilizing fiber optic cables directly to the home or business and is capable of offering virtually unlimited symmetrical bandwidth. Most FTTP networks can offer 1 Gbps of bandwidth in both download and upload directions, with some providers offering 2 Gbps and even 10 Gbps service capacity. The majority of new networks being deployed utilize this type of technology.

FTTH networks can be configured and operated in a number of different ways. These include:

- As a single service provider in a closed network environment;
- As an open access dark fiber[4] configuration where, competing providers can lease the fiber and place their own optical/electronics to complete the service;
- As an open access dark fiber configuration where the network owner provides the optical/electronics and leases the service to competing providers; and,
- As a Software Defined Network, where competing providers interconnect with the network and users select their provider in a virtual manner.

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[4] Dark fiber is fiber optic strands that have no optical/electronic equipment connected at both ends to "light" the fiber for use by a consumer. In this example, the network owner would provide the "dark fiber" leased by a service provider who would place their own optical electronics on the fiber to provide a finished service.

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4 Inventory of Existing Broadband Infrastructure

Three (3) service providers currently provide broadband service within the Town. Charter Communications (Spectrum) shared a small PDF map of their infrastructure. Consolidated Communications, Inc. (CCI) chose not to share any detailed mapping information but did share detailed information directly with the Town under a non-disclosure agreement that restricts disclosure in this report. Since the TDS service areas was so small and mostly covered with higher speed service from Charter (Spectrum), we did not solicit mapping information from TDS. In order to accurately inventory the existing infrastructure, Casco Bay drove along every roadway, private road and/or long driveway to visually inspect and map the location of CCI and TDS fiber optic cables, and the hybrid fiber/coaxial infrastructure of Charter (Spectrum).

4.1 Spectrum

For Spectrum we have identified areas where their service is available through their hybrid fiber/coaxial cable network. For residences, Spectrum provides a minimum 100Mbps/10Mbps service and can provide residential service up to 940Mbps/35Mbps. Business service is available up to 10Gbps.

4.2 CCI

For CCI, we have identified areas where they have deployed fiber optic cables, recognizing the use of this fiber optic infrastructure is limited to providing capacity to enable their own DSL remote terminal infrastructure and to deliver business grade data and Internet services *(see Section 4.6 below)*. Business grade services are available up to 10Gbps.

Casco Bay has made no attempt to map CCIs DSL infrastructure as the speeds and capabilities cannot be determined by a visual review of the copper infrastructure in the field.

4.3 TDS

We found no fiber optic cable in the Town that can be attributed to TDS.

4.4 Wireless Providers

While not part of the scope of work for this study, we are aware of reports that some residents, depending upon their specific location, may be able to secure functional service from a wireless provider. Those providers may include TK Networks, Redzone Wireless, AT&T, Verizon and T-Mobile.

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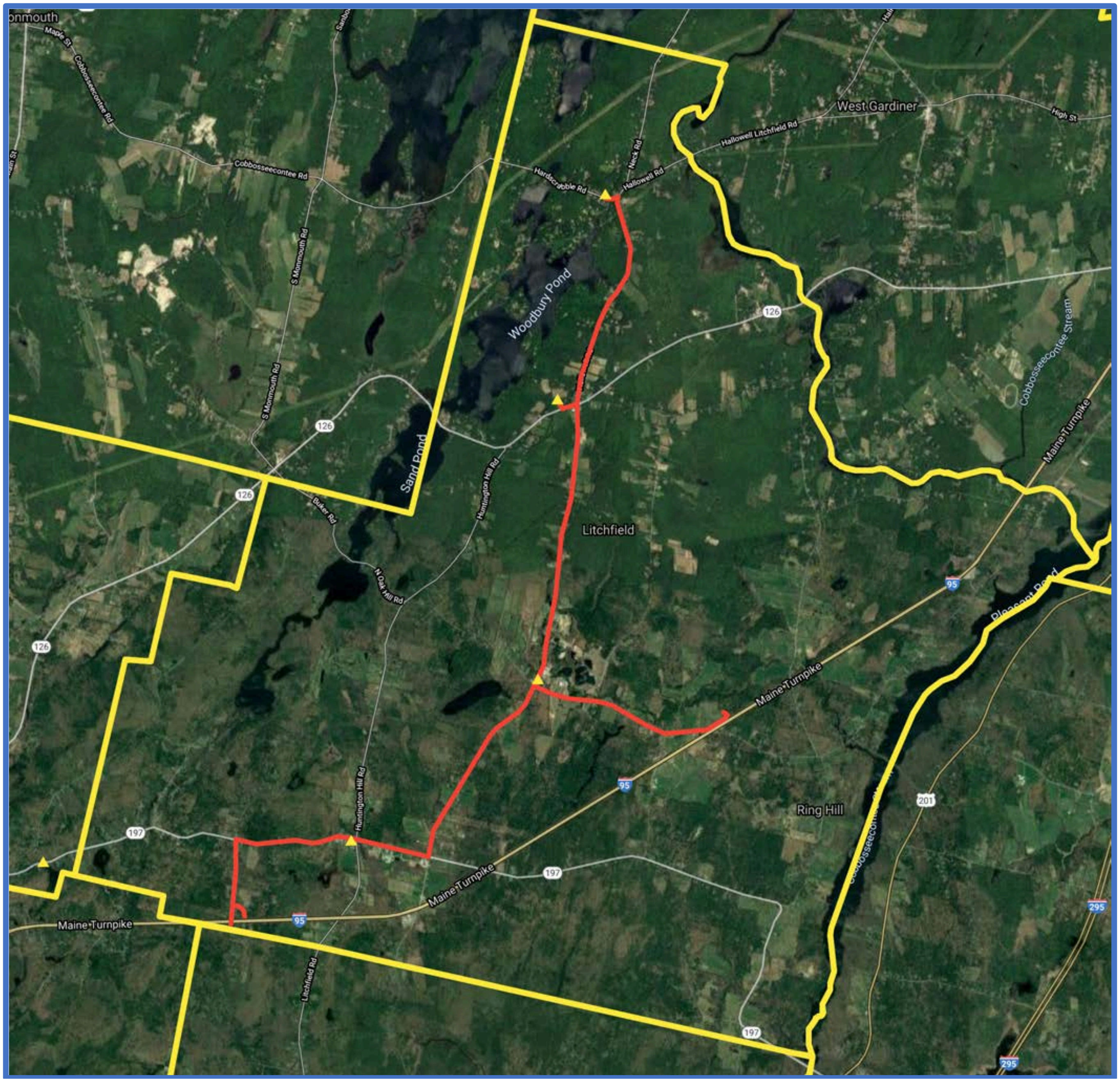
4.5 ConnectMaine Authority Data

As a surrogate for mapping of CCI DSL speed capability and availability, we have accessed data collected by the ConnectMaine Authority that illustrates speed availability on a combined service provider basis without identifying the underlying service providers. Since the minimum speed offered by Spectrum is 100Mbps/10Mbps, one can assume that speeds identified on the ConnectMaine Authority mapping below 100Mbps/10Mbps is that of CCI or TDS[5].

[5] It is important to understand that the ConnectMaine mapping data is provided by the service providers in a process defined by the FCC and is the "maximum advertised" speed available. The data as submitted also assumes that if a single location within a census block is served, then the entire census block is considered to have service available at that "maximum advertised" speed. Finally, the data as represented can be as much as 18 months old. As such, we know this data is of limited value, availability is over-stated geographically, and service may have been improved since the data was submitted and mapped by the ConnectMaine Authority. We provide this information for lack of availability of better information.

4.6 CCI Mapping



The red lines in the map above represent CCI fiber optic cable connecting to either their central offices / remote terminals *(represented by the yellow triangles)* or wireless towers.

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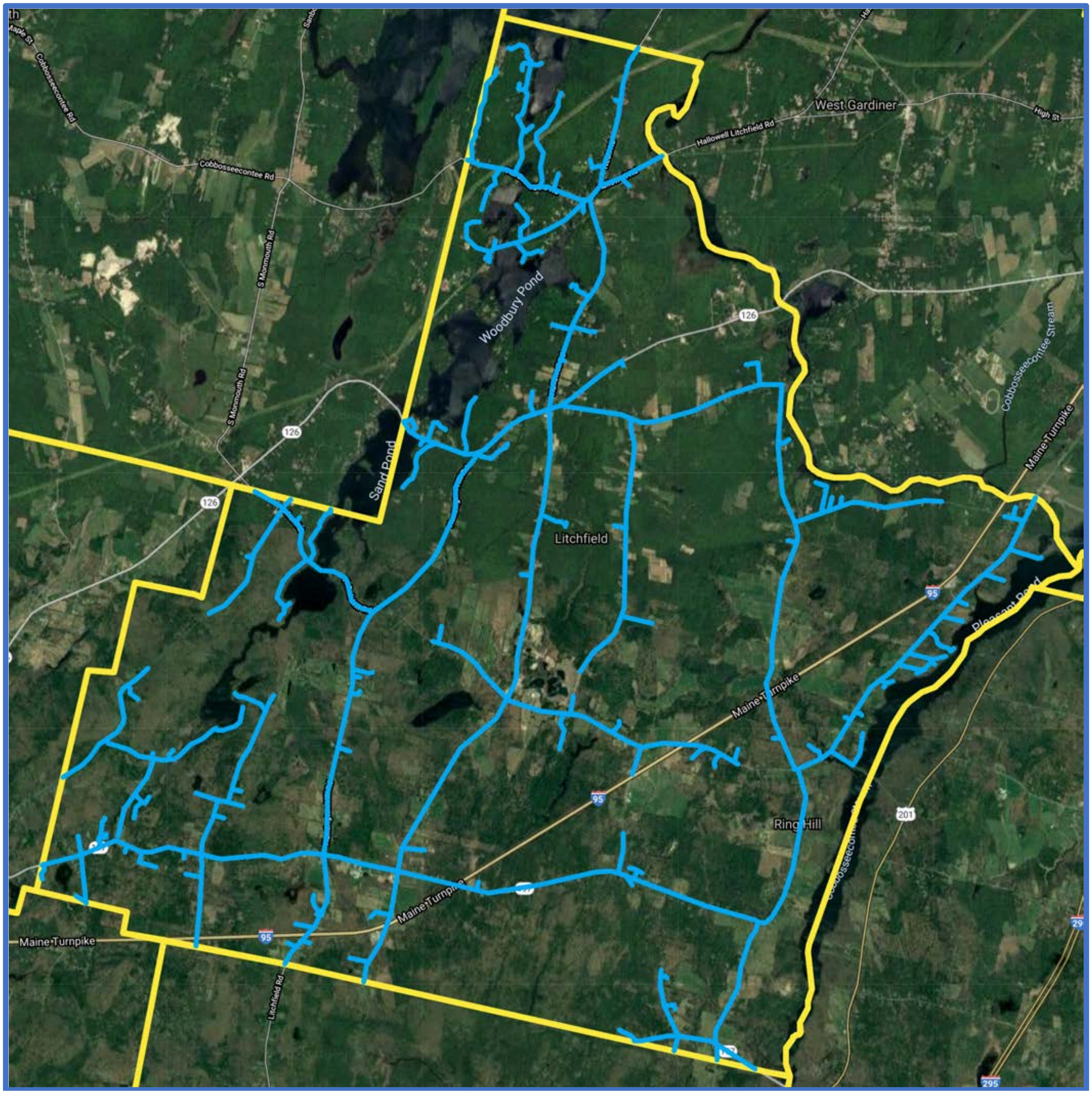
4.7 Charter (Spectrum) Mapping



The blue lines in the map above illustrate the existing road segments served by Charter (Spectrum).

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4.8 Gap Analysis Between Goals and Existing Infrastructure

While the Town has not established specific goals, it plans to establish specific goals once this report is shared with the Select Board and citizens of the Town. As such, we are comparing the existing infrastructure against four (4) different levels of service (goals).

4.8.1 Geographic areas with service of less than 1Gbps symmetrical

No service providers currently offer 1Gbps symmetrical service to residential subscribers anywhere within the town boundaries.

4.8.2 Geographic areas with service of less than 100Mbps/10Mbps

The only service provider currently offering 100Mbps/10Mbps service is Spectrum. The maps in Section 4.7 illustrate the extent of their service availability. Any roads not highlighted in the color "blue" are considered gaps in coverage.

4.8.3 Geographic areas with service of less than 25Mbps/3Mbps

The map in Section 4.5 illustrate areas with service of less than 25Mbps/3Mbps. Roads illustrated in the colors yellow, orange and red define the gaps in this level of coverage. We provide the same level of caution here as described in Section 4.5.

> It is important to understand that the ConnectMaine mapping data is provided by the service providers in a process defined by the FCC and is the "maximum advertised" speed available. The data as submitted also assumes that if a single location within a census block is served, then the entire census block is considered to have service available at that "maximum advertised" speed. Finally, the data as represented can be as much as 18 months old. As such, we know this data is of limited value, availability is over-stated geographically, and service may have been improved since the data was submitted and mapped by the ConnectMaine Authority. We provide this information for lack of availability of better information.

4.8.4 Geographic areas with no service

The map in Section 4.5 illustrate areas no service by highlighting those roads in the color red.

4.9 Assessment of Municipal Procedures, Rules and Ordinances

We have not found any municipal procedures, rules or ordinances that may inhibit the deployment of affordable, reliable high-speed Internet services within the Town.

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5 Gap Statistics and High-Level Network Designs

With the Cable TV system mapping completed, combined with 911 address data, parcel boundary data and Google Earth imagery; we have identified the road segments where the Cable TV system can be extended to provide 100% coverage. A map of these Cable TV gap areas is included in Section 5.1 below, with the blue colored lines representing existing Cable TV system infrastructure and green lines representing the gap road segments.

For each gap road segment, we have measured the length and the number of potential subscribers along that road segment, or which would be served by infrastructure along that road segment. Using industry standard design parameters, we have designed road segments to be extended to the second to the last potential subscriber along that segment, with the last potential subscriber to be served by a drop cable connection that is not illustrated on the maps.

The accuracy and currency of 911 address data was not sufficient for our purposes. As such, we also examined current and historical Google Earth imagery[6] to identify potential subscriber locations not identified with 911 address data. We have identified 550 more potential subscriber locations than the 1,449 contained in the 911 address data, for a total of 1,999. *(NOTE: Our process is not an exact science and we may have identified some potential subscriber locations incorrectly but believe the overall discrepancy is less than 2%).*

We have provided a table on the page following the map listing each road segment currently served by Charter (Spectrum) and each "uncabled" road segment with the corresponding mileage, quantity of potential subscribers and the average potential subscribers count per mile. This is critical information that will be utilized by potential service providers to examine the economic viability of extending service to currently unserved areas.

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[6] The date of the Google Earth imagery = 05/04/18.

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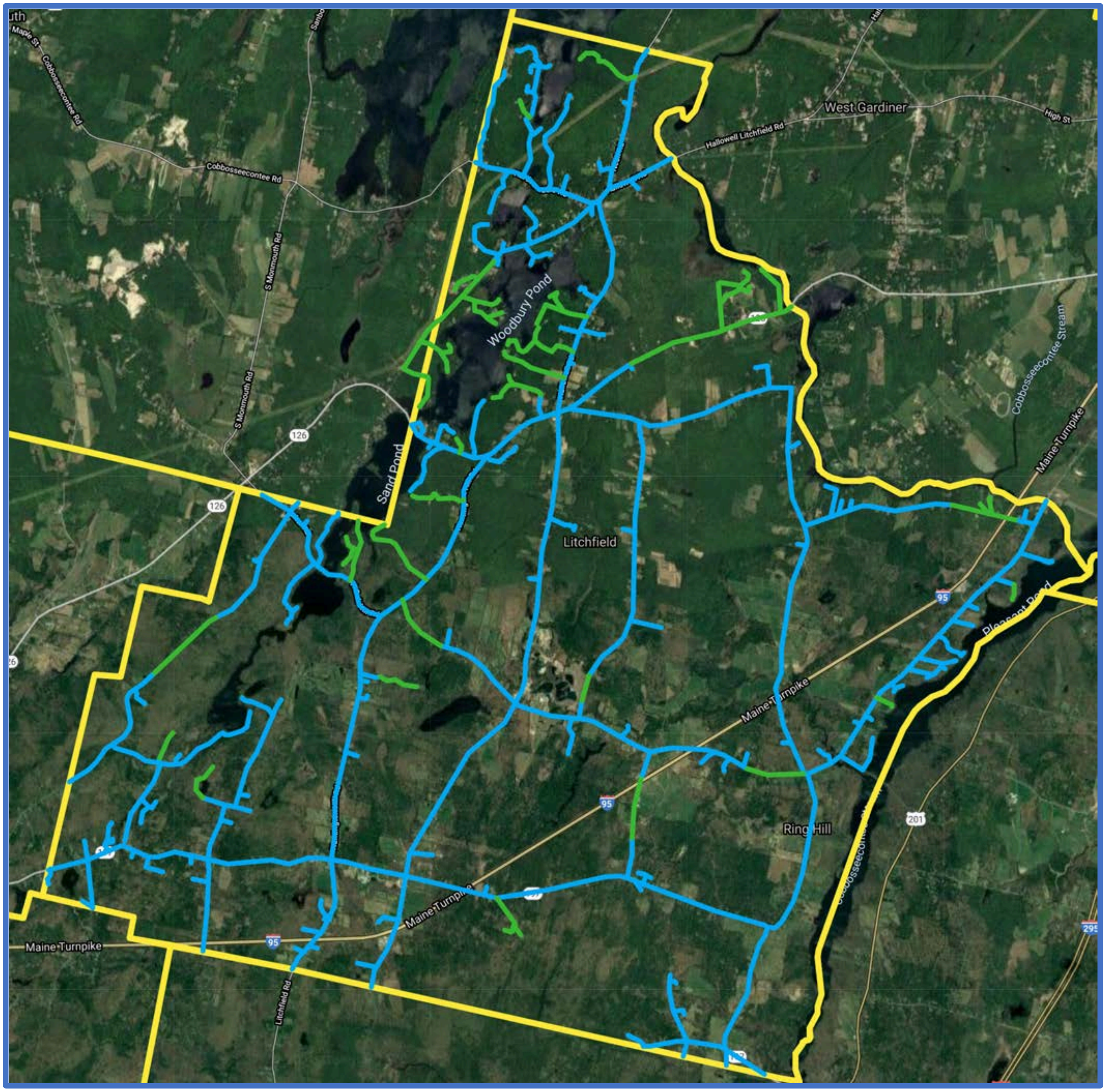
5.1 Cable TV system gaps



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Casco Bay Advisors, LLC
Broadband/Telecom Consulting

Charter (Spectrum) Gap Analysis

Cabled Road Segments						Uncabled Road Segments (gaps)		
Road Segment	Length (feet)	Road Segment	Length (feet)	Road Segment	Length (feet)	Road Segment	Length (feet)	Potential Subscriber Locations
Arquette Ln	426	Huntington Hill Rd	20,982	Pine Tree Rd (south)	834	Black Dr	2,148	6
Beals Ln	1,146	Isabella Ln	446	Plains Rd (east)	17,401	Chesley Dr	3,208	9
Birdhouse Ln	711	Jean's Way	650	Plains Rd (west)	11,594	Chickadee Dr	644	6
Blen Dr	845	Jean's Way	201	Pleasant Pond Ln	1,579	Community Dr	2,721	15
Breezemore Ln	1,023	Jeffery Ln	658	Porter Park Ln	427	Evergreen	938	2
Brissette Ln	510	Jimmy Pond Ln	4,486	Potters Brook Ln	915	Finley Ln	1,892	4
Brookside Ln	909	John Tar Rd	729	Purgatory Dr	2,212	FR 624	2,390	3
Buffee Landing Ln	446	Kennedy Ln	1,441	Reagan Ln	225	Goodwin DR	3,112	4
Buker Rd	6,274	Kennedy Ln Circle	472	Richmond Rd	43,118	Haley Ln	652	2
Bush Ln	1,031	Kenway Dr	2,022	Ricker Ln	367	Hartford Dr	2,977	12
Canty Ln	1,589	Keziah Ln	508	Ridley Ln	5,452	Hyles Dr	4,170	3
Cedar Grove	429	Labbe Ln	1,055	Route 126	12,073	Island Dr	1,198	4
Center Rd	5,734	Lakeview Dr	7,254	S Adams Rd	3,244	Keri Ln	928	3
Chapman Dr	893	Larrabee Ln	588	Sawmill Dr	546	Lahey Dr	741	0
Clinton Ln	884	Lemay Ln	963	School Ln	737	Lebel Ln	2,840	11
Collins / Park Ave	646	Libby Rd	4,502	Scotty Ln	448	Libby Rd	2,894	3
Community Dr	1,092	Little Dr	2,566	Shepard Ln	636	Loch Sloy Ln	740	3
Cove Dr	536	Lois Ln	547	Small Rd	1,874	Lucien Ln	895	10
Crystal Ln	1,694	Lovering Dr	511	Small Rd (north)	1,363	Lunts Hill Rd	3,024	3
Cummings Dr	192	Lunts Hill Rd (east)	917	Southside Estates	1,357	Manchester Ln	4,202	7
Daffodil Ln	989	Lunts Hill Rd (west)	7,135	Stevenstown Rd	18,628	Military Ln	707	6
Davis / Penny Ln	1,824	Lynn Ln	1,791	Stone Ln	773	My Way Dr	1,846	5
Dead River Rd	3,928	Mace Rd	2,784	Sunshine Farm Rd	356	N Greenleaf Woods Ln	2,078	4
Deer Run Ln	741	MacWinnie Ln	402	Tacoma Lake Rd	2,877	Nutting Ln	1,326	3
Dennis Hill Rd	10,828	Maple Dr	1,086	Thornton Ln	852	Oak Hill Rd	3,667	6
Dingley Rd	1,455	Marissa Ln	414	Thorofare Rd	1,241	Overlook Dr	1,400	7
Doyle St	3,556	Marlene Dr	1,172	Tower Ln	837	Pamrok Ln	884	2
Doyle St Ext	302	Maxwell Rd	2,240	Town Line Dr	933	Perch Dr	1,454	6
Ellie Ln	378	Memory Rd	292	Turcotte Ln	918	Pine Tree Rd	1,237	0
Eternity Dr	280	Military Ln	935	Turtle Cove Ln	644	Plains Rd	2,699	3
Ferin Rd	3,162	N Adams Rd	574	Unnamed Rd	287	Rosser Dr	4,056	14
Fern Ln	720	N Evergreen Dr	589	Unnamed Rd	849	Route 126	7,993	13
Finley Ln	1,075	N Oak Hill Rd	2,442	Unnamed Rd	296	Rustic Dr	2,745	14
Flaherty Ln	439	Nadeau Dr	1,109	Unnamed Re	807	Shady Ln	790	2
Ford Ln	331	Neck Rd	6,729	Upper Pond Rd	8,002	Simard Dr	784	6
Forest Ln	1,760	Norris Point Rd	4,685	Vida Ln	261	Small Rd	2,792	2
Gamage Dr	1,176	Nottingham Ln	1,829	Wabenaki Ln	197	Thorton Rd	1,763	5
Getch Hill Ln	1,450	Nutting Ln	263	Warren Ln	1,811	Tru Dr	507	4
Gordon Ln	585	Oak Hill Rd (south)	7,053	Washington Ln	1,600	Weed Dr	741	6
Gowell Ln	482	Oak Hill Rd (north)	6,003	Waterfall Dr	373	Whippoorwill Rd	6,516	6
Grant Rd	2,875	Old Lodge Rd	1,543	Wentzell Rd	4,040	Woodbury Dr	2,323	9
Gustin Rd	3,410	Osprey Ln	1,064	West Rd	4,294	Woodland Ln	2,675	6
Hallowell Rd	43,482	Patten Woods Rd	964	Whipperwill Rd	5,663			
Hardscrabble Rd	6,309	Peacepipe Dr	4,910	Whispering Pines Ln	522			
Harvey Ln	679	Pelican Dr	359	Whodathunkit Ln	388			
Heron Dr	374	Perkins Rd	519	Wood Frog Ln	495			
Hilltop Ln	540	Perry Dr	392	Woodpecker Dr	745			
Huff Mill Rd	728	Pine Tree Rd (north)	12,557					
				Total (feet)	**409,292**	**Total (feet)**	**93,297**	
				Total (miles)	**77.5**	**Total (miles)**	**17.7**	
		Potential Subscriber Locations			**1,760**	**Potential Subscriber Locations**	**239**	
			Average Locations per Mile		**22.7**	**Average Locations per Mile**	**13.5**	

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5.2 Fiber-to-the-Home gaps

Our investigation reveals there is no Fiber-to-the-Home (FTTH) infrastructure deployed within the study area. As such, the FTTH gaps are equal to the sum of the road segments currently served by a Cable TV system and the roads that are currently uncabled, for a total of 95.2 miles and an average of 21 potential subscriber locations per mile.

5.3 Minimum 25Mbps/3Mbps DSL gaps

Consolidated Communications DSL Coverage	
Potential Subscriber Locations per 911 & Imagery Analysis	**1,998**
Addresses in CCI system	**2,105**
No service	**137**
Percent	*7%*
Less than 10Mbps/1Mbps	**327**
Percent	*16%*
Less than 25Mbps/3Mbps	**1,641**
Percent	*78%*

Consolidated Communications (CCI) is the incumbent local telephone company covering 98.5% of all road segments with the remaining 1.5% served by TDS. CCI has shared maps of their service availability and statistical tables of their speed capabilities, with the promise that we not publish the material. The maps and tables have been provided to the Town and those who wish to view the materials may do so by contacting the Town office.

For purposes of this report, we have summarized the information by the quantity of potential subscribers who have no DSL service availability, those with service capability of less than 10Mbps/1Mbps and those with service capability of less than 25Mbps/3Mbps. All three (3) of these categories are considered to be "unserved" by the ConnectMaine Authority and eligible for funding through their Implementation Grant program, provided there is no other service provider who provides service with a capability greater than 25Mbps/3Mbps at that address.

Because we do not have access to CCI's cable plant records to determine the direction the cable is fed, the wire gauge of the copper cables or their condition, it is impossible to estimate the cost to expand the availability and capability for improving service using DSL technology to speeds in excess of 25Mbps/3Mbps.

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5.4 High-level capital cost estimates

The table below provides a high-level cost estimate to extend the Cable TV system to cover 100% of the potential subscribers in each town and the high-level cost estimate to construct a FTTH system for each community. Each line item is discussed below the table.

	B	C	D
1	Town Metrics		
2			
3	Cable TV Mileage		77.5
4	Potential Subscribers		1,760
5	Average per mile		22.7
6			
7	Uncabled Mileage		17.7
8	Potential Subscribers		239
9	Average per mile		13.5
10			
11	Total Potential FTTH Subscribers		1,999
12	Potential FTTH Subs per Mile Avg		21.0
13	Total FTTH Mileage		95.2
14	Cable TV Extension		
15	Cost per mile	$45,000	$795,147
16			
17	Fiber-to-the-Home High-level Estimate		
18	Poles per mile	33	3,141
19	Make-ready per pole	$400	$1,256,473
20	Annual License per pole	$20	$62,824
21	Backbone Construction	$25,000	$2,379,684
22	Central Office Construction	$250,000	$250,000
23	Subscriber Drops (50% take rate)	$1,000	$999,500
24	Subtotal		$4,885,657
25			
26	Project Management	5%	$244,283
27	Contingency	10%	$488,566
28	Total		$5,618,505
29			
30	Difference between Cable & FTTH		$4,823,358

B3 - Cable TV Mileage – Total mileage of existing Cable TV infrastructure.

B4 – Potential Subscribers – Total calculated quantity of potential subscribers who can be served by the existing Cable TV infrastructure.

B5 – Average per mile – The average quantity of potential subscribers per mile across the existing Cable TV infrastructure.

B7 – Uncabled Mileage – Total mileage of road segments not served by Cable TV infrastructure.

B8 – Potential Subscribers - Total calculated quantity of potential subscribers who could be served by extending the Cable TV infrastructure to road segments currently uncabled.

B9 - Average per mile – The average quantity of potential subscribers per mile who could be served by extending the Cable TV infrastructure to road segments currently uncabled.

B11 – Total Potential FTTH Subscribers – The total quantity of potential subscribers who could be served by a FTTH system covering 100% of the community.

B12 – Potential FTTH Subs per Mile avg - The average quantity of potential subscribers per mile who could be served by a FTTH system covering 100% of the community.

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B13 – Total FTTH Mileage - Total mileage of road segments that would be required to reach 100% of the potential subscribers.

C15 – **Cost per mile** quoted by Charter (Spectrum) in a similarly situated community in Maine.

Row 15 – Estimated cost to extend Cable TV system to serve 100% of the community. The percentage of the cost the Town would be required to contribute is unknown. Based upon what we have seen in other communities, the Town should expect to shoulder at least 50% of the cost.

C18 – Poles per mile – Based on our experience across Maine for other project, we are using an average of 33 poles per mile. The actual quantity of poles may differ.

C19 – Make-ready per pole - Based on our experience across Maine for other projects, we are using an average of $400 per pole to create sufficient space for an additional attachment within the National Electrical Safety Code guidelines. The actual amount cannot be determined until the pole owners perform a survey to measure the available space on each pole and what steps are necessary to rearrange existing attachments.

C20 – Annual License per pole[7] – Based on our experience across Maine for other projects, we are using an average of $20 per pole per year. During the make-ready process, poles ownership will be identified as phone company solely owned, power company solely owned or jointly owned by phone and power. Actual costs will be determined by pole attachment agreements which will be required to be negotiated with both phone and power company owners.

C21 – Backbone Construction – Cost for materials and labor to construct the backbone FTTH network on a per mile basis, not including the drop cables and optical / electronics deployed at subscriber locations. Actual costs may be lower or higher depending upon a number of variables that can only be known after performing detailed engineering, having the results of the pole owner surveys and the schedule and availability of construction contractors.

C22 – Central Office Construction – Cost for a prefabricated concrete central office structure, land acquisition and development with all peripheral equipment.

C23 – Subscriber Drops – Average cost per subscriber for installation of the drop cable and optical network termination (ONT) at the subscriber premise. The amount assumes 50% of the potential subscribers become FTTH customers.

[7] Pole license fees are an annual operating expense and this amount is not included in the Capital Cost estimates for construction of the network.

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C26 – Project Management – Cost to oversee and management the construction and subscriber activation.

C27 – Contingency – Amount to cover unforeseen circumstances.

Row 28 – Total high-level estimated cost to deploy a FTTH system.

Row 30 – Difference in high-level estimated cost to extend existing Cable TV infrastructure and deploying a new FTTH network.

6 Public-private partnership strategies

There are a number of potential public-private partnership strategies to improve service at a lower cost than deploying a town-owned FTTH network. Below we provide a brief overview of those options and potential partners.

6.1 Charter (Spectrum)

Balancing cost, speed to deployment and capability, extending the Cable TV system is an option that should be considered, although the negotiating process we have experienced in other communities has taken an extraordinary long and trying time.

Based on our review of the franchise agreements and experience in other communities, it is unlikely Charter (Spectrum) will extend their network under any build-out obligation of the existing agreement. A better approach will be to share the maps and statistics with Charter (Spectrum) and have them quote the cost to fully extend their network.

6.2 Consolidated Communications (CCI)

As the incumbent phone provider, CCI has access to all of the pole and existing cables on which to over-lash new cables. As such, CCI should have a lower cost to improve service than any other service provider. CCI has also been active in Vermont and New Hampshire partnering with towns to overbuild their copper networks with FTTH systems. In some cases, CCI will partner with the town to share the cost and ownership of a FTTH network and the town will apply a special surcharge to the subscriber's monthly bill to cover the cost of servicing any bond debt to fund the town portion. Should there not be a sufficient quantity of subscribers to cover the monthly bond payment, CCI has guaranteed those bond payments.

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We recommend sharing the maps and statistics included in this report with CCI to begin the process of exploring a potential partnership.

6.3 Alternative service providers

There are a number of alternative service providers who are active across the state of Maine who are willing to partner with towns to deploy FTTH networks. Those providers include GWI, Pioneer Broadband, Axiom, Premium Choice Broadband, LCI and Matrix. Each service provider has a different model with variable ownership and funding options. Each is experienced in leveraging various government grant and/or loan programs with the USDA, ConnectMaine Authority, Northern Border Regional Commission and the EDA. Sharing this report with each of these providers will generate interest and discussions which should be pursued.

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7 Next step recommendations

With the publication of this report, we recommend the Town pursue the following steps in parallel to ensure your Town is well positioned with ongoing service provider expansion plans, current funding programs and to take the necessary steps to educate and inform your constituents.

7.1 Revisit and confirm goals and vision

Now that the costs and options for various solutions have been identified in this study, the Town committee should revisit its goals and vision. This effort should be completed at the earliest opportunity in order to inform the next steps.

7.2 Public-private partnership negotiations

We recommend exploring potential partnerships with all service providers concurrently in a fully transparent and inclusive manner. This is important from a due diligence perspective to generate confidence by your constituents that all avenues have been explored and the differences given the appropriate weight.

7.3 Secure funding to support negotiations

While the efforts of Town staff, select board members and committee member volunteers should be celebrated and continue, any public-private partnership negotiations will benefit from the guidance and facilitation of a consultant with deep telecom/broadband engineering and operating experience and relationships with the service providers. The Town committee must secure additional funding from both municipal and grant funding opportunities to continue to support these efforts.

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8 Digital Inclusion

Through the Committee's ongoing efforts and the participation of CCI, Spectrum and Casco Bay, the Digital Inclusion component of the Study has been completed per the summary below.

8.1 Affordable Internet

The Committee has determined the following through its meetings with CCI and Spectrum and intends to publicize the availability via the Study and its ongoing community engagement efforts:

8.1.1 FCC Lifeline Program

Lifeline is the FCC's program to help make communications services more affordable for low-income consumers. Lifeline provides subscribers a discount on monthly telephone service purchased from participating providers in the marketplace. Subscribers can also purchase discounted broadband from participating providers. The discounts, which can be applied to stand-alone broadband, bundled voice-broadband packages (either fixed or mobile, along with stand-alone voice service) will help ensure that low-income consumers can afford 21st-century broadband and the access it provides to jobs, education and opportunities.

Consolidated Communications, Inc. (CCI) offers a Lifeline Program for eligible low-income residential subscribers at their primary residence[8]. The Lifeline Program is a government benefit program. Eligible subscribers can apply the monthly $9.25 federal Lifeline Program discount to a voice service or to a qualifying Internet service. In some states, an additional monthly voice discount is also available. Eligible subscribers who apply the Lifeline Program discount to their CCI voice service may also qualify for free toll blocking to help control long distance usage. These eligible subscribers can still use pre-paid calling cards or dial-around services to place long distance calls from their homes.
Only one Lifeline Program discount is available per household on either a wireless or wireline qualifying service. Under the Lifeline Program, a household is defined as any individual or group of individuals who live together at the same address and share income and expenses. The Lifeline Program benefit is non-transferable. Consumers who willfully make false statements in order to obtain the discount can be punished by fine or imprisonment or can be barred from the Lifeline Program. Visit Universal Service Administrative Co. at www.usac.org for more information on the Lifeline Program.

How do I apply?
To receive the Lifeline Program discount, residential customers must establish the eligibility of their household. Eligibility requirements are explained in detail on the Lifeline Program application and

[8] https://www.consolidated.com/support/residential-support/lifeline-assistance-programs

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at www.lifelinesupport.org. If you meet the eligibility requirements, complete and sign the application form, attach proof of eligibility and mail directly to USAC. Alternatively, you can verify your eligibility with USAC at www.checklifeline.org. After your eligibility is verified, call CCI at (1.844.968.7224) to add the Lifeline Program discount to your CCI account.

8.1.2 Spectrum Internet Assist[9]

Through the Spectrum Internet Assist program, qualified households can receive:

- High-speed 30 Mbps Internet with no data caps
- Internet modem included
- No contracts required
- Add in-home WiFi for $5 more per month

To qualify for Spectrum Internet Assist, a member of the household must be a recipient of one of the following programs:

- The National School Lunch Program (NSLP) free or reduced lunch
- The Community Eligibility Provision (CEP) of the NSLP
- Supplemental Security Income (>/= age 65 only)

8.2 Affordable Equipment

The Committee has determined the following and intends to publicize the availability via the Study and its ongoing community engagement efforts:

- **PC's for Maine[10]** – A nonprofit effort to increase technology access for people and nonprofits that need technology to achieve important goals. So far, this program has provided more than 9,000 computers that have been used by more than 120,000 Mainers. The average actual cost for each computer with all of its support services is $277. The market value of this service is more than $910 - if such a service was available.

- **Goodwill Technology Access Program[11] -** Goodwill's GoodTech Technology Access Program (TAP) offers refurbished computers to qualified individuals at discounted prices. Computers are guaranteed to work and come with new, legal installations of Windows and Microsoft Office obtained directly from Microsoft.

[9] Further information can be found at: www.spectruminternetassist.com
[10] www.pcsformaine.org
[11] www.goodwillnne.org/stores/goodtech/

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8.3 Digital Literacy

The Committee has identified digital literacy as a key requirement of its community and is in the process of publicizing the availability of webinar classes available through the National Digital Equity Center (NDEC)[12]. When the Covid-19 public gathering restrictions are completely eliminated, the Committee plans to invite NDEC to conduct an informational workshop in the community and depending upon demand, facilitate training classes in its community center and/or senior center.

8.4 Public computer access

There are 3 – 4 desktop computers available at the Litchfield Senior Center. With funds from the Maine Community Foundation, the Committee has recently purchased 4 new tablets, with additional devices on the way. The Committee has plans to provide informal mentoring on computer literacy as required. Normal hours are Monday and Friday 8:30 – 4:00 and Wednesday 8:30 - Noon.

While the Town does not have a public library of its own, they are a member of the towns that support the Gardiner Public Library and enjoy the benefits of free Internet access and use of computers at that facility.

[12] https://digitalequitycenter.org/classes/

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