TILSON

Broadband Study for the Maine Off-Shore Islands of:

Islesford, Great Cranberry, Sutton, Vinalhaven, North Haven, Monhegan, Matinicus, Frenchboro, Swan's, Chebeague, Long Island, Isle Au Haut, Cliff, and Peaks

Submitted to:

The Island Institute

Prepared by:

Tilson
245 Commercial Street, Suite 203
Portland, ME 04101
Phone: 207-591-6427
E-mail: broadband@tilsontech.com

Submitted:
November 6, 2015

Note:

Price and cost information included in the following report is an estimate based on recent quotes, historical data, assumptions about the project scope and approach, and the current regulatory environment and market conditions. Tilson recommends updating the estimates and allocating sufficient contingency to allow for changes in prices, costs, scope and market conditions as time passes.

Tax estimates, where provided, are approximate. It is the responsibility of service providers to assess and collect taxes in accordance with local, state and federal law.

TILSON

Table of Contents

Study Background 1

Report Structure 1

Executive Summary 2

Defining Broadband 4

The Town of Cranberry Isles 8

Vinalhaven.....31

North Haven.....45

Monhegan.....58

Matinicus.....72

Frenchboro.....87

Swan's 101

Chebeague.....115

Long.....132

Isle Au Haut.....145

Cliff.....159

Peaks.....168

Island Cellular Service.....175

Service Offering Overview by Provider 178

Business Model Overview.....181

Cost Savings Strategies.....191

Economic Benefits Analysis.....196

Appendix.....A-1

Study Background

Broadband represents one of the most effective ways to address the access challenges associated with island life. Superior connections can provide economic, educational, medical, and other benefits without the need for physical connectedness. As such, the Island Institute engaged Tilson to conduct a broadband study of thirteen of Maine's year-round inhabited islands, plus Sutton Island. The objective of this study is to provide each island with information that will enable informed decisions as these communities move toward their goals.

Components of the study included:

- A community meeting to assess each community's broadband related goals;
- An inventory of current broadband assets and services;
- A randomized survey of residents and businesses to measure broadband satisfaction, subscribership, and attitudes regarding new service;
- High-level network design and cost estimates for various solutions that address the community standard;
- Valuation of the economic benefits (improved GDP, job growth, tax base growth) associated with broadband improvements;
- A summary of various community broadband projects in Maine and around the US; and
- Analysis of potential operating and business models for serving Maine's offshore islands.

The islands included in this study are those of The Town of Cranberry Isles (Islesford, Great Cranberry Sutton), Vinalhaven, North Haven, Monhegan, Matinicus, Frenchboro, Swan's, Chebeague, Long Island, Isle Au Haut, Cliff, and Peaks. The scope for Cliff and Peaks islands was narrower than the rest of the study and did not include an asset inventory, fiber design, economic benefits valuation, or a survey that was random (a survey was taken, but it was an opt-in online survey). The Cliff and Peaks scope however did include high-level capital cost estimates for a fiber solution.

Report Structure

The report is structured with an overview of broadband, sections for each municipality with findings specific to their island community, and sections at the conclusion of the report with information applicable to all island communities: options for improving cell phone service, service offering overview and pricing by broadband provider, a potential business models overview, opportunities for regional cost savings, economic benefits analysis, and in the appendix, a list of the islander comments received on each survey, by island.[1]

[1] Tilson omitted portions of comments that contained personal contact information, which was shared by some respondents as an offer to provide additional insight.

Executive Summary

Shared Goals. Many of the islands shared the same goals, including the goals of sustaining the year-round community by enabling telecommuting and attracting young families, ensuring access to government services and telemedicine, and maintaining geographic isolation while having access to important information and services. Educational goals were also common—ensuring that students of all ages have the ability to complete school assignments at home as well as at school.

Different Inputs, Different Solutions. While there is a high level of consistency in the islands' goals, there are wide variations in the islands' current levels of service, the cost to implement a particular solution, and the ability to municipally or privately fund a solution. For a wireless Long Term Evolution (LTE) solution, an island with a large land mass or a lot of topographical relief would require a large number of expensive and visually obtrusive cell towers. A smaller island would not have that constraint. There are, however, opportunities for islands to collaborate in a solution. For example, multiple islands that are served by the same municipal utility would be suitable candidates to share in a solution. Islands in close physical proximity could share microwave backhaul to lower costs or create redundant microwave links.

Fiber to the Premise is an Expensive Long Term Solution That Requires a High Level of Buy-In. Of all the potential solutions to improve broadband access, a Fiber to the Premise (FTTP) solution offers the fastest speeds, is the only solution offering universal same-speed access, and has the least-cost projected upgrade path. However, the capital costs to deploy are very high, starting in the millions of dollars. The economics of running a FTTP network are such that there are high fixed operating costs independent of how many users are on the network. That means that very high adoption rates are key to keeping average cost per user, and therefore prices, down.

Wireless LTE Has Current Limitations to Universal Coverage. Redzone's wireless LTE technology, like today's cell phone technology, is sensitive to obstructions like trees, buildings and land masses between the user and the antenna tower. For many of the islands, Redzone's current technology requires multiple 150' towers to provide close to 100% coverage. Redzone is currently testing wireless LTE small cells in the lab. Small cells technology will enable Redzone to mount fiber-fed antennas on the top of utility poles. These antennas will help fill in coverage gaps and obviate the need for multiple towers.

ILEC Upgrades Provide a Gap Solution. Most of the communities rely on DSL technology from FairPoint or TDS, the incumbent local exchange carriers (ILECs) serving the islands. Both TDS and FairPoint have known DSL upgrades in process for four of the islands (Matinicus, Frenchboro, Isle Au Haut, and new service on Chebeague), which will provide improved residential access for users in close physical proximity to the ILEC infrastructure, plus better service in the schools and libraries. While DSL technology has limitations of lower overall speeds and service inconsistencies as a function of distance, it may be a viable solution for many of the islands for the next few years. Islands without planned upgrades have the opportunity to work with the ILECs to improve their DSL-based service.

Regional Cost Savings Opportunities: Available to FTTP, Largest Opportunity in OpEx. The ability for municipalities and users to save money by acting together is largely limited to the FTTP solution. The greatest opportunity lies in sharing microwave backhaul infrastructure and bandwidth. There are also

administrative savings, although those are likely offset by an increased governance complexity. Islands that share a small electrical utility – if that utility becomes a broadband provider – potentially have the least added governance complexity in working together.

Cell Service: Limited Coverage, Limited Solutions. On most islands, residents were not satisfied with their current cellular service. As detailed in the report, an island community's ability to improve its cellular service is limited. However, a strong and reliable broadband connection can improve cell service on-site by supporting a network extending device. Indirectly, a town could overcome the barriers to a cell phone company build-out within its boundaries by easing restrictions on towers, or possibly building a tower to deploy a wireless LTE solution that could be used by the cell phone tenants.[2]

Chebeague.net Provides Important Island Precedent. By most definitions, Chebeague.net is Maine's first municipal broadband network. Chebeague's experience with their network is useful for what an island can achieve with a municipal effort (e.g. subsidized service for some); the challenges of the effort (e.g. the limitations of DSL technology); and the network's ability to share useful network information that would likely not be shared by a public provider (e.g. network usage statistics). The section on Chebeague Island in this report is particularly useful to any island considering a municipally sponsored broadband solution. Islands that take steps to improve their broadband service will benefit from information-sharing, even if they pursue different solutions.

[2] This presumes a cell phone company has a business case to support an island build out.

Defining Broadband

It is important to note that the term "broadband" does not refer to any technology in particular. Rather, it refers to data transmission through a medium in excess of certain threshold. From an information technology perspective, it represents the amount of data that a consumer can download or upload from the Internet in a given second. This is the measurement known as bandwidth. Greater bandwidth is analogous to a faster connection. Connection speeds are generally measured in kilobits per second (Kbps), megabits per second (Mbps) or gigabits per second (Gbps).[3]

In the U.S., broadband standards are defined nationally by the Federal Communications Commission (FCC), and also sometimes by states, as is the case in Maine. The FCC uses a tiered approach to define broadband based on download and upload speeds for wireline and wireless technologies:

FCC Speed Tiers

FCC Speed Tier	Download Speeds	Upload Speeds
1st Generation Data	200 Kbps to 768 Kbps	200 Kbps to 768 Kbps
Tier 1	768 Kbps to 1.5 Mbps	768 Kbps to 1.5 Mbps
Tier 2	1.5 Mbps to 3 Mbps	1.5 Mbps to 3 Mbps
Tier 3	3 Mbps to 6 Mbps	3 Mbps to 6 Mbps
Tier 4	6 Mbps to 10 Mbps	6 Mbps to 10 Mbps
Tier 5	10 Mbps to 25 Mbps	10 Mbps to 25 Mbps
Tier 6	25 Mbps to 100 Mbps	25 Mbps to 100 Mbps
Tier 7	> 100 Mbps	> 100 Mbps

Until recently, the FCC defined broadband as 4 Mbps downstream and 1 Mbps upstream. As shown in the table above, that standard translates to a minimum Tier 3 download and Tier 1 upload connection to qualify as broadband service. In January 2015 the FCC changed its broadband definition to 25 Mbps download and 3 Mbps upload. This evolving baseline reflects a growing need for higher bandwidth as Americans increasingly use the Internet and communications technologies in all aspects of their lives. It also has the potential to dramatically increase the number of communities in the U.S. eligible for subsidy.

In January 2015, the ConnectME Authority changed its broadband definition from 1.5Mbps download (and no upload speed provision) to 10 Mbps upload and 10 Mbps download. The rationale for specifying the 10 Mbps upload speed – significantly higher than the federal standard – is that upload

[3] 1 Gbps = 1000 Mbps = 1,000,000 Kbps.

speeds are particularly important for businesses and telecommuters that use applications like video-conferencing and cloud-based services that are sensitive to delays caused by slower upload speeds. The effect of this change is that a much greater portion of the state – including the entire geography covered in this report – is considered underserved, and thus likely eligible for ConnectME grants, to the extent they are available.

Delivered data speeds in the US have been getting faster. In 2000, only 4.4 percent of American households had a broadband connection (as defined prior to January 29, 2015) in their homes. By 2010, that number had jumped to 68 percent. Moreover, since 2010, average delivered speeds in the U.S. have doubled overall, and today roughly 94 percent of Americans have access to wireline or wireless broadband speeds of at least 10 Mbps downstream. [4]

The following table[5] shows download speeds required for a range of common internet-based activities, by number of simultaneous users:

Minimum Download Speed for Common Activities

	Basic Use **(Email, Web Surfing Basic Video)**	**Moderate Use (Basic use plus high demand functions i.e. gaming, conferencing, HD video)**	**Heavy Use** **(Basic use plus multiple high demand functions)**
1 user on 1 device (laptop, tablet, gaming console)	1 – 2Mbps	1 – 2Mbps	6 – 15 Mbps
2 users on 2 devices at a time	1 – 2Mbps	1 – 2Mbps	6 – 15 Mbps
3 users on 3 devices at a time	1 – 2Mbps	2 – 5 Mbps	15 Mbps or more
4 users or devices at a time	2 – 5 Mbps	6 – 15 Mbps	15 Mbps or more

[4] Pg. 4. *Four Years of Broadband Growth*, June 2013. The White House Office of Science and Technology Policy & The National Economic Council. http://www.fcc.gov/document/fcc-finds-us-broadband-deployment-not-keeping-pace

[5] FCC, Household Broadband Guide.

Download and upload speeds depend on the type of communications technology service providers utilize. There are a number of different technologies currently available to residential and business users, which offer varying bandwidth capabilities:

Technological Speed Capabilities

Technology	Download & Upload Speeds
Dial-up	Up to 56 Kbps
2G Mobile	Up to 100 Kbps
3G Mobile	384 Kbps – 2 Mbps
4G Mobile[6]	2 Mbps – 18 Mbps
Satellite[7]	200 Kbps – 2 Mbps
Standard DSL	768 Kbps – 15 Mbps
Traditional Cable	1 Mbps – 10 Mbps
DOCSIS 3.0 Cable	1 Mbps – 150 Mbps
Fixed Wireless[8]	1 Mbps – 1.5 Gbps
T-1	1.5 Mbps
Fiber Optic	Up to 1,000 Gbps. Effectively infinite

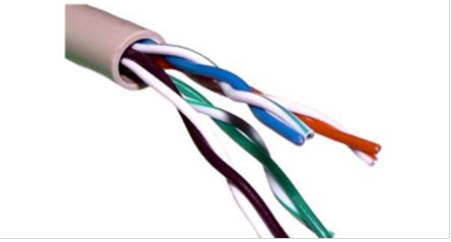
The speeds shown above are ranges for each technology. Variability in realized speeds is possible for certain technologies depending on network layout and user saturation. For example, if a user is located close to a network node, which houses the networking equipment that sends the network signal, and overall network use at that point in time is low, that user will obtain higher connection speeds. DSL subscribers commonly experience this phenomenon. If a DSL subscriber is located close to the service provider's remote terminals this subscriber can achieve download speeds as high as 15 Mbps.[9] However, as one moves farther away from the remote terminal, download and upload speeds decrease. Outside of one mile from a central office, it is very difficult to achieve a broadband connection over DSL.

[6] AT&T Wireless currently has the highest tested capacity at 18 Mbps.
[7] Current satellite service may achieve broadband level speeds, but the excessive latency or delay precludes the use of many broadband applications.
[8] The Rhode Island company Towerstream offers up to 1.5Gbps.
[9] Some DSL technologies, like VDSL, can achieve speeds of up to 50Mbps when the user is within 3,000 feet of a VDSL-enabled node.

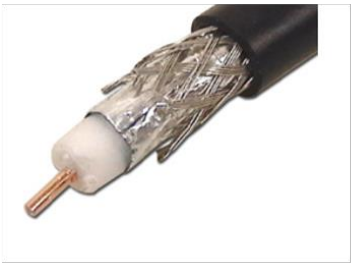
The following are the different broadband technologies and their speeds, for context on the connectivity possibilities available.

Different Broadband Technologies

DOCSIS3 Cable
1-150 Mbps



Standard DSL
.75-15 Mbps

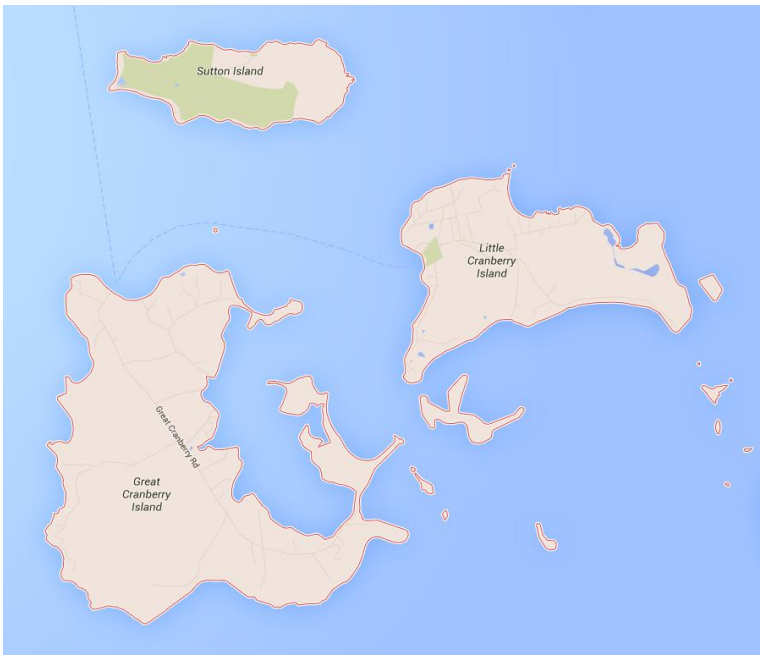


Wireless LTE
2-100 Mbps

Commercial Satellite
200Kbps – 2 Mbps

Fiber Optic Cable
Up to 1 Tbps

The Town of Cranberry Isles



Background

The Cranberry Isles are comprised of five islands in Down East Maine off the coast of Mount Desert Island. For the purpose of this study, this report will focus on Great Cranberry, Islesford (Little Cranberry), and Sutton Island. 2010 census figures put the total year-round population in the Cranberries at 141.[10]

Great Cranberry

Great Cranberry is an island just over 1,000 acres in size and is the largest island in the Town of Cranberry Isles. As of the 2010 U.S. Census, it had a year-round population of 47, which rises to approximately 250 residents in the summer.

Tilson visited Great Cranberry Island and met with residents and stakeholders to assess broadband service and goals and to conduct a survey of existing broadband assets on the island. Great Cranberry has a small amount of FairPoint fiber optics on the island via subsea cable following the main road through Town to the school and library as part of the Maine School and Library Network (MSLN) project. In addition, similar to Islesford, there is a legacy Redzone non-LTE node present at the town dock on Great Cranberry.

[10] U.S. Census Data, 2010.

Islesford (Little Cranberry)

Islesford is a 1,000 acre island which is part of the Town of Cranberry Isles. It has a year round population of 94 (2010 U.S. Census data), with a seasonal population that swells to 600 in the summer months.

In mid-July, Tilson visited the Town of Islesford on Little Cranberry Island and met with 15 Islesford residents and stakeholders at the Islesford Neighborhood House to gain a sense for the Town's goals with regard to broadband.

Sutton Island

Sutton Island is a small island that is part of the Town of Cranberry Isles. Tilson did not conduct a community visit to Sutton Island but received input from residents via communications as well as a broadband survey mailing. Sutton Island has 26 seasonal-only residents who rely on dial-up or legacy fixed wireless Internet connections currently. For Sutton, telephone, electricity, and wireless service are delivered from Northeast Harbor and Seal Harbor on Mount Desert Island. The power and telephone lines generally run along the two walking paths on the island as there are no roads on Sutton. The island is approximately 1.25 miles long and 1/3 of a mile wide. There are no commercial businesses on Sutton Island, but many telecommuters in the warmer months of May through October.

Asset Inventory

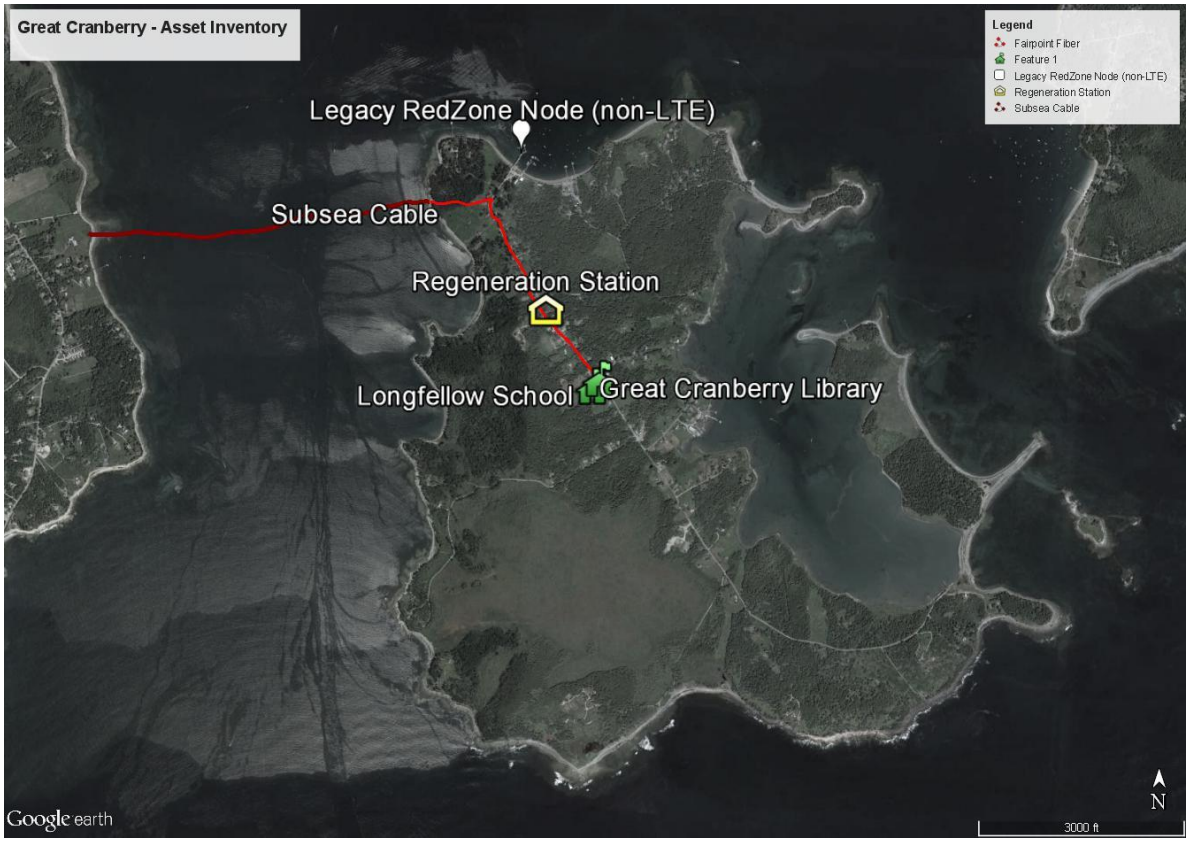
Great Cranberry

FairPoint has subsea fiber to the island feeding a remote terminal that supplies a DSL service with maximum speeds of 3/1 Mbps, thus falling short of both the ConnectME and the FCC standard. An inventory scan of existing the Island discovered subsea cable running to Great Cranberry, with fiber running along this along the main road to the library. Tilson believes that the premises and buildings along this fiber route however are still only served by DSL quality service, as the library is the only premise currently served by the fiber as part of the MSLN program. There is also a regeneration station next to the Cranberry House, but no cellular towers on the island. Tilson observed that the aerial copper cable on Great Cranberry is relatively new as well. As for existing wireless assets, the image below shows the non-LTE legacy Redzone node present in the Town Dock area.

Legacy Redzone non- LTE Infrastructure (Town Dock)

The following screenshot shows the broadband assets found on Great Cranberry. The subsea cable is in dark red, with fiber optical assets depicted in light red. The Redzone wireless node is depicted by the white placemark and the school and library are shown as well (green icons).

Great Cranberry Asset Inventory

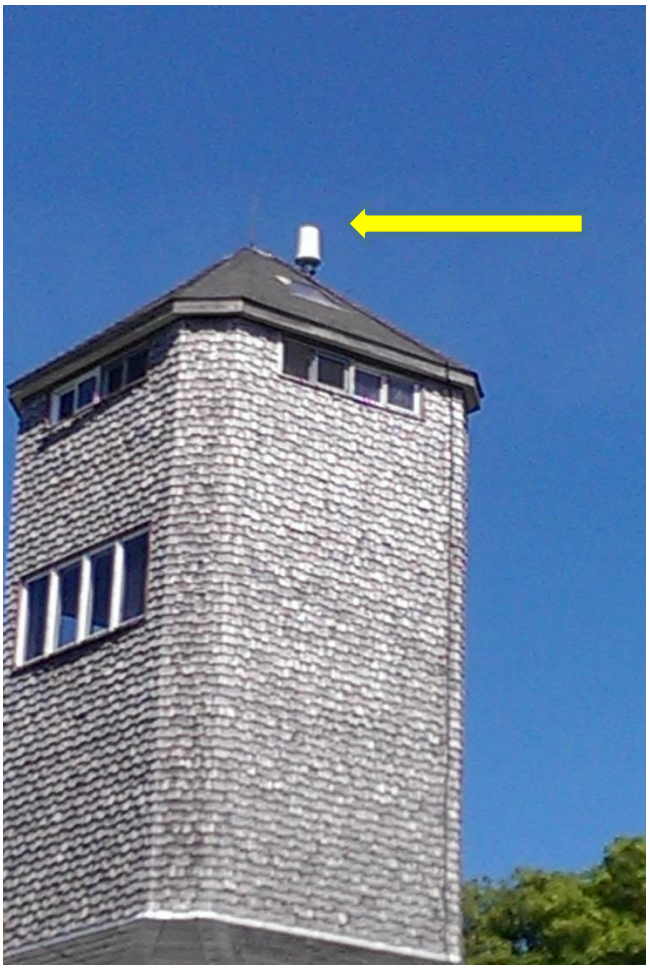


Islesford

Currently, Islesford has no fiber optic infrastructure and no Digital Subscriber Link (DSL) infrastructure and relies exclusively on wireless access from Redzone, a legacy non-LTE service which has been on the island for a number of years. Little Cranberry has a bigger year round population than Great Cranberry, but unlike Great Cranberry, it is not fiber-fed by FairPoint, and has no DSL service. Phone service on Little Cranberry is fed from a voice-only remote terminal, which connects to Great Cranberry via a submarine copper cable that has adequate capacity to service DSL. While the library and school on Islesford are connected to the MSLN network via T-1 (non-fiber) connections, the surrounding premises on Islesford do not have access to these T-1 speeds.

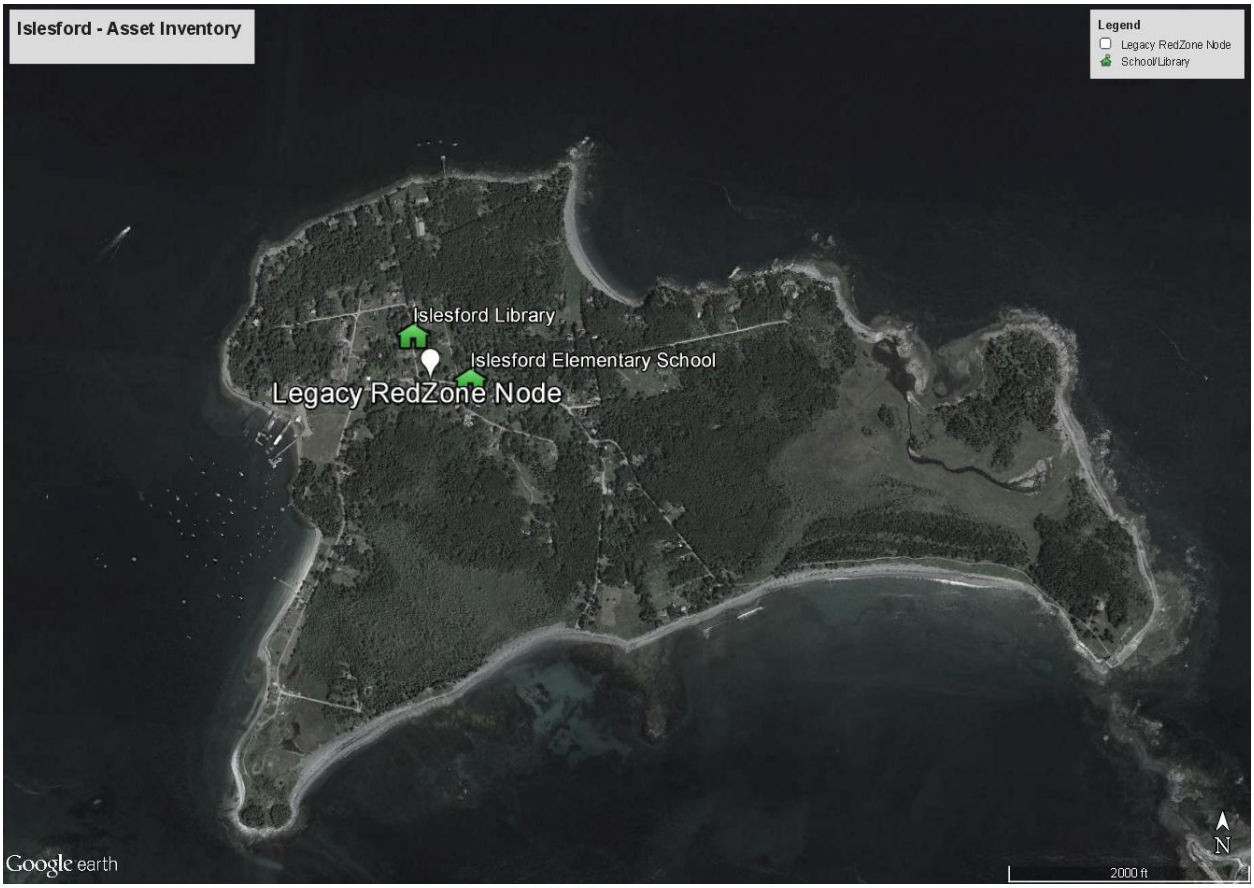
Tilson's inventory of the island showed a lack of any true broadband infrastructure currently. There is at least one legacy (non-LTE) Redzone Node on a residence at a high point near the center of the Island. (see below).

Legacy Redzone non- LTE Infrastructure



The following image shows an aerial view of the existing connectivity assets on Islesford. As is evident, there are currently neither fiber optic nor DSL assets on the island, and the only infrastructure currently in existence is at least one and possibly two (not located) wireless non-LTE Redzone nodes on island highpoint structures.

Islesford Asset Inventory



With no DSL on the island and only a legacy Redzone (non-LTE) solution not meeting the current ConnectME definition of broadband, all of Islesford is essentially a broadband gap. This fact, in combination with residents' expressed needs for improved connectivity for every resident and business on the island, presents a new Internet standard in Islesford. This standard calls for reliable connectivity that is not affected by weather or the summertime seasonal population swell and consequent saturation issues associated.

Sutton

Through information gathered from the meetings with residents on Great Cranberry and Islesford, Sutton's on-island copper infrastructure is of older quality, thus making a DSL solution problematic for this island. There are no broadband assets currently on Sutton. Sutton Island, like Little Cranberry, is not fiber-fed by FairPoint, and has no DSL service. (Per French Scott of FairPoint, Sutton residents qualify for low-speed DSL service and the island is served by Northeast Harbor.)

Current Service Offerings

Great Cranberry

The following table summarizes the various Internet, voice, video, and cellular service types, providers, and service notes related to resident experiences. As is evident from the chart, only the school has access to broadband; other locations have Internet access that falls short of that.

Type	Provider	Service Notes
Internet	DSL, FairPoint, Redzone	• Residents are supposed to get 3 Mbps but do not due to seasonal saturation (overutilization). • Reliability complaints
Voice	FairPoint	• Customer Service issues
Video	Dish/DirectTV	• Dish is not reliable; DirectTV is great service
Cellular	Verizon, ATT, Cellular	• Residents stated that overall, cell coverage is poor to non-existent, particularly in winter

Public Broadband Service – Great Cranberry

Type	Provider, Service	Service Notes
Library/School	MSLN (fiber)	Well-Served (fiber); Speed Test.net: 87.18 Mbps down and 93.83 upload.
Public WiFi		Library and Cranberry House currently have it

Current Service Offerings - Islesford

Type	Provider	Service Notes
Internet	Redzone (legacy non-LTE)	• Hot spot reception comes from Great Cranberry. • Residence (tower) on Islesford has Redzone node • No DSL in Islesford
Voice	FairPoint, Verizon (homeconnect), Redzone	• Residents dissatisfied with both FairPoint and Redzone service; generally happy with Verizon Homeconnect.
Video	Dish/DirectTV	• Residents reported that quality is generally good, but that bad weather affects it.
Cellular	Verizon, ATT, Cellular	• All were described by residents as bad quality

Public Internet Service

The following table shows the current service available through the Maine School and Library Network (MSLN) program on Islesford, which is said to offer speeds meeting the State's definition of "broadband" at 10 Mbps for both download and upload ("symmetrical") speeds. Tilson conducted a speed test (via Speedtest.net) at the Islesford Library. The speed test was performed on a dedicated T1 line and the speeds were found to be 2.8 Mbps symmetrical. In contrast to the broadband speeds found at Great Cranberry's library, these speeds on Islesford fall short of the FCC and ConnectME Authority definition of "broadband."

Public Internet Service - Islesford

Type	Provider, Service	Service Notes
Library	FairPoint MSLN, T1 5 Mbps Ethernet bandwidth	• Speedtest 2.8 Mbps symmetrical • Library and School share dedicated T1 line
School	FairPoint MSLN, T1 5 Mbps Ethernet bandwidth	• Shared T1 line with library, so probably similar speeds

Sutton

Sutton residents currently have Redzone's legacy non-LTE service for Internet, and AT&T and Verizon for cell phone service. Wireline voice is supplied by FairPoint via sub-sea copper cable from Northeast Harbor. Each of these were described as not meeting residents' needs and fail to meet the state and federal definition of broadband. Currently, there is no public Wi-Fi service on Sutton Island.

Community Goals

Great Cranberry

The group of Great Cranberry residents present Tilson's on-island meeting agreed that current Internet service on the island suffered from significantly decreased reliability, particularly in the summertime, due to the influx of seasonal residents and island visitors. Because of this—as with Islesford—the primary goal for residents is an Internet service that is reliable at all times of the year, and one that is additionally scalable so as to allow more than one device per household not to choke home connectivity. This connectivity issue was viewed as a problem for achieving the community goals of increasing both year-round residents and the seasonal visitors as well, both on Great Cranberry as well as nearby Sutton Island. 10 Mbps was stated as a minimum speed that would satisfy most residents in the near-term. Currently, residents of Great Cranberry are getting "nominal" 3Mbps DSL service. In terms of off-island needs, residents expressed that they tend to leave Great Cranberry on average about once a week for grocery shopping and cultural escapes. That being said, online retail shopping has enabled residents to minimize the need to leave the island, and this is something that residents expressed a desire to do more of in the future.

While the school and library are well served, the residents of Great Cranberry are unsatisfied with their current FairPoint DSL service. Nominally, this service is expected to provide download speeds of 3 Mbps, but residents are experiencing speeds of 2.5 Mbps at best, and significantly slower during peak usage and seasonal population spikes in the summer months. In addition, as with many island communities surveyed as part of this project, residents of Great Cranberry are seeking broadband that is reliable consistent, while also being scalable (i.e. able to handle multiple devices per household). Once again, the preferred minimum speeds of the broadband solution should be in the realm of 10 Mbps.

Islesford

The primary connectivity problem cited by those on Islesford was the current lack of reliability of Internet in the area. The group expressed a desire for a more reliable solution with the goals of serving current businesses and attracting new small business to the island as well as the need for more robust broadband to serve residents' video streaming needs. Currently, residents' ability to stream video through the Internet is slow and intermittent on Islesford. Compounding Islesford's reliability problem is the limited nature of cellular service on the Island, thus necessitating that the Internet be more robust. Just as on nearby Great Cranberry Island, Islesford residents do a great deal of Internet shopping to minimize off-island trips. In addition, residents were hopeful that improved broadband could reduce the need to do banking off-island.

As an alternative to the legacy Redzone service, some people on the island, in particular the Islesford Dock Restaurant, have resorted to using a portable AT&T LTE hotspot for their business connectivity, however, even this is limited in certain geographical locations on-island. The few residents who use such hotspots are able to achieve 20-30 megabits per second (Mbps) download speeds. For an Islesford business owner utilizing this AT&T hotspot, the primary use for this connectivity is primarily for bill paying as this business's credit card system operates through the phone line.

With no DSL on the island and only a legacy Redzone (non-LTE) solution not meeting the current FCC or ConnectME definition of broadband, all of Islesford is essentially a broadband gap. This, along with residents' expressed needs for improved connectivity presents a new connectivity standard in Islesford. This standard calls for reliable connectivity that is not affected by weather or the summertime seasonal population swell and consequent saturation issues associated with this.

In order to meet Islesford's community's business goals, a broadband solution providing at least a 10 Mbps connection will be necessary. Islesford residents are seeking a solution that will be reliable, immune to weather variation, and can scale to meet the summer influx of island users.

Sutton

Sutton Island is currently served by Redzone. In communications with Tilson, residents from Sutton Island emphasized the desire to telecommute and have better access to digital media and entertainment as community broadband goals, and most agreed that the outer ring of premises was the primary need as opposed to the heavily wooded center of the island. In terms of areas that are comparatively better served, the Town Dock area typically has better connectivity than the east end of the island. In terms of off-island needs, residents go off island to visit the library and to get their mail, as well as for food needs. The search for a better Internet connection was expressed by residents as part of the reason for these off-island trips as well. Sutton's population is comprised of a high percentage of individuals active in many diverse industries/occupations such as film, finance, law, business, philanthropy, and medicine. For these residents, the need for telecommuting is vitally important.

For Sutton residents, the expressed goals of residents are that a broadband solution could enable them to live on Sutton year-round, and the lack thereof is a significant factor that continues to prevent these residents from doing so.

Sutton residents are looking for a broadband solution to enable telecommuting work, to minimize trips off island in search of better connectivity, and to provide them the option to live year round on the island. As such, any solution for Sutton Island residents should also provide a minimum of 10 mbps connectivity speeds.

Community Priority Buildings/Businesses

Great Cranberry

Residents described the Library and the School as well served through the Maine Schools and Library Network (MSLN). A speed test conducted by Tilson at the Library indeed revealed speeds of 87.18 Mbps down and 93.83 upload. As for buildings and businesses which Town stakeholders would like to see served by an investment in broadband, these are:

- The two local boatyards
- The Post Office
- Summer Contractors
- Transcription Services
- Graphic Arts
- The Community Center
- The Town Store/Restaurant (currently served by Redzone, but they have reported issues with their service—consistency problems)
- The Cafe
- The Cranberry House
- Several businesses located near the Town dock

Islesford

Residents of Islesford would like improved connectivity for all 150 Island residences, but also cited a number of Town buildings/areas in particular, including the Dock Area, the Islesford Dock Restaurant, and the Neighborhood House as areas where improved broadband was most needed. In addition, the following businesses were mentioned by those present as businesses, areas, and entities that could best be served by improved broadband:

- The Fisheries Co-op
- Local photographers
- Graphic Design business
- Bed and breakfasts
- Jewelry Business
- Lobster Shipping
- Gift Shops
- The Art Gallery
- Pottery business

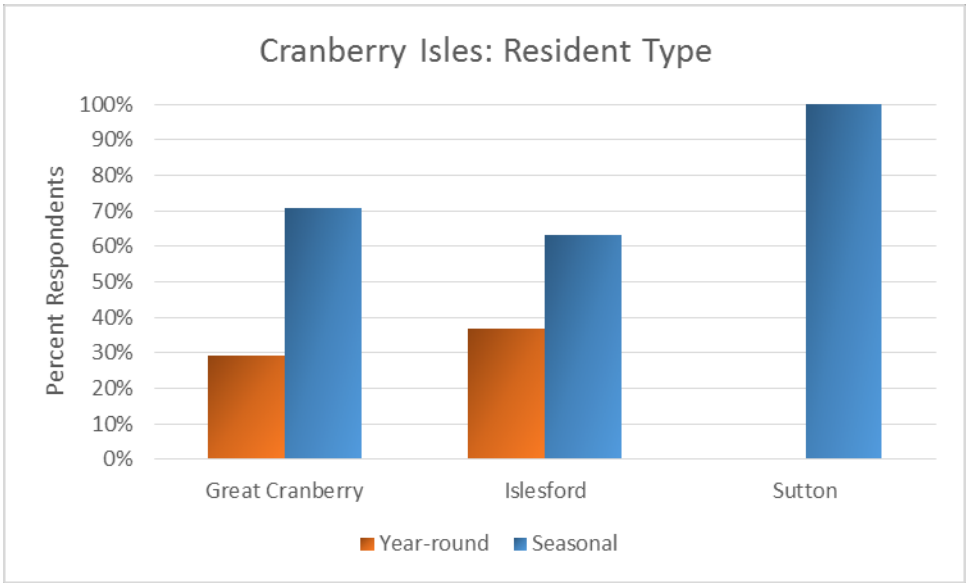
Sutton

For Sutton residents, the primary goal is improving existing connectivity for all 26 residences on the Island. In terms of common areas that might be served by a free WiFi solution on Sutton, the following were noted as possible areas where it could be useful:

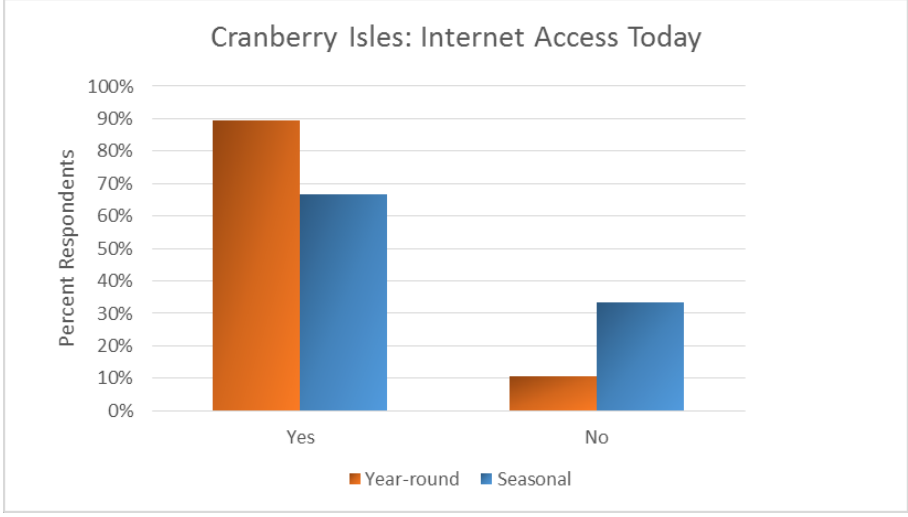
- The Schoolhouse
- The Town Dock Area
- Mid-Island near Rogers Dock

Survey Results – The Town of Cranberry Isles

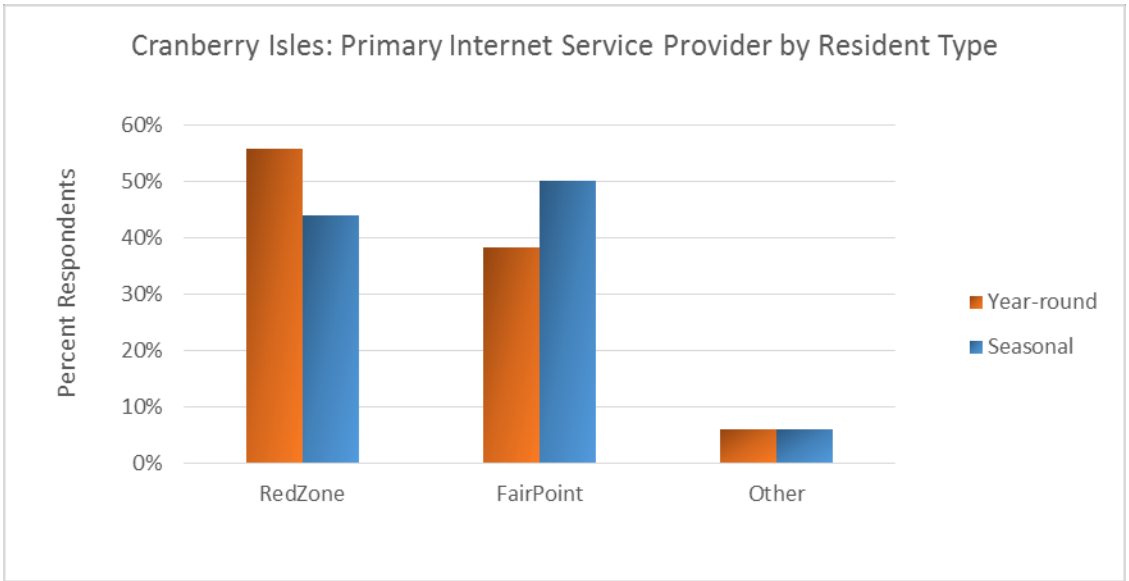
Tilson conducted a randomized survey of a subset of the 386 property owners on the Cranberry Isles (consisting of Great Cranberry, Islesford, and Sutton Island). Of the 281 surveys sent out, 115 total respondents from the three islands surveyed completed and returned the survey. Of this number, 77 respondents (67%) were seasonal residents of the Isles, and 38 (33%) were year-round residents.



89% of year-round and 67% of seasonal respondents to the survey indicated that they currently had internet service, as shown by the following chart.



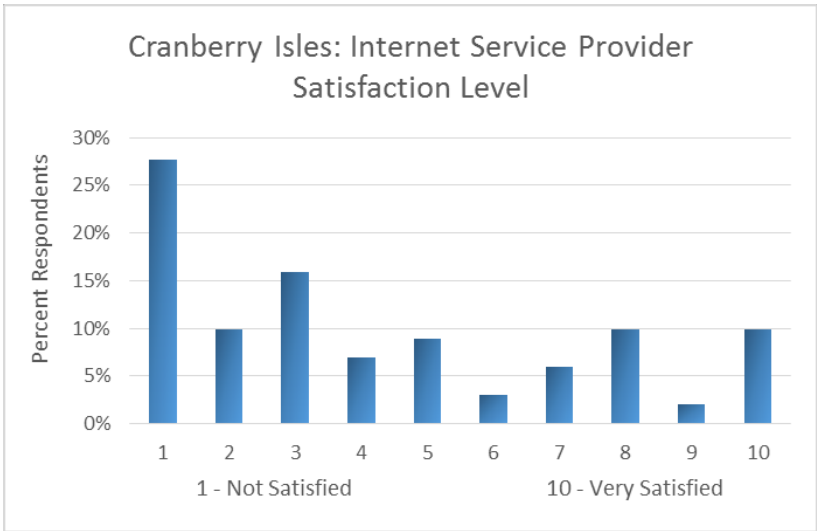
For this group of respondents with Internet access, Redzone (using Redzone's legacy wireless technology) was the primary ISP with 41 respondents (49%); FairPoint with 38 respondents (45%), with the remaining five respondents (6%) indicating that they had a different provider.



In terms of satisfaction level towards the ISP, on a scale of 1 to 10, 61respondents (61%) indicated dissatisfaction (a score between 1 and 4) with their ISP, with 31 respondents (31%) indicating that they were satisfied with their current ISP. The remaining 9 respondents indicated that they were neither satisfied nor dissatisfied.

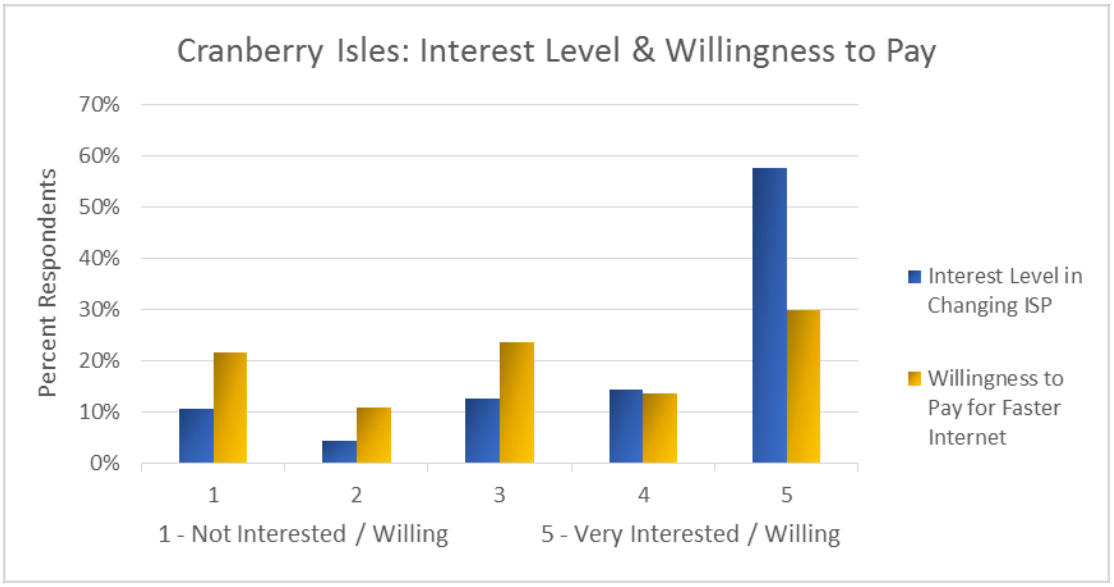
According to the Institute for Customer Service, customers that rate a service provider at less than eight are often willing to switch if an alternate offering is available.[11] For the Cranberry Isles as a whole, seventy-nine percent (79%) of respondents were in this category, scoring their provider between 1 and 7.

[11] Institute of Customer Service. *UK Customer Satisfaction Index.* July 2015.

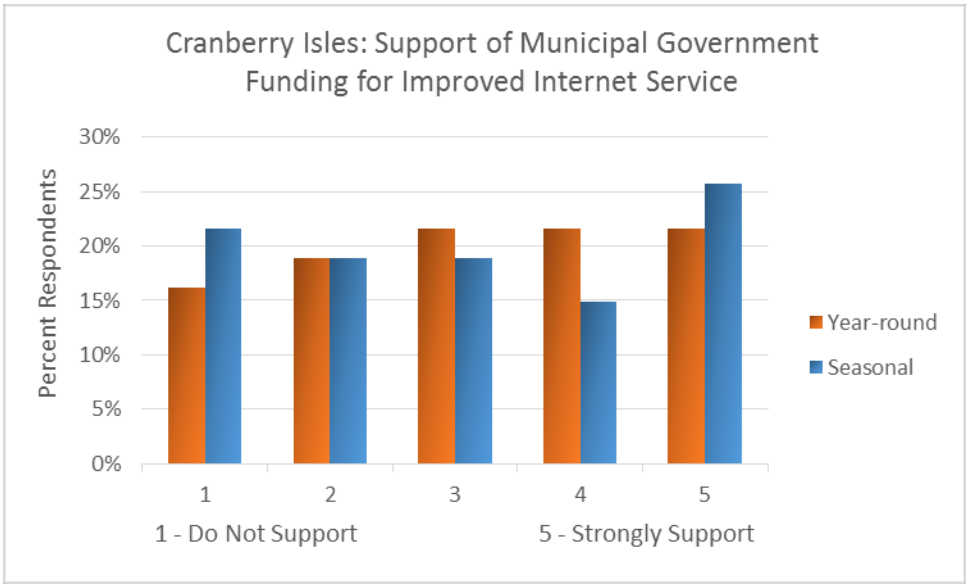


The survey also attempted to gauge islanders' attitudes toward change. A significant majority (72%) of survey respondents from the three islands indicated that they would be willing to switch ISPs if it meant being able to have faster connectivity with only 16% indicating that they would not be willing to switch.

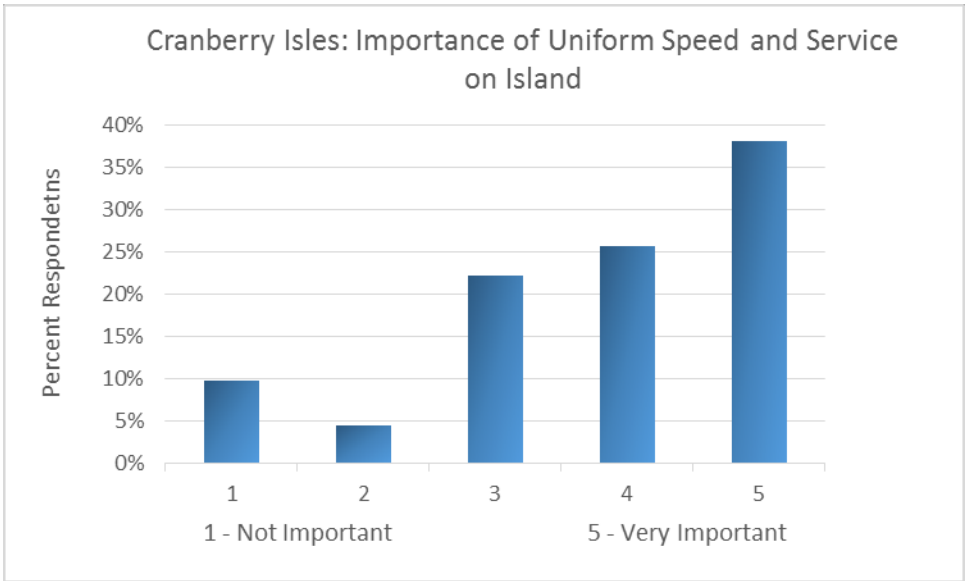
Despite the clear interest in better service indicated (nearly two-thirds of respondents), a significantly lower percentage of (44%) of this same group of respondents from the three islands indicated that they would be willing to pay more money to obtain that service, with a sizable contingent (33%) being unwilling to do so, and about a quarter of respondents not sure one way or the other. These two metrics—interest and willingness to pay—can be compared side-by-side in the following graph. It should be noted that while the willingness to pay results emphasize the importance of a cost effective solution, the survey did not collect information regarding the current Internet costs being paid by respondents.



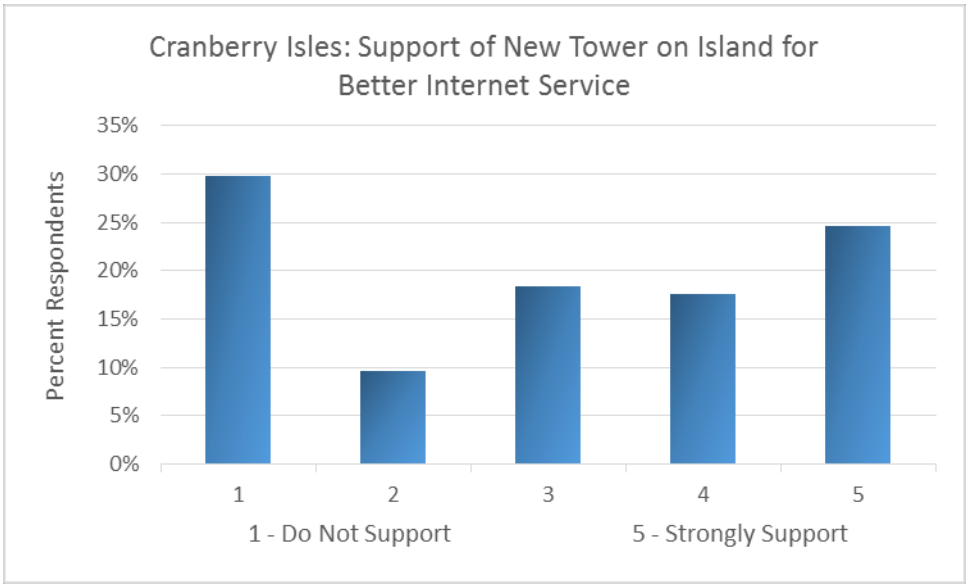
In terms of Cranberry Isles respondents' support for municipal government funding an improvement of internet service on the island, the results were fairly evenly divided, with an average of about 42% of respondents indicating that they would either support or strongly support their municipal government funding an improvement in broadband, and an average of 38% (seasonal and year-round) respondents who would not support this. The remaining 20% of respondents did not indicate a strong preference in either direction.



As for uniformity of a connectivity solution and the importance of everyone on the islands having access to the same level of internet speed and service, most respondents (64%) agreed that this was very important to them, with only 14% of respondents indicating otherwise.



Finally, residents of the Cranberry Isles were asked their opinion of how they would feel about a new telecommunications tower being built on the island so as to enable better internet service. While a sizable contingent, 45 respondents (40%) would not support this at all, 48 respondents (43%) indicated that they would. The remaining respondents were ambivalent on the question.



Possible Solutions

Tilson examined two options for The Town of Cranberry Isles to consider: improving existing DSL service;[12] and a fiber to the premise (FTTP) network, which would meet and possibly exceed the community's short term needs. Taking no action to address the lack of broadband is also an option, however it would prevent the town from achieving its stated goals for telecommuting, enabling business, supporting education, entertainment, and the ability to maximize time on the islands while minimizing off-island trips.

Fiber Network Design – Cranberry Isles

A fiber to the premise (FTTP) network is the gold standard in municipal network design: it is the most upgradeable, the least expensive to operate on a whole-island basis, the fastest, the most reliable, but also the most expensive to build. Because an FTTP network is so reliable, it requires less customer support and is less expensive to operate than DSL, hybrid fiber/coax, or wireless networks. The largest operating disadvantage to fiber is that if it is cut, it requires a technician skilled in fiber repair (and typically a bucket truck) to fix. Fiber networks can be configured to provide 1 Gigabit (Gbps) speed upload and download—100 times faster than the current ConnectME standard.

Tilson designed a FTTP solution that would pass and connect to all premises on the three islands. Fiber counts were specified for each segment to optimize for current building distribution, and with future growth in mind. Tilson designed multi-port service terminals (MST's) throughout the network to enable easy and short interconnections with existing and future premises.

To complete the local access portion of this network, electronics are needed at the customer premise and at the traffic collection node, or end. In addition, an ISP would need to place its own electronics and microwave backhaul to the mainland. There are various operating models whereby these network elements could be owned and operated either by the town, a network operator, or the ISP. [13]

[12] This option may meet the needs of the community in the near term, but does not meet the ConnectME or FCC definition of broadband.

[13] Tilson will describe municipal models that include ownership of a greater proportion on the infrastructure in the business model section.

Great Cranberry

The following is Tilson's fiber design for Great Cranberry, consisting of three different strand counts: 6-count (blue); 24-count (red); and 48-count (pink).

Fiber Network Design – Great Cranberry

Islesford

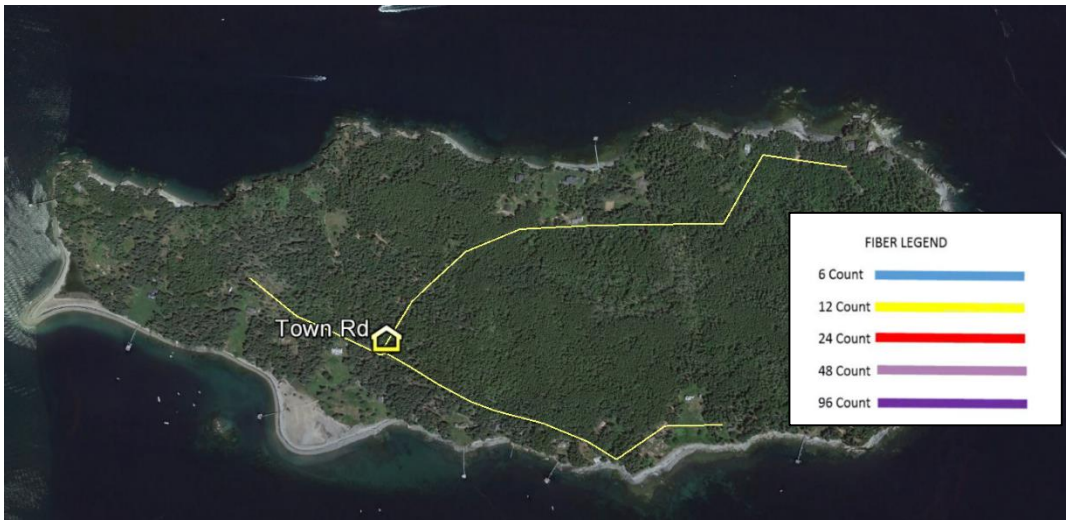
The following image shows the fiber optical network design for the Town of Islesford. The different colors represent different strand counts of fiber: 6 (blue), 12 (yellow), 24 (red), and 48 (pink).

Fiber Design - Islesford

Sutton Island

The following image depicts the fiber to the premise design for the residences on Sutton Island.

Fiber Design - Sutton



Fiber Capital Cost Estimate

Tilson's detailed cost estimate included all of the design, application, materials and labor costs associated with the fiber to the curb network. For all of the islands, Tilson assumed that 90% of the route miles were aerial, and 10% were underground. The estimate also assumes that all of the fiber drops would be built at once, rather than on-demand. An island premium of 10% on materials, and 20% on labor was added onto all of Tilson's standard estimates, and is reflected in the numbers below.

Fiber Capital Cost Estimate – Great Cranberry

Project Miles		5.8
Aerial Miles		5.2
Poles		167
Premise Count		135
Application and Make Ready	$	47,314
Materials	$	78,745
Labor	$	222,153
Engineering	$	14,810
Margin/Profit (20%)	$	72,604
Service Provider Tax (6% Labor and Engineering)	$	18,574
Sales Tax (5.5% Materials)	$	4,331
Total	$	454,201
Per Premise Cost	$	3,364

Fiber Capital Cost Estimate – Islesford

Project Miles		3.6
Aerial Miles		3.2
Poles		103
Premise Count		139
Application and Make Ready	$	30,073
Materials	$	59,208
Labor	$	173,730
Engineering	$	11,582
Margin/Profit (20%)	$	54,919
Service Provider Tax (6% Labor and Engineering)	$	14,414
Sales Tax (5.5% Materials)	$	3,256
Total	$	343,925
Per Premise Cost	$	2,474

Fiber Capital Cost Estimate – Sutton

Poles		39
Premise Count		22
Application and Make Ready	$	10,868
Materials	$	15,211
Labor	$	58,810
Engineering	$	3,921
Margin/Profit (20%)	$	17,762
Service Provider Tax (6% Labor and Engineering)	$	4,830
Sales Tax (5.5% Materials)	$	837
Total	$	112,237
Per Premise Cost	$	5,102

The incremental capital cost of building out the networks, which would be borne by either the ISP, the municipality, or a network operator—depending on the business model—are not included above.

To complete the local access portion of this network, electronics would be required at the customer premise and the traffic collection node, or head end. These electronics cost about $570 per premise. In addition, an ISP would need to deploy network electronics, which are customarily paid for by the ISP, even though they may be housed in a municipal building.

The electronics described above would need to be housed in a space with redundant power, heating and sufficient heat dissipation ("conditioned space"). That conditioned space could be provided by a stand-alone shelter for about $250,000, or a municipality could provide it in one of its buildings to deliver substantial cost savings.

If the network were to be connected to the mainland via microwave, the capital cost estimate for two microwave dishes and one new small tower on the island (this assumes the mainland microwave dish is mounted on an existing tower), would be $45,000. While a microwave link will be necessary for every island without a subsea fiber cable, there are opportunities for islands collaborate to either save money in operating the link and/or increasing the redundancy and reliability of the links. These options are highlighted in the "Opportunities for Regional Cost Savings" section near the end of this report.

ILEC Network Improvements

ILEC network improvements to the DSL infrastructure are the least expensive way to improve Internet service on the islands, but will not achieve speeds that meet the FCC or Connect ME definition of broadband. DSL improvements take two forms: existing DSL nodes can be upgraded to have faster maximum speeds, and/or DSL nodes can be added. As with all DSL, users closest to the nodes have access to the highest speeds. Users greater than four route miles from the node have no access. The more DSL nodes, the greater the proportion of islanders with access to the highest speeds.[14]

[14] See the "Service Offering Review by Provider" section at the end of this report for known speeds and pricing.

Great Cranberry

Practical solutions to improve FairPoint service include upgrading the existing remote terminal to speeds of up to 15/1 Mbps. Additional remote terminals could be added and connected via fiber. The additional remote terminals would shorten the distance of the copper wire between users and fiber-fed DSL terminals. Shorter copper wire distances increase the proportion of homes with access to the fastest speed tiers, and—with short enough loop lengths—could enable a bonded DSL configuration with speeds up to 50/2 Mbps.

Islesford

Practical solutions to improve FairPoint service start with creating adequate capacity between Little and Great Cranberry to feed DSL service on Little Cranberry. This would be done by either a microwave connection (which FairPoint uses on other islands, such as Vinalhaven) or subsea fiber optic cable. With this capacity in place, FairPoint could add equipment to DSL-enable its remote terminal. A practical "starter" DSL remote terminal would be one offering speeds of up to 15/1 Mbps. Increasing the density of remote terminals on the island would increase the uniformity of coverage and enable DSL configurations with higher speeds.

Sutton

Sutton Island's potential ILEC solution would essentially mirror that of Islesford's.

ILEC Improvements – Cost Estimate

The costs for adding remote terminals vary widely, and are determined by the ILEC. The ILEC's costs are a function of whether additional microwave backhaul capacity is needed, how much fiber needs to be run to reach the remote terminal, and how much rewiring of copper cables is necessary. On the mainland, the costs for adding a remote terminal are typically less than $100,000. Tilson estimates that a private provider might charge $30,000 for upgrading an existing microwave link, $45,000 for installing a new microwave link and one tower. However, it is likely that an ILEC might spend (and charge) more money putting up a microwave link than an alternate provider would due to company technology and process specifications and labor restrictions.

Funding

The FCC's Connect America Fund (CAF II) program is funded by the Federal Universal Service Charge on phone bills, and in Maine, that money is redistributed through the ILECs to broaden coverage of at least 10 Mbps download speeds. Eligible communities are outlined on the FCC's CAF II maps.[15] Not all eligible communities will necessarily receive improved service through this program due to limited funding. FairPoint is in the process of determining which municipalities will yield the greatest return on their CAF II subsidized investment.

[15] https://www.fcc.gov/maps/fcc-connect-america-fund-phase-ii-initial-eligible-areas-map

In the Cranberry Isles, Great Cranberry and Islesford are eligible for CAF II subsidy. Sutton Island does not qualify.

Independently of the CAF II possibility, those present at the Great Cranberry meeting expressed that the Town itself might have the ability and willingness to fund a solution and that there is precedent for fundraising through the local Futures Group. These residents mentioned that they had approached Redzone in the past but the provider up to this point has not been receptive to working with the Town.

Vinalhaven

Background

The largest island in Penobscot Bay both geographically and in terms of population size, Vinalhaven has a year-round population of over 1,100 residents (2010 U.S. Census data) with nearly double this population (2,200) in the summer months. The more recent informal survey conducted by the Island Institute put the number of year-round island residents at 1,514 earlier this year.[16]

Current Infrastructure/Asset Inventory

Vinalhaven has three Internet service providers selling service on the island: GWI, Time Warner Cable, and FairPoint. Almost all of the homes and businesses on Vinalhaven have access to FairPoint's DSL service. According to FairPoint, 68% of the locations have access to speeds of 10 Mbps or greater and 96% have access to speeds of at least 3 Mbps. Over 40% have access to speeds of 20 Mbps or more. FairPoint achieves this coverage with three remote terminals.

FairPoint offers universal DSL service throughout the Island. Despite this seemingly comprehensive footprint, customers at Tilson's onsite community meeting on Vinalhaven complained of overcongestion during the summer months. The FairPoint central office is located near the town center at Lawson's

[16] Island Institute Informal Survey, Spring 2015.

Quarry. Many of the premises on the island lie farther than two miles from the central office, where DSL signal starts to degrade rapidly. FairPoint backhauls with 100Mbps microwave.

Time Warner Cable offers cable service a limited number of premises in the southern part of the island. TWC connects to the Internet via a fiber optic cable that runs the length of the island from Carvers Harbor to the thoroughfare, where it runs underwater to North Haven and ultimately over the submarine power transmission cable across Penobscot Bay. This cable has sufficient spare fiber capacity to support a new broadband investment.

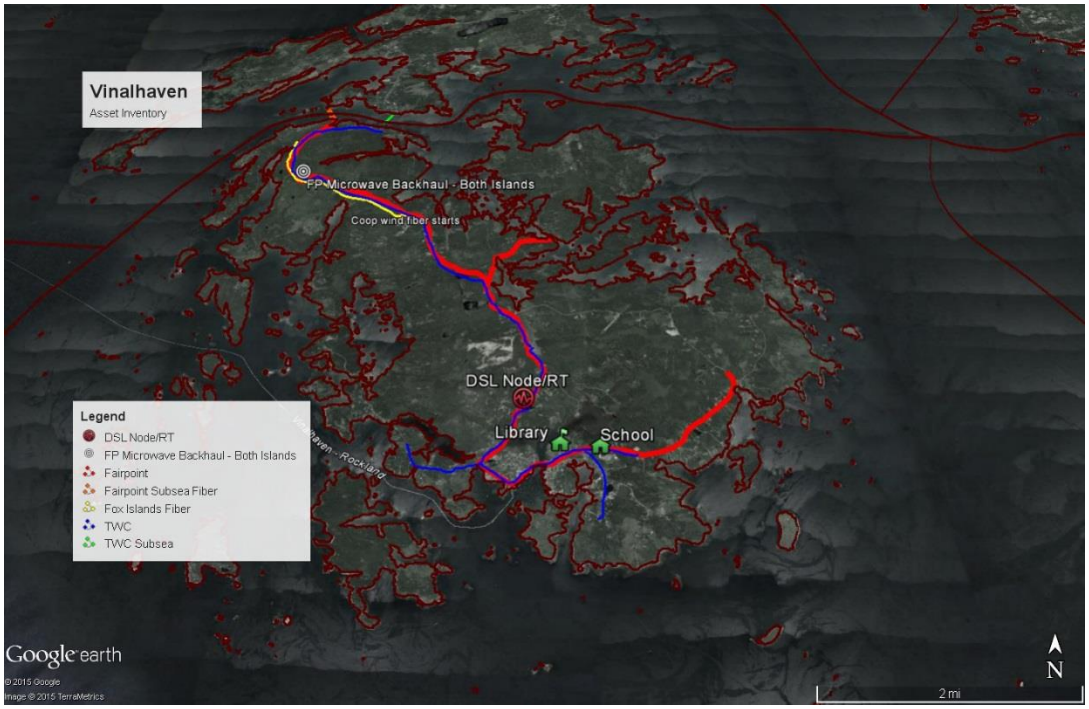
GWI provides fixed wireless service on the island. GWI transmits from the water tower on North Haven to premises on the Vinalhaven side of the thoroughfare. The service is present but few premises subscribe.

An electric cooperative provides electrical service to both islands. This Co-op, the Fox Islands Electric Co-op, owns the transmission cable to the mainland, which has several strands of dark fiber available for lease.

Vinalhaven also has a cell tower near the center of the island. AT&T currently provides 4G cellular service off of the tower. However, the signal does not reach many parts of the island due to terrain and tree cover.

The following image shows inventory of existing assets on Vinalhaven.

Asset Inventory -Vinalhaven



Current Service Offerings

The following table summarizes the various Internet, voice, video, and cellular service types, providers, and service notes related to resident experiences on Vinalhaven. Only the school and library have access to both the ConnectME and the FCC definition of broadband; premises with access to TWC can subscribe to speeds meeting the FCC's broadband definition.

Type	Provider	Service Notes
Internet	Time Warner Cable, FairPoint GWI	• Standard residential and business services from FP and TWC
Voice	FairPoint GWI	• Varies throughout the year
Video	Dish DirectTV TWC	• Residents reported service ranging from "good" to "very good"
Cellular	AT&T Verizon U.S. Cellular	• Residents reported service ranging from "strong" to "very weak"
Public Wi-Fi	Library Town Office	• Residents reported "very strong" service

Public Internet Service - Vinalhaven

Type	Provider, Service	Service Notes
The Vinalhaven School	Fiber Optic from MSLN 100/100 Mbps FairPoint Ethernet	• Current service through MSLN meets streaming and videoconferencing needs
Vinalhaven Public Library	Fiber Optic from MSLN 100/100 Mbps TWC Ethernet	• Currently sufficient to meet streaming and video conferencing needs
Town Hall		• Streaming/videoconference needs
Public Safety (Fire/Police)	FairPoint DSL	• Interest in upgrading current service to 4G LTE and optical service
Doctor's Offices		• The medical center is well served

Stakeholders' Stated Community Goals

Among the foremost goals of Vinalhaven stakeholders is economic development for the island. The community views an improvement in connectivity for Vinalhaven as something which will enable it to attract small, high-bandwidth using businesses with sufficient infrastructure.

In addition, the community has objectives for empowering existing small businesses, and they view an Internet improvement as similarly instrumental to these types of entities, specifically in that residents believe that this infrastructure will help these small businesses be more efficient with current operations as well as thrive in the future.

The empowerment of telework and telecommuting on the island is another area of emphasis for Vinalhaven as the town wishes to give seasonal residents the ability to work on Vinalhaven remotely.

In terms of education for Island students, the goal for the community is less about improving existing connectivity in the schools, but more about improving student connectivity when students leave the school. The Vinalhaven schools currently have excellent connectivity through the Maine Schools and Libraries network program, but the island wishes to ensure that students have the same connectivity at home.

Reliability of service is another stated goal of the Vinalhaven community. Residents described predictable variability in performance of different service packages. They reported that FairPoint DSL meets needs during off seasons but that it fails to perform the same tasks during the summer months. This suggests oversubscription and saturation with the summertime doubling of people on the island. Residents are seeking a connectivity solution that is able to handle the summertime surge in island population and still be reliable service, while also achieving faster speeds in general.

Finally, residents stated that they are interested in improved cellular coverage on Vinalhaven. Current service is comprised of AT&T and very limited Verizon coverage. Islanders want to expand existing coverage and to bring more carriers to the island as well.

Community Priority Buildings/Businesses

Those present at the stakeholder meeting stated that in terms of where improved connectivity was most needed, the priority should be to serve the areas of the Town that only have weak DSL due to their distance from the central office. In addition, the community expressed the need for improved cellular coverage as well as improved infrastructure for businesses in the downtown area.

Many of the businesses on the island would benefit from improved connectivity. These include:

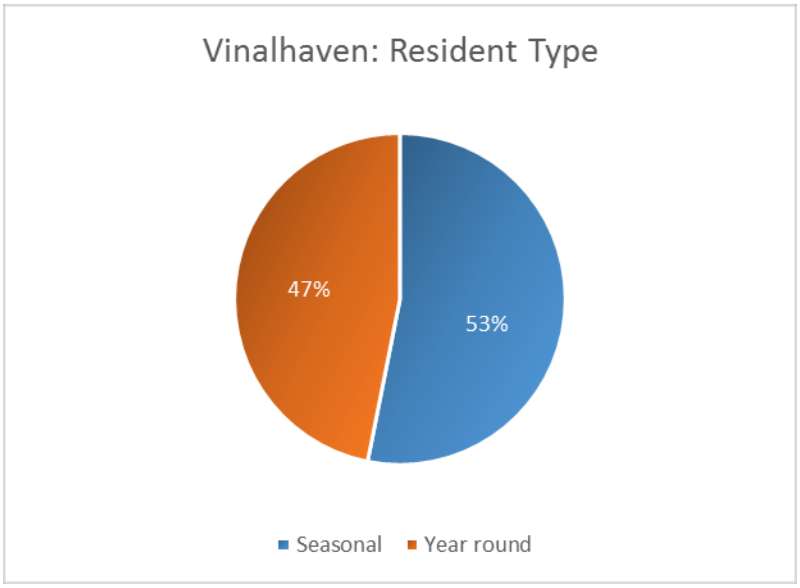
- Teleworkers and telecommuters – For these, the stated goals are reliable mid-single digit to low double-digit Mbps home connections. Current service is Time Warner Cable and frequently congested FairPoint DSL. This contingent is seeking improved reliability and uncongested lines.
- WiFi at the ferry terminal
- WiFi on the ferry

- WiFi in the public park
- Fire Station
- Downtown businesses – For this group, the needs expressed are cellular service or Wi-Fi for purposes of using Square or other similar type payment processors. Current service in this regard is extremely limited, with the service goal being improved cellular or Wi-Fi services. For high bandwidth using businesses, these entities are seeking double to triple digit Mbps symmetrical service. Their current service is Time Warner Cable Business Class and their goals are a fiber optic solution.
- Home internet for school age children – For Vinalhaven residents, the needs expressed were to have reliable DOCSIS 3.0 equivalent speeds as current DSL is unreliable and DOCSIS 3.0 speeds equally unreliable.
- Unserved areas
- Calderwood Neck
- The center of the island
- Thoroughfare
- Granite Island
- Coombs Neck Rd.

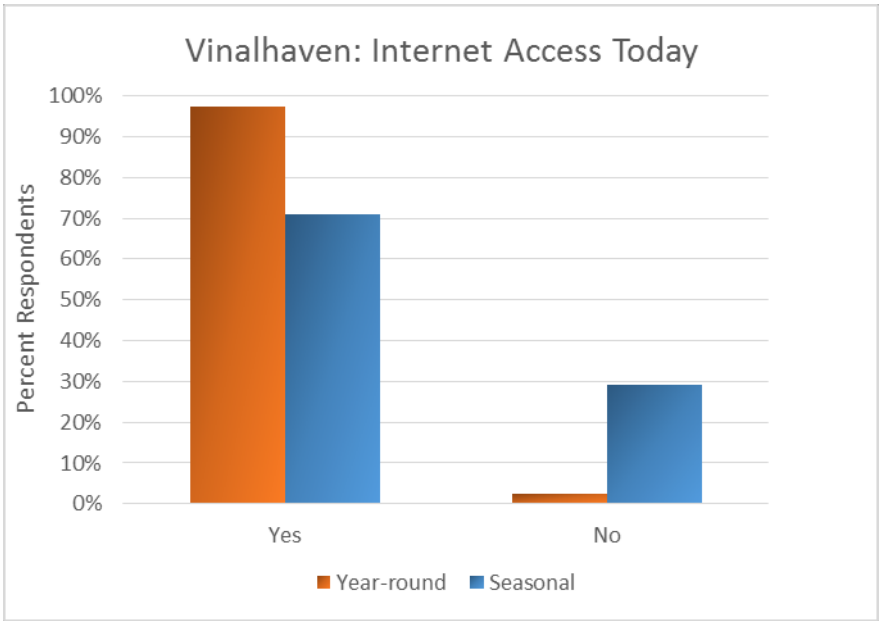
Survey Results

Tilson surveyed a random subset (506 out of 955) property owners on Vinalhaven Island to gather information regarding current levels of internet and cellular service, satisfaction, and interest in funding improvements to those levels.

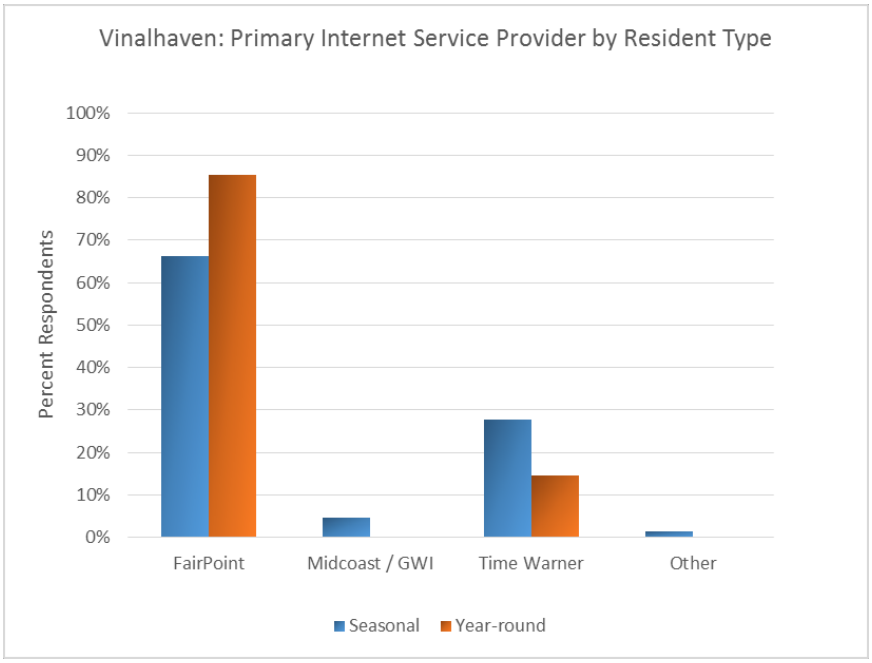
175 respondents (35%) provided information. These represented a fairly even split of seasonal (53%) and year-round (47%) residents.



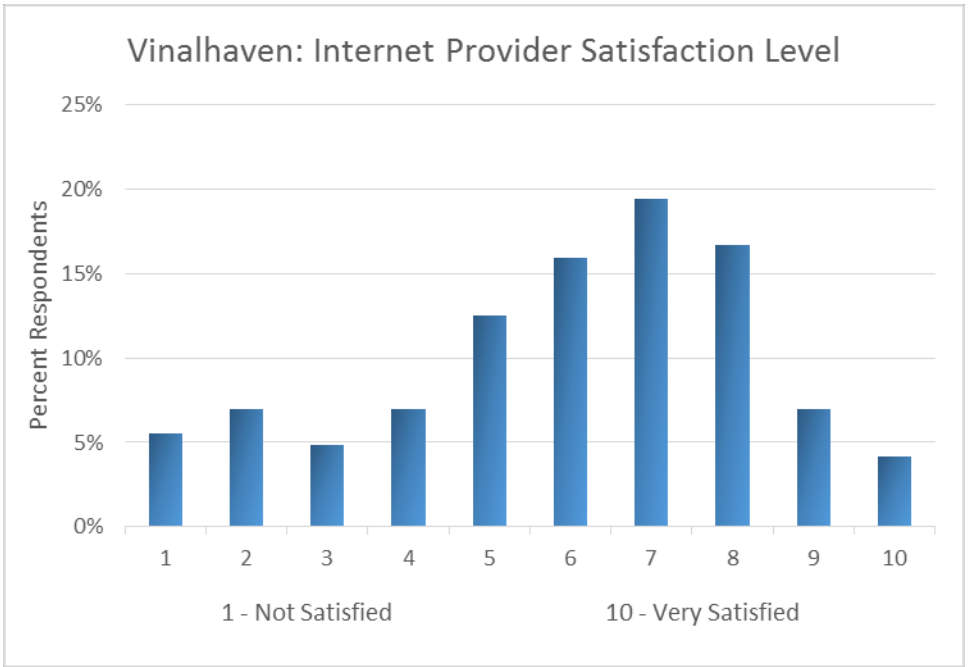
Of this group, 98% of year-round residents who responded to the survey have internet access today, as compared with 71% of seasonal survey respondents.



The following chart illustrates the breakdown of respondent internet access by resident type and ISP. 85% of year-round respondents and 66% of seasonal residents surveyed indicated that they currently have FairPoint as an ISP, with 15% of year-round and 28% of seasonal having Time Warner cable. A small number of respondents indicated that their provider was Midcoast/GWI or “other”.

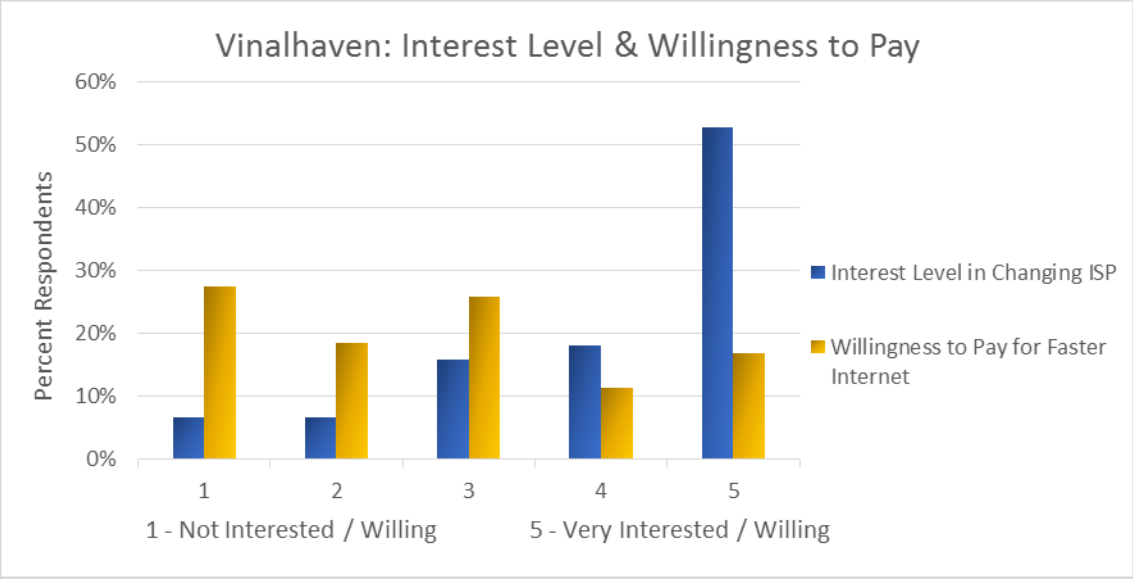


Satisfaction with current service providers gives some indication of users' willingness to switch vendors. The figure below shows the distribution, on a scale of 1 to 10, of respondents' satisfaction with their provider. 91 out of 144 (63%) respondents indicated a satisfaction level of 6 or greater, with 35 respondents (25%) indicating a satisfaction level between 1 and 4 (dissatisfied). 13% rated their ISP satisfaction at a 5 (neither satisfied nor dissatisfied). According to the Institute for Customer Service, customers that rate a service provider at less than eight are often willing to switch if an alternate offering is available.[17] Seventy-three percent (73%) of respondents were in this category, scoring their provider between 1 and 7.

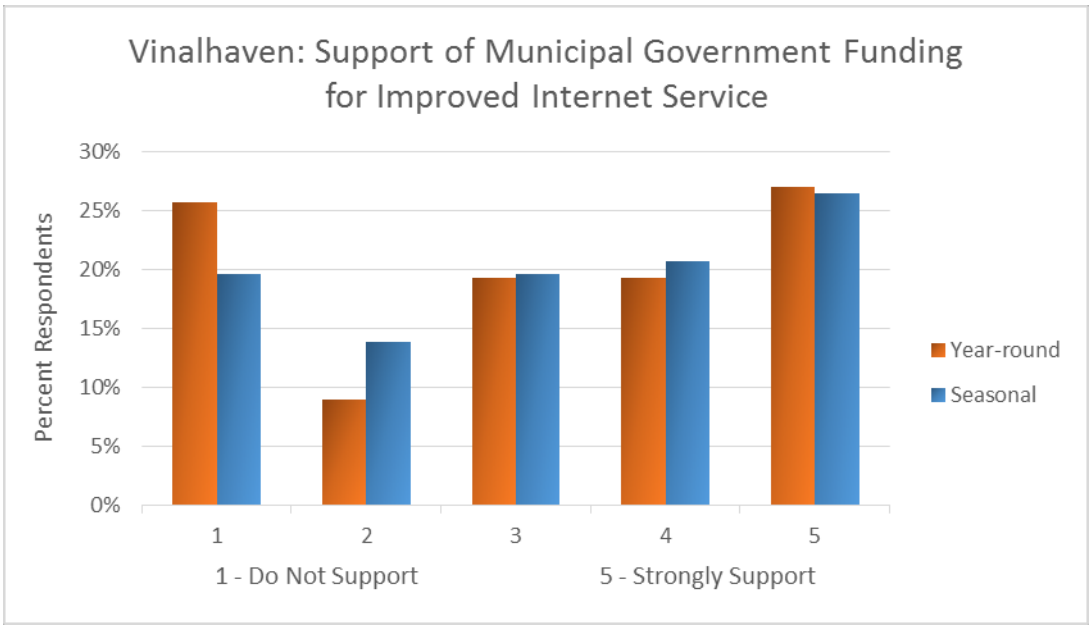


The last few questions of the survey provided an indication of islanders' attitudes towards change. The responses indicate that residents are willing to switch ISPs for faster service, but are value sensitive, and not as enthusiastic about paying more for the service. It should be noted that while the willingness to pay results emphasize the importance of a cost effective solution, the survey did not collect information regarding the current Internet costs being paid by respondents.

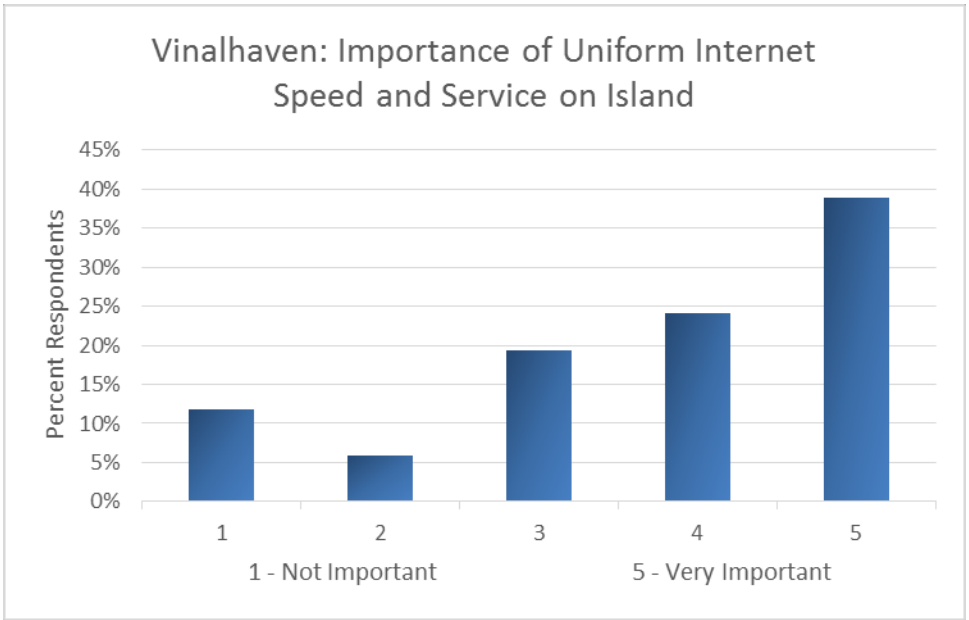
[17] Institute of Customer Service. *UK Customer Satisfaction Index.* July 2015.



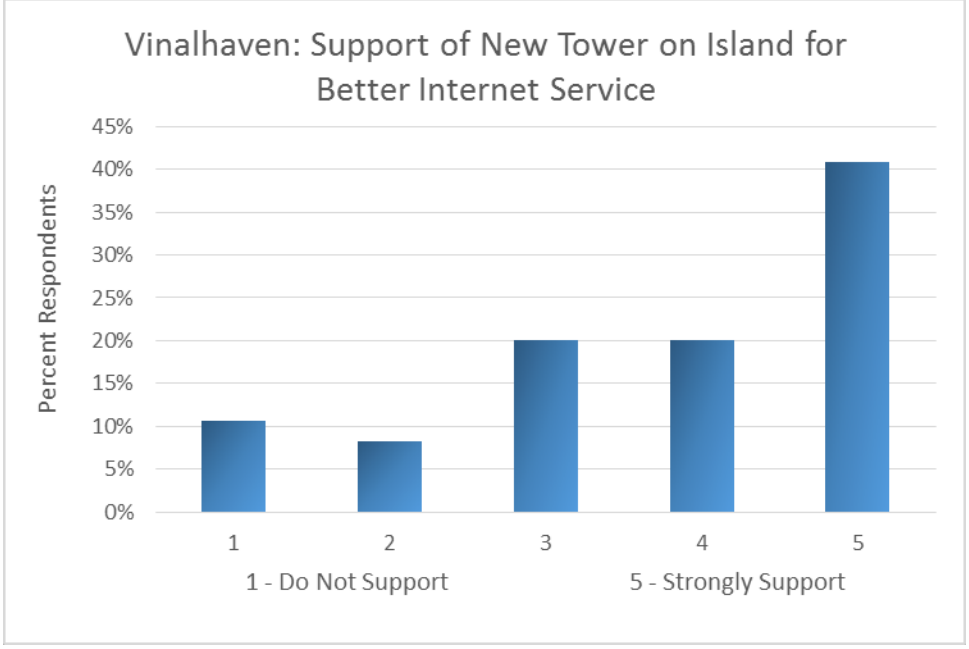
Support for municipal government funding of internet improvements was fairly divided, with an average (seasonal and year-round) of 46% indicating that they support this, and an average of 35% indicating that they do not. The remainder did not express support or lack of support for municipal funding of Internet improvements.



For Vinalhaven respondents, the majority of survey responses (63%) indicated that uniform speed and service for everyone on the island was a priority to them, with 18% indicating that it was not. The remainder (19%) did not indicate that it was important or unimportant to them.



In terms of support for a new tower build on the island for the purpose of improving Internet service, 61% of respondents indicated that they supported this idea, with a significant contingent (19%) expressing opposition.



Possible Solutions

Tilson examined two options for the Town of Vinalhaven to consider: improving existing DSL service[18]; and a fiber to the premise (FTTP) network, which would meet and possibly exceed the community's short term needs. There is also a third option: to work with Time Warner Cable to improve coverage, which was not explored in this study.[19] Taking no action to address the lack of broadband is also an option—however it would prevent the town from achieving its stated goals for telecommuting, enabling business, supporting education, entertainment, and the ability to maximize time on the islands while minimizing off-island trips.

Fiber Network Design

A fiber to the premise (FTTP) network is the gold standard in municipal network design: it is the most upgradeable, the least expensive to operate on a whole-island basis, the fastest, the most reliable, but also the most expensive to build. Because an FTTP network is so reliable, it requires less customer support and is less expensive to operate than DSL, hybrid fiber/coax, or wireless networks. The largest operating disadvantage to fiber is that if it is cut, it requires a technician skilled in fiber repair (and typically a bucket truck) to fix. Fiber networks can be configured to provide 1 Gigabit (Gbps) speed upload and download—100 times faster than the current ConnectME standard.

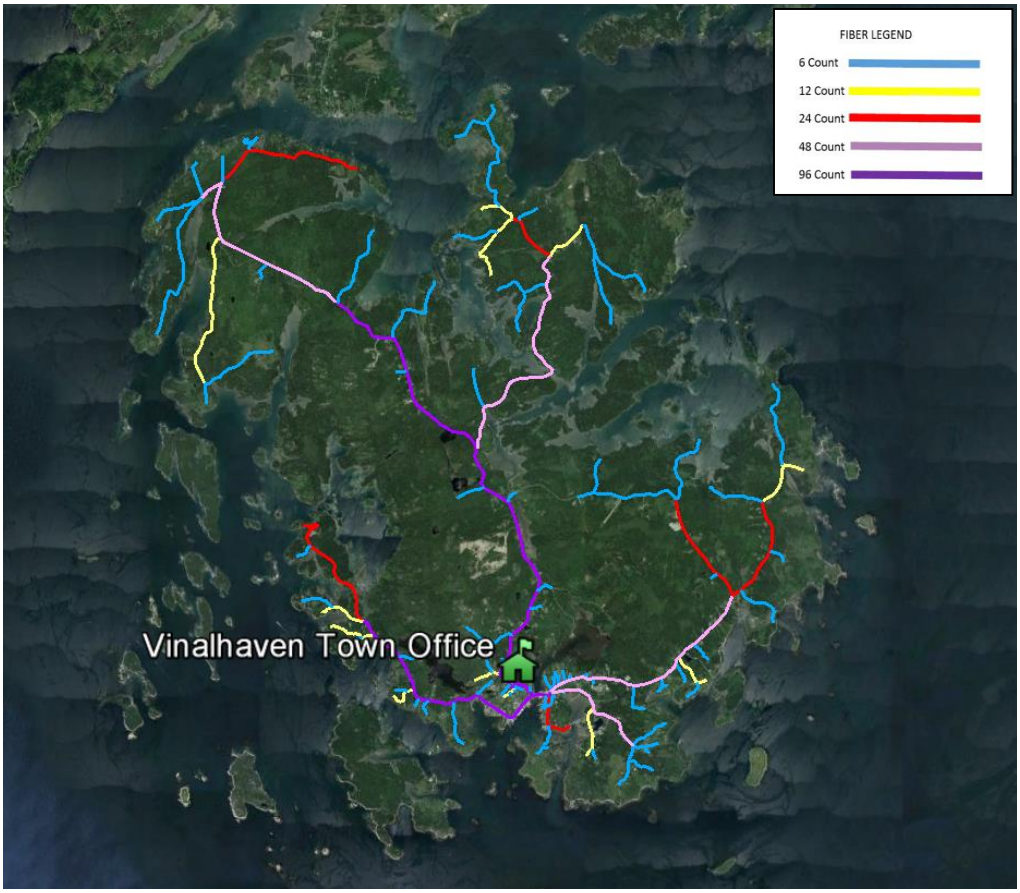
Tilson designed a FTTP solution that would pass and connect to all 1003 premises on the island. Fiber counts were specified for each segment to optimize for current building distribution, and with future growth in mind. Tilson designed multi-port service terminals (MST's) throughout the network to enable easy and short interconnections with existing and future premises.

To complete the local access portion of this network, electronics are needed at the customer premise and at the traffic collection node, or end. In addition, an ISP would need to place its own electronics and microwave backhaul to the mainland. There are various operating models whereby these network elements could be owned and operated either by the town, a network operator, or the ISP. [20]

[18] This option may meet the needs of the community in the near term, but does not meet the ConnectME or FCC definition of broadband.

[19] Tilson recommends that the Town of Vinalhaven do this with Time Warner directly. The option was excluded because Tilson does not have insight to the costs, and is not aware of precedent involving a subsidized coverage solution.

Fiber Network Design - Vinalhaven



Fiber Capital Cost Estimate

Tilson's detailed cost estimate included all the design, application, materials and labor costs associated with the fiber to the curb network.[21] For all of the islands, Tilson assumed that 90% of the route miles were aerial, and 10% were underground. The estimate also assumes that all of the fiber drops are built at once, rather than on-demand. An island premium of 10% on materials, and 20% on labor was added onto all of Tilson's standard estimates, and is reflected in the numbers below.

[21] Tilson's detailed cost estimate is based on the known cost of the network components of its high level fiber design, plus estimates for labor costs, engineering and margin. A firm estimate is obtained when a project is put out to bid. Projects can be separated into engineering design and build, or put out to bid as a combined design/build.

Fiber Capital Cost Estimate – Vinalhaven

Project Miles		51.3
Aerial Miles		46.2
Poles		1477
Premise Count		1003
Application and Make Ready	$	418,924
Materials	$	628,361
Labor	$	1,642,994
Engineering	$	109,533
Margin/Profit (20%)	$	559,962
Service Provider Tax (6% Labor and Engineering)	$	132,177
Sales Tax (5.5% Materials)	$	34,560
Total	$	3,526,511
Per Premise Cost	$	3,516

The incremental capital cost of building out the network, which would be borne by either the ISP, the municipality, or a network operator - depending on the business model - are not included above.

To complete the local access portion of this network, electronics are required at the customer premise and the traffic collection node, or head end. These electronics cost about $570 per premise. In addition, an ISP would need to deploy network electronics, which are customarily paid for by the ISP, even though they may be housed in a municipal building.

The electronics described above need to be housed in a space with redundant power, heating and sufficient heat dissipation ("conditioned space"). That conditioned space can be provided by a stand-alone shelter for about $250,000, or a municipality can provide it in one of its buildings to deliver substantial cost savings.

If the network were to be connected to the mainland via microwave, the capital cost estimate for two microwave dishes and one new small tower on the island (this assumes the mainland microwave dish is mounted on an existing tower), is $45,000. While a microwave link will be necessary for every island without a subsea fiber cable, there are opportunities for islands collaborate to either save money in operating the link and/or increasing the redundancy and reliability of the links. These are highlighted in the Opportunities for Regional Cost Savings section near the end of this report.

ILEC Network Improvements

ILEC network improvements to the DSL infrastructure are the least expensive way to improve Internet service on the islands, but will not achieve speeds that meet the FCC or Connect ME definition of broadband. DSL improvements take two forms: existing DSL nodes can be upgraded to have faster maximum speeds, and/or DSL nodes can be added. As with all DSL, users closest to the nodes have

access to the highest speeds. Users greater than four route miles from the node have no access. The more DSL nodes, the greater the proportion of islanders with access to the highest speeds.[22]

ILEC Improvements – Capital Cost Estimate

The costs for adding remote terminals vary widely, and are determined by the ILEC. The ILEC's costs are a function of whether additional microwave backhaul capacity is needed, how much fiber needs to be run to reach the remote terminal, and how much rewiring of copper cables is necessary. On the mainland, the costs for adding a remote terminal are typically less than $100,000. Tilson estimates that a private provider might charge $30,000 for upgrading an existing microwave link, $45,000 for installing a new microwave link and one tower. However, it is likely that an ILEC might spend (and charge) more money putting up a microwave link than an alternate provider would due to company technology and process specifications and labor restrictions.

Time Warner Cable Coverage Extension

Time Warner Cable (TWC) has partial coverage on Vinalhaven. In the areas where TWC has service, users can subscribe to speeds up to 50 Mbps down, 5 Mbps up. These speeds meet the FCC definition of broadband, but not the ConnectME definition. Tilson does not have insight to the cost of expanding TWC's footprint on Vinalhaven. However, because of the relatively higher speeds offered by TWC's hybid/fiber coax and FairPoint's DSL technology, Tilson recommends that the town explore this option with TWC directly.

Funding

In terms of funding a network solution, some community members were generally supportive of town funding, while others were skeptical. The Town has funded several large capital projects in recent years, including a sewer treatment facility, a wind farm, and a transmission cable. As such, the Town is hesitant to outlay significantly more capital toward future high cost investments. A tactical solution in the Downtown /Carvers harbor area may be more attractive. The Town has a very strong preference for externally funded solutions but public subsidy is possible with a strong business case and planning process.

The FCC's Connect America Fund (CAF II) program is funded by the Federal Universal Service Charge on phone bills, and in Maine, that money is redistributed through the ILECs to broaden coverage of at least 10 Mbps download speeds. Eligible communities are outlined on the FCC's CAF II maps.[23] Not all eligible communities will necessarily receive improved service through this program due to limited funding. FairPoint is in the process of determining which municipalities will yield the greatest return on their CAF II subsidized investment. Parts of Vinalhaven are eligible for CAF II subsidy according to the CAF II eligibility map.

[22] See the Service Offering Review by Provider section at the end of this report for known speeds and pricing.
[23] https://www.fcc.gov/maps/fcc-connect-america-fund-phase-ii-initial-eligible-areas-map.

North Haven

Background

North Haven is a 7,200-acre island in Penobscot Bay that neighbors Vinalhaven. 2010 U.S. Census numbers placed its year-round population at 355, with the summer population estimated to be 1,000. A more recent survey conducted by the Island Institute put the current number of year-round residents at 375.[24]

Current Infrastructure/Asset Inventory

According to FairPoint data, 80% of the homes and businesses on North Haven have access to FairPoint's DSL service. Connectivity speeds on the island can reach a maximum of 7 Mbps (download)/1 Mbps (upload). The island currently has one DSL remote terminal serving its population, meaning that copper wire lengths between the end user and the terminal are long, thus adversely affecting Internet speed. In terms of Internet service providers (ISP), North Haven has three ISPs selling service on the island: GWI, Time Warner Cable, and FairPoint.

While FairPoint offers almost universal DSL service throughout the Island, customers and residents present at Tilson's on-site visit complained of slower speeds due to more people on the island in the summer months.

[24] Island Institute Informal Survey, Spring 2015.

As for exisiting assets on North Haven, Tilson's scan of the island determined that FairPoint has inactive Digital Subscriber Link Access Multiplexers (DSLAMs) on S. Shore road on the eastern side of the island. If activated, these DSLAMs could improve the DSL service around the island.

As for Time Warner Cable, it offers cable service to the majority of addresses on the island. Unlike most mainland addresses, Time Warner Cable uses fiber optic cable instead of coaxial cable to deliver service. While end users do not experience a noticeable difference in service, this does mean that TWC's exisiting infrastructure on North Haven is highly scalable.

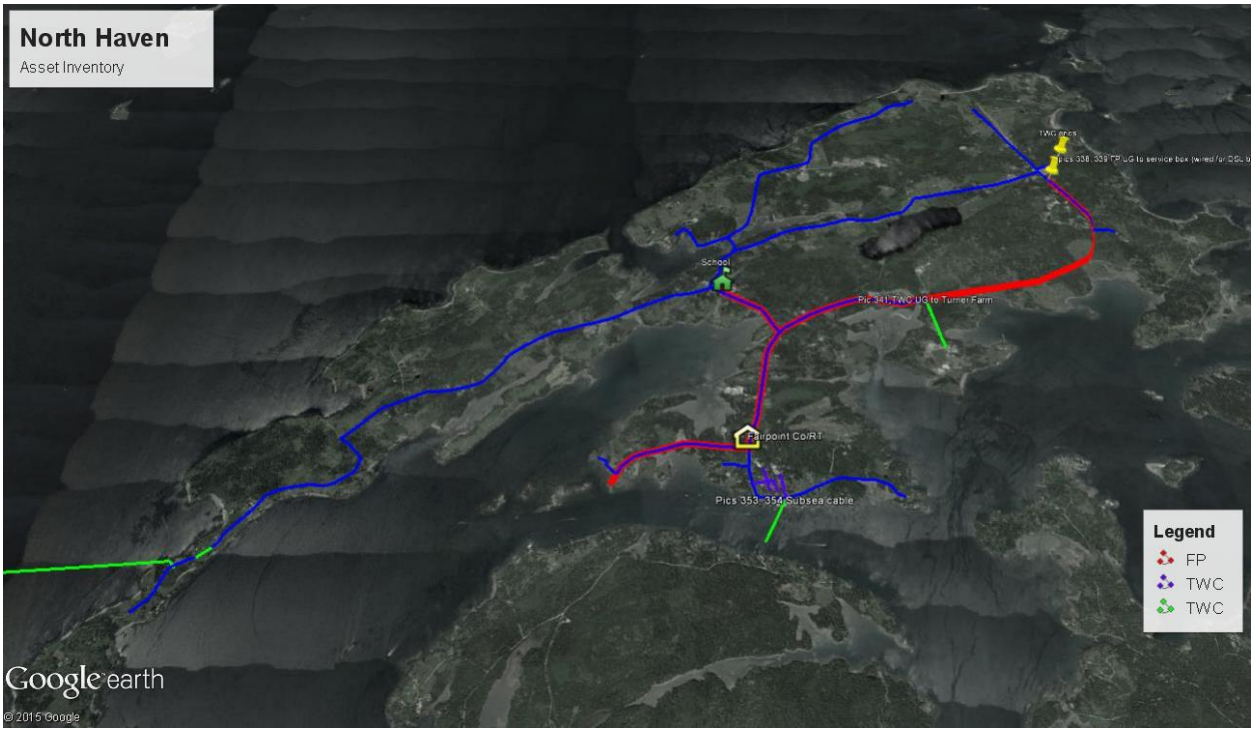
GWI provides fixed wireless service on the island, transmitting from the water tower on North Haven. While this service is present on the island, few premises subscribe to it.

An electric cooperative provides electrical service to both North Haven and Vinalhaven islands. This Co-op, the Fox Islands Electric Co-op, owns the transmission cable to the mainland, which has several strands of dark fiber available for lease.

Vinalhaven also has a cell tower near the center of the island. AT&T currently provides 4G cellular service off of the tower, however, the signal does not reach many parts of the island due to terrain and tree cover.

The image below illustrates the aforementioned assets and their locations on the island of North Haven.

Asset Inventory – North Haven



Current Service Offerings

The following table summarizes the various Internet, voice, video, and cellular service types, providers, and service notes related to resident experiences. Only the school and library have access to both the ConnectME and the FCC definition of broadband; premises with access to TWC can subscribe to speeds meeting the FCC's broadband definition.

Type	Provider	Service Notes
Internet	TWC FairPoint GWI	• Standard residential and business services from FP and TWC
Voice	FairPoint GWI	• Residents reported that this service varies throughout the year
Video	Dish Direct TV TWC	• Residents reported "good" to "very good" service
Cellular	AT&T Verizon U.S. Cellular	• Residents reported service ranging from "strong" to "very weak"
Public Wi-Fi	Library Town Office	• Residents reported "very strong" service

Public Broadband Service – North Haven

Type	Provider, Service	Service Notes
Library	Fiber Optic from MSLN 100/100 Mbps (FairPoint)	• Is the library on MSLN fiber—MSLN database doesn't show
North Haven Community School	Fiber Optic from MSLN 100/100 Mbps (FairPoint)	• Current service meets streaming and video conferencing needs
Town Hall	Fiber Optic from MSLN 100/100 Mbps (FairPoint)	• Streaming and video conferencing needs
Public Safety (Fire/Police)	FairPoint DSL	• 4G LTE and optical service
Doctor's Offices		• The medical center is well served currently

Stakeholders' Stated Community Goals

One of the initial goals expressed by islanders on North Haven was to have an ISP with greater responsiveness. The community expressed frustration with the rate of responsiveness of TWC and FairPoint to common problems. As such, islanders believe that a provider who can have an on-island service presence would be optimal for their needs.

In addition, community residents and stakeholders are seeking improved and expanded cellular coverage. Currently, there is limited U.S. Cellular and AT&T coverage on the island. The residents expressed interest in universal coverage for safety reasons in the event of emergencies in particularly remote areas, whether at sea or in the land preserve areas.

As mentioned in the asset inventory, there are currently existing DSLAM assets on the island that are not activated. Residents expressed that these DSL assets be utilized to the fullest extent possible, including activating DSLAMs on the island.

In terms of residential service needs and goals, North Haven residents are looking to improve the reliability and speed of their current DSL and DOCSIS 3.0 speeds. In addition, the areas of Town that only have access to weak DSL are also a high priority for any solution. Because these areas are far away from the central office (CO), their DSL service is noticeably weaker than others located in closer proximity to the CO.

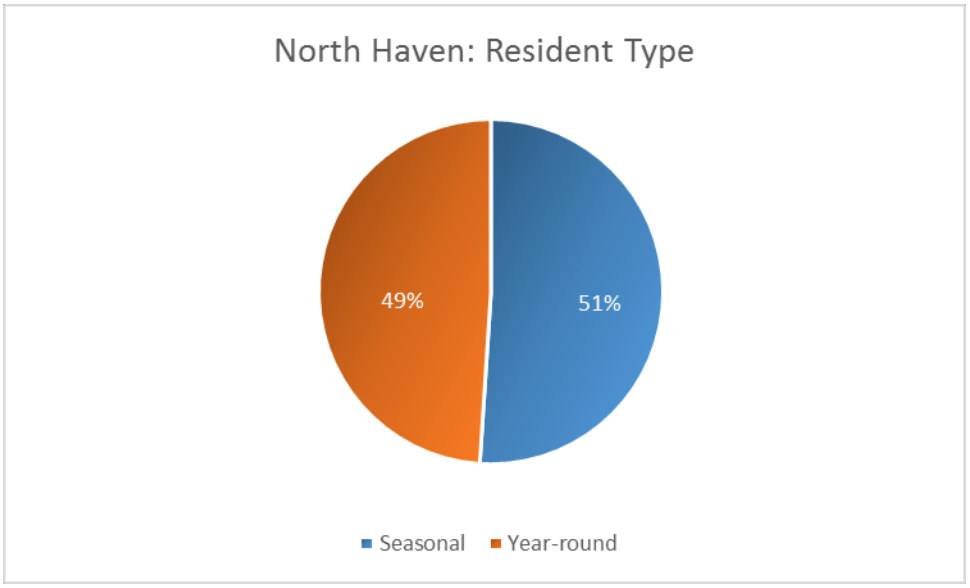
Community Priority Buildings/Businesses

Many of the businesses on the island would benefit from improved connectivity. These include:

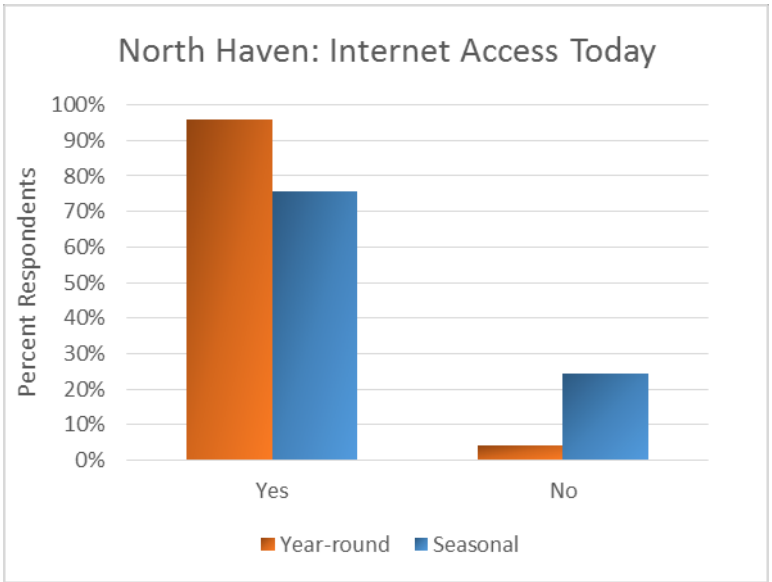
- Teleworkers and telecommuters – Are seeking reliable mid to low double digit Mbps home connections. Current TWC service and frequently congested FairPoint DSL service is not meeting these needs, thus this constituency is looking for improved reliability and uncongested lines.
- WiFi at the ferry terminal
- WiFi in the public park
- WiFi on the ferry
- Library
- Community center
- Downtown businesses – Currently facing limited bandwidth issues and are seeking improved cellular or WiFi services to better utilize Square or other payment processing applications.
    - High bandwidth using businesses are seeking double to triple digit symmetrical service and are not satisfied with their current TWC Business Class service. For this reason, their service goal is optical symmetrical service.
- Home internet for school age children.
- Unserved areas:
    - Service in the Mullens Head and Indian Point Road areas
    - Service on the northeastern tip of the island

Survey Results

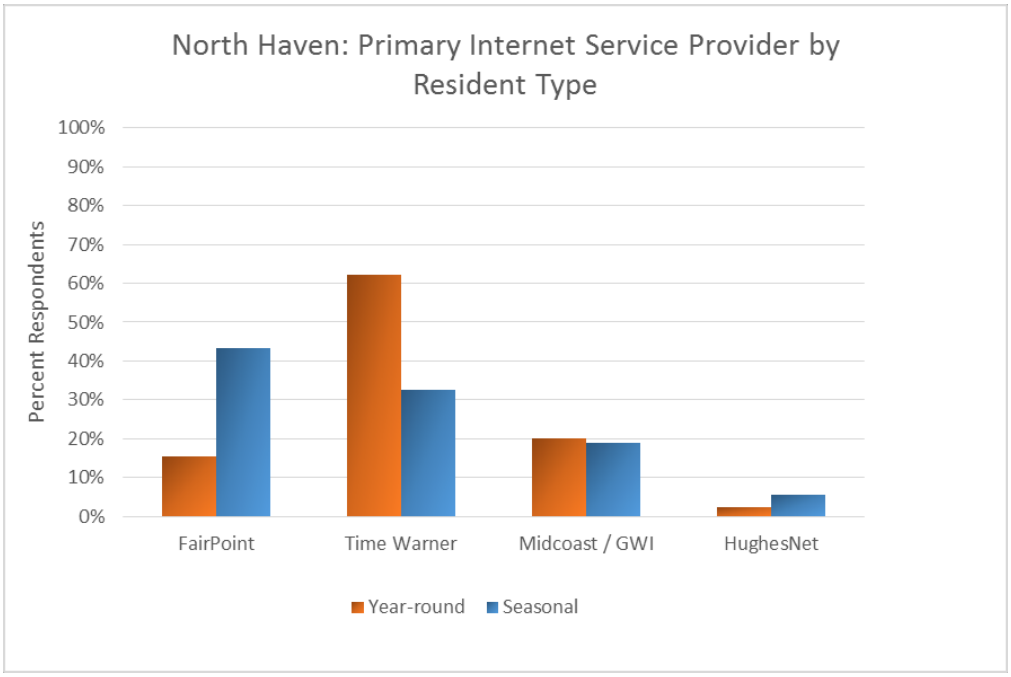
Tilson conducted a randomized survey of 265 of the 348 property owners on North Haven Island. Of the 265 surveys sent out, 96 respondents completed and returned the survey. This group was comprised of 49 seasonal residents and 47 year-round residents.



96% of year-round and 76% of seasonal respondents to the survey indicated that they currently had internet service, as shown by the following chart.

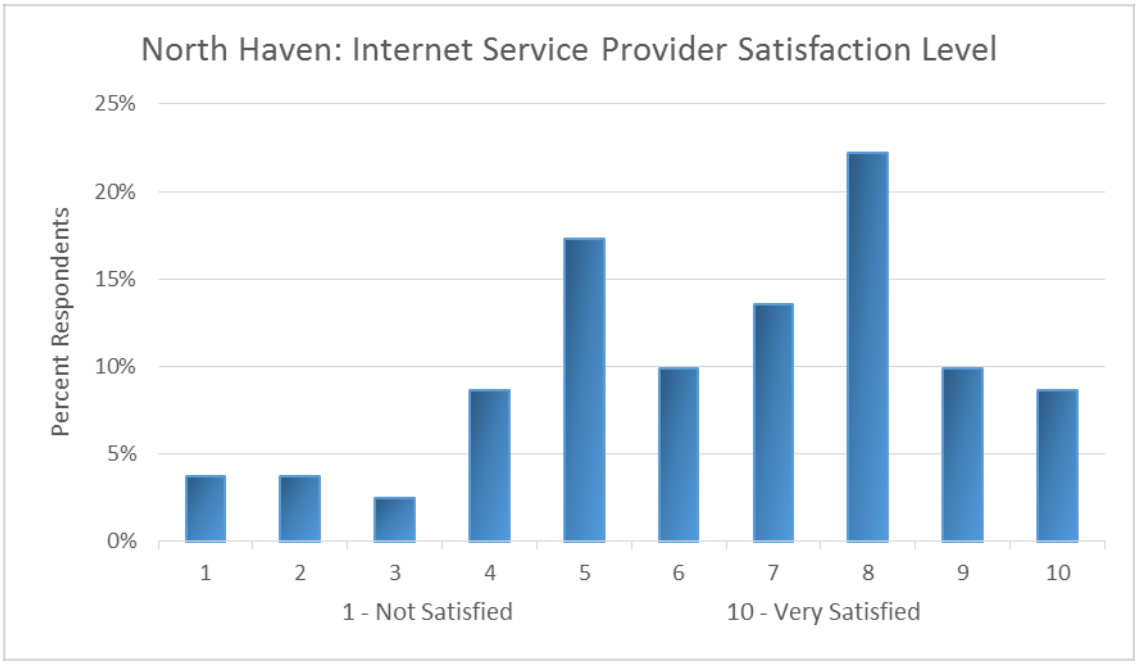


FairPoint is the primary ISP for 43% of seasonal respondents and 16% of year-round residents on the island, while 62% of year-round respondents and 32% of seasonal currently have Time Warner as their primary ISP. Approximately 20% of both populations indicated that Midcoast/GWI was their ISP, with a significantly smaller percentage (2-5%) handful of respondents indicating that HughesNet is their primary ISP.



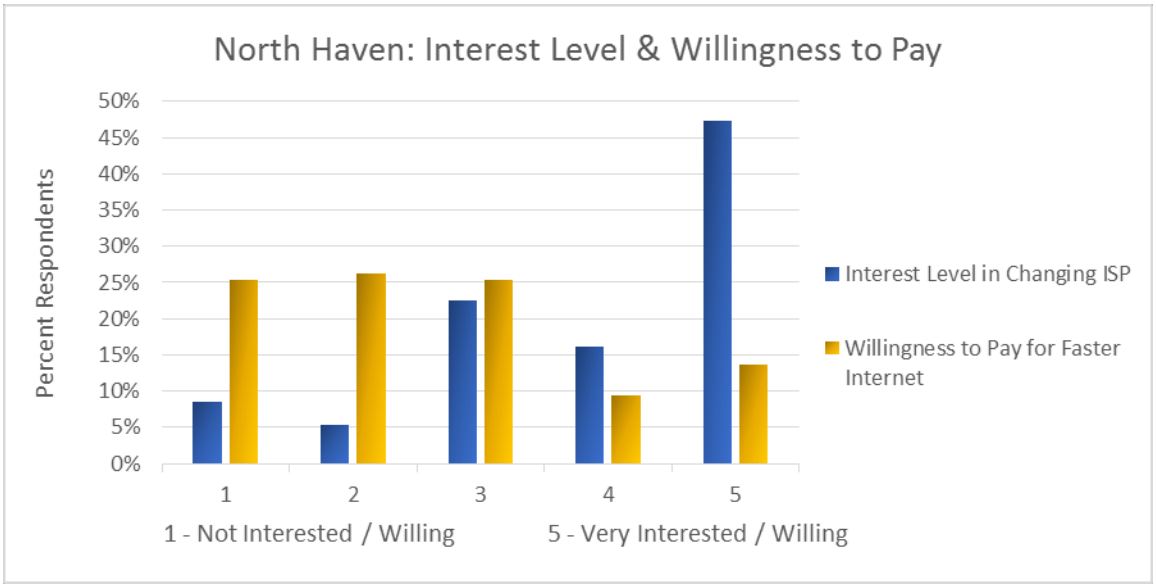
In terms of satisfaction level towards the ISP, on a scale of 1 to 10, 52 respondents (65%) indicated satisfaction (a score between 6 and 10) with their ISP, with 15 respondents (19%) indicating that they were not satisfied with their current ISP. 17% of respondents indicated that they were neither satisfied nor dissatisfied.

Satisfaction with current service providers gives some indication about users' willingness to switch vendors. The figure below shows the distribution, on a scale of 1 to 10, of respondents' satisfaction with their provider. According to the Institute for Customer Service, customers that rate a service provider at less than eight are often willing to switch if an alternate offering is available.[25] Fifty percent (50%) of North Haven respondents were in this category, scoring their provider between 1 and 7.

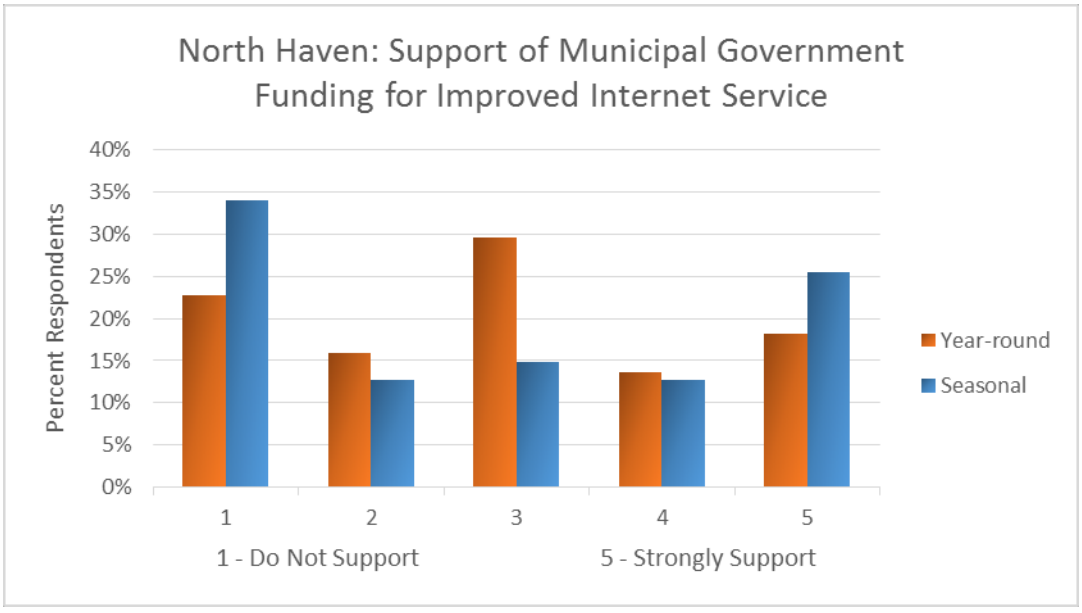


The survey also attempted to gauge islanders' attitudes toward change. 63% of North Haven survey respondents indicated that they would be willing to switch ISPs if it meant being able to have faster connectivity. Despite this clear interest, only 23% of this same group of respondents indicated that they would be willing to pay more money to obtain that service, with 51% being unwilling to do so, and 25% not sure one way or the other. These two metrics—interest and willingness to pay—can be compared side-by-side in the following graph. It should be noted that while the willingness to pay results emphasize the importance of a cost effective solution, the survey did not collect information regarding the current Internet costs being paid by respondents.

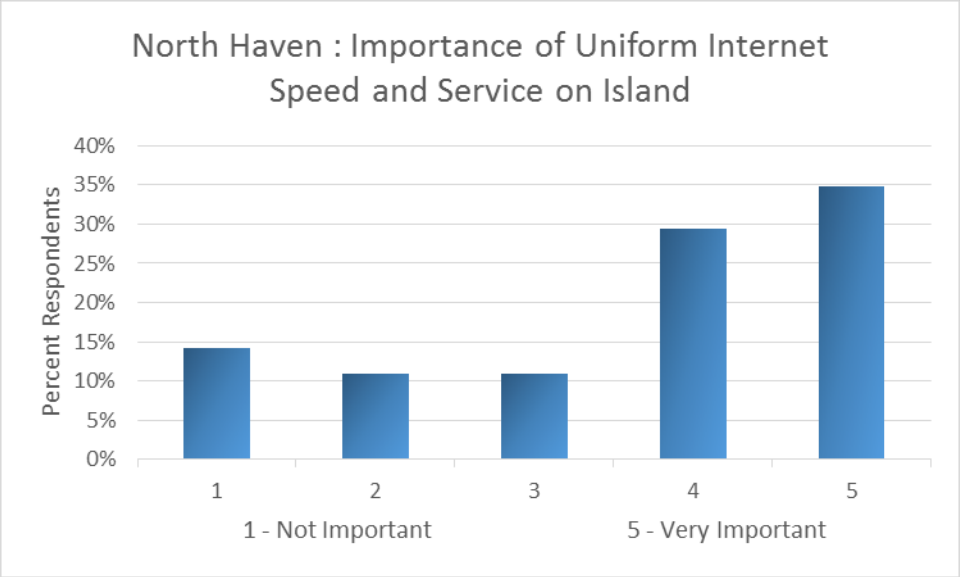
[25] Institute of Customer Service. *UK Customer Satisfaction Index.* July 2015.



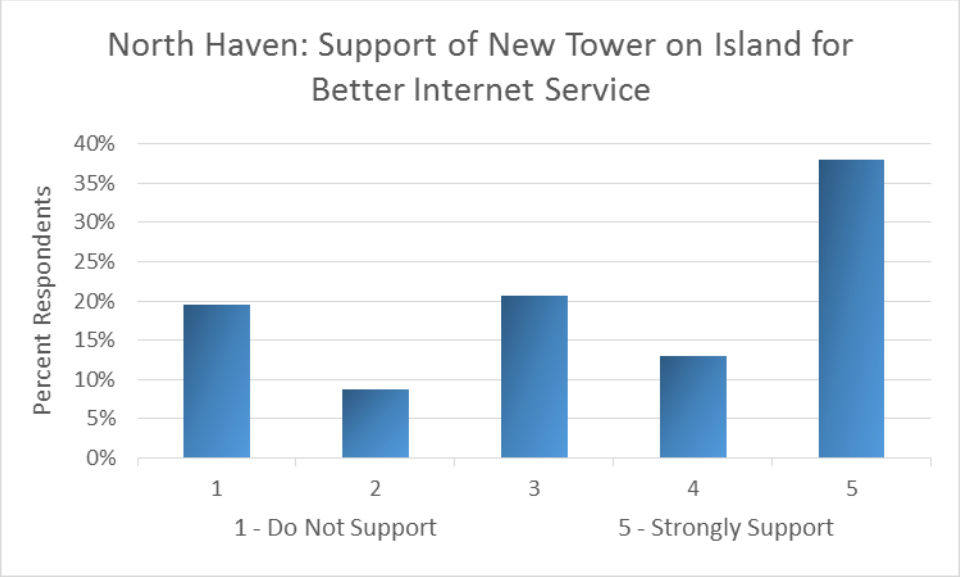
In terms of North Haven respondents' support for municipal government funding an improvement of internet service on the island, an average of about 35% of respondents would either support or strongly support their municipal government funding an improvement in Internet speed, with an average of 43% of respondents indicating that they would not support this. The remaining 22% of respondents indicated that they neither supported nor did not support municipal government funded Internet improvement.



As for uniformity of a connectivity solution and the importance of everyone on the island having access to the same level of internet speed and service, more than half of all respondents (64%) agreed that this was very important to them, with 23 respondents (25%) indicating that it was not important to them. Ten respondents (11%) considered uniformity neither important nor unimportant to them.



Finally, North Haven Island residents were asked their opinion of how they would feel about a new telecommunications tower being built on the island so as to enable better internet service. 47 respondents (51%) indicated that they would support this, with 26 respondents (29%) indicating that they would not. 21% of respondents did not express support or opposition for a new tower on North Haven.



Possible Solutions

Tilson examined two options for the Town of North Haven to consider: improving existing DSL service[26]; and a fiber to the premise (FTTP) network, which would meet and possibly exceed the community's short term needs. There is a third option, to work with Time Warner Cable to improve coverage, was not explored.[27] Taking no action to address the lack of broadband is also an option: however, it would prevent the town from achieving its stated goals for telecommuting, enabling business, supporting education, entertainment, and the ability to maximize time on the islands while minimizing off-island trips.

Fiber Network Design

A fiber to the premise (FTTP) network is the gold standard in municipal network design: it is the most upgradeable, the least expensive to operate on a whole-island basis, the fastest, the most reliable, but also the most expensive to build. Because an FTTP network is so reliable, it requires less customer support and is less expensive to operate than DSL, hybrid fiber/coax, or wireless networks. The largest operating disadvantage to fiber is that if it is cut, it requires a technician skilled in fiber repair (and typically a bucket truck) to fix. Fiber networks can be configured to provide 1 Gigabit (Gbps) speed upload and download—100 times faster than the current ConnectME standard.

Tilson designed a FTTP solution that would pass and connect to all 466 premises on the island. Fiber counts were specified for each segment to optimize for current building distribution, and with future growth in mind. Tilson designed multi-port service terminals (MST's) throughout the network to enable easy and short interconnections with existing and future premises.

To complete the local access portion of this network, electronics are needed at the customer premise and at the traffic collection node, or end. In addition, an ISP would need to place its own electronics and microwave backhaul to the mainland. There are various operating models whereby these network elements could be owned and operated either by the town, a network operator, or the ISP. [28]

[26] This option may meet the needs of the community in the near term, but does not meet the ConnectME or FCC definition of broadband.

[27] Tilson recommends that the Town of North Haven do this with Time Warner directly. The option was excluded because Tilson does not have insight to the costs, and is not aware of precedent involving a subsidized coverage solution.

[28] Tilson will describe municipal models that include ownership of a greater proportion of the infrastructure in the "business model" section of this report.

Fiber Network Design – North Haven

Fiber Capital Cost Estimate – North Haven

Tilson's detailed cost estimate included all the design, application, materials and labor costs associated with the fiber to the curb network.[29] For all of the islands, Tilson assumed that 90% of the route miles were aerial, and 10% were underground. The estimate also assumes that all the fiber drops are built at once, rather than on-demand. An island premium of 10% on materials, and 20% on labor was added onto all of Tilson's standard estimates, and is reflected in the numbers below.

[29] Tilson's detailed cost estimate is based on the known cost of the network components of its high level fiber design, plus estimates for labor costs, engineering and margin. A firm estimate is obtained when a project is put out to bid. Projects can be separated into engineering design and build, or put out to bid as a combined design/build.

Fiber Capital Cost Estimate – North Haven

Project Miles		31.2
Aerial Miles		28.1
Poles		898
Premise Count		438
Application and Make Ready	$	254,629
Materials	$	381,720
Labor	$	856,544
Engineering	$	62,294
Margin/Profit (20%)	$	311,038
Service Provider Tax (6% Labor and Engineering)	$	73,793
Sales Tax (5.5% Materials)	$	20,995
Total	$	1,961,012
Per Premise Cost	$	4,477

The incremental capital costs of building out the network, which would be borne by either the ISP, the municipality, or a network operator - depending on the business model - are not included above.

To complete the local access portion of this network, electronics are required at the customer premise and the traffic collection node, or head end. These electronics cost about $570 per premise. In addition, an ISP would need to deploy network electronics, which are customarily paid for by the ISP, even though they may be housed in a municipal building.

The electronics described above need to be housed in a space with redundant power, heating and sufficient heat dissipation ("conditioned space"). That conditioned space can be provided by a stand-alone shelter for about $250,000, or a municipality can provide it in one of its buildings to deliver substantial cost savings.

If the network were to be connected to the mainland via microwave, the capital cost estimate for two microwave dishes and one new small tower on the island (this assumes the mainland microwave dish is mounted on an existing tower), is $45,000. While a microwave link will be necessary for every island without a subsea fiber cable, there are opportunities for islands to collaborate to either save money in operating the link and/or increasing the redundancy and reliability of the links. These are highlighted in the "Opportunities for Regional Cost Savings" section near the end of this report.

ILEC Network Improvements

ILEC network improvements to the DSL infrastructure are the least expensive way to improve Internet service on the islands, but will not achieve speeds that meet the FCC or Connect ME definition of broadband. DSL improvements take two forms: existing DSL nodes can be upgraded to have faster maximum speeds, and/or DSL nodes can be added. As with all DSL, users closest to the nodes have

access to the highest speeds. Users greater than four route miles from the node have no access. The more DSL nodes, the greater the proportion of islanders with access to the highest speeds.[30]

ILEC Improvements – Cost Estimate

The costs for adding remote terminals vary widely, and are determined by the ILEC. The ILEC's cost are a function of whether additional microwave backhaul capacity is needed, how much fiber needs to be run to reach the remote terminal, and how much rewiring of copper cables is necessary. On the mainland, the costs for adding a remote terminal are typically less than $100,000. Tilson estimates that a private provider might charge $30,000 for upgrading an existing microwave link, $45,000 for installing a new microwave link and one tower. However, it is likely that an ILEC might spend (and charge) more money putting up a microwave link than an alternate provider would due to company technology and process specifications and labor restrictions.

Time Warner Cable Coverage Extension

Time Warner Cable (TWC) has partial coverage on North Haven. On North Haven, TWC's last mile plant is fiber, rather than the more common hybrid fiber coax plant.[31] The speeds offered over TWC's fiber plant are identical to those offered elsewhere - maximum speeds up to 50 Mbps download, 5 Mbps upload. These speeds meet the FCC definition of broadband, but not the ConnectME definition. Tilson does not have insight to the cost of expanding TWC's footprint on North Haven. However, because of the relatively higher speeds offered by TWC's fiber plant than FairPoint's DSL technology, Tilson recommends the town explore this option with TWC directly.

Funding

Much like Vinalhaven, some community members are generally supportive of town funding, while others are highly skeptical of any action that might raise taxes. The island has a high number of retirees on fixed incomes, and tax increases fall heavily on them. In addition, residents of North Haven have dealt with unexpected costs related to the recent wind turbine and submarine cable project and for this reason as well are sensitive to additional capital expenditures.

For the foregoing reasons, the Town has a very strong preference for externally funded solutions that involve partnering with incumbent providers or private capital.

[30] See the Service Offering Review by Provider section at the end of this report for known speeds and pricing.
[31] Email from Mike Edgecomb, TWC Government relations, on 8/12/15.

Monhegan Island

Background

Monhegan Island is a 513-acre island of 69 year round residents[32] and has an estimated population of 250 in the summertime months. A recent survey conducted by the Island Institute placed the number of year-round residents on Monhegan at 50 people.[33] There are about 170 houses on the island and power is generated on the island via diesel generation. Phone is provided via a microwave tower at the island's lighthouse. Monhegan Island has a total of 2 miles of road on it.

Asset Inventory

All of the homes and businesses on Monhegan Island can access the Internet using FairPoint's DSL service, with a maximum speed of 3/1 Mbps. The following image shows the locations of the MSLN FairPoint served buildings--the Monhegan School and Library (green icons) as well as the microwave

[32] U.S. Census Data, 2010.

[33] Island Institute Informal Survey, 2015.

tower and antenna locations on Lighthouse Hill (white placemarks). The small yellow house-shaped icon represents the FairPoint remote terminal and central office (pictured below as well).

Monhegan Asset Inventory

Remote Terminal/Central Office and Microwave Infrastructure

Current Service Offerings

The following table summarizes the various Internet, voice, video, and cellular service types, providers, and service notes related to resident experiences. As is evident from the chart, current connectivity on Monhegan Island is served by DSL and wireless infrastructure that does not meet the FCC or ConnectME definition of broadband. Tilson did not observe any fiber optic infrastructure present on the island currently. The library's observed speeds were close to the ConnectME definition of broadband of 10 Mbps download and 10 Mbps upload; the school's speeds were significantly slower.

Type	Provider	Service Notes
Internet	FairPoint (DSL) and GWI (Microwave)	• 3 Mbps DSL service inadequate for uploading files • Streaming capabilities are inconsistent
Voice	FairPoint (DSL)	
Video	Direct TV (Satellite), No cable	• Satellite TV service is significantly affected by weather
Cellular	U.S. Cellular, AT&T, Verizon	• Cellular service on the island is "generally good" according to residents

Public Internet Service – Monhegan

Type	Provider, Service	Service Notes
Library	MSLN (FairPoint)	• Needs are currently being served. Working towards an online database. Currently used for e-mail. Served by microwave tower on island. Speedtest.net: 9.97 Mbps down/10.04 up[34]
School	MSLN T1 (FairPoint)	• Speedtest.net: 3.77 Mbps down/ 2.80 up
Public WiFi	GWI	• Monhegan Brewery offers free Wi-Fi, but when many people use it this affects credit card capabilities. • Island Inn (15 Mbps)

Community Goals

Tilson met with residents and community stakeholders consisting of summer residents, year-round residents, town officials, and business owners. Residents were generally interested in having faster Internet service and particular needs such as uploading files. For local business owners, needs such as swiping credit cards are not being met by current service. Another problem that the group agreed on was scalability—the problem of having multiple users choking a local connection, particularly with the influx of summer residents and visitors to the island. For simple tasks such as online database work, current services were viewed as adequate, but with regard to Skype and uploading needs, most residents agreed that current connectivity was not able to meet most residents' needs. Other areas of need cited by those in attendance included better connectivity for purposes of telemedicine as well as connectivity to serve collaborative video-conferencing with other schools. Currently, kids at the Monhegan School use Tanberg videoconferencing—however, this service is inconsistent and often does not work properly, something which could be caused by faulty equipment or a lack of connectivity or both. In addition, 8th graders' preparation for the Maine Learning Technology Initiative (MLTI), a State program which integrates laptop technology into school curriculum, is affected by lack of connectivity. Furthermore, residents conveyed that current Internet service is not adequate for group usage at home, thus echoing the scalability issue faced by many island residents. For residents who do not upload files or do not download large files, more of them find current service to be adequate.

In terms of business goals, current connectivity is not usable on the dock, which prevents those who conduct business in this area from being able to scan customer credit cards in this location. For other business owners who need to download large data files, download times were described by these residents as "far too slow", often taking 20 minutes or more to download 10 Meg files. Other issues

[34] Speedtests on Monhegan were conducted by Tilson on July 22, 2015.

centered around reliability—residents agreed that while 3 Mbps was a relatively slow speed, if this speed were consistent and reliable, this would be acceptable. However, recurring and lengthy interruptions in service was common among resident experiences, such that some residents turn to cellphone 4GLTE service in order to get work done. The group agreed that a faster, more reliable Internet service on Monhegan would open the island to new development and business opportunities.

As for overall goals of the Monhegan Island community, these consist of attracting new residents, reducing power consumption and electricity demands, and improving telemedicine capabilities to reduce trips off island for doctor's appointments.

Like many island communities, the standard DSL nominal 3 Mbps download speed provided by the current FairPoint service suffers from saturation and intermittency problems due to weather and the seasonal resident and summer visitor influx that does not allow local businesses to upload large files and documents and prevents local schools and Town groups from teleconferencing and dependable telemedicine capabilities. In general Monhegan residents feel that the current 3 Mbps DSL service could be "adequate" for their needs, were it not for the problems with consistency and reliability. These problems appear to affect the island as a whole, with the exception of certain pockets (i.e. the Island Inn, which is served by 15 Mbps GWI Wi-Fi).

Community Priority Buildings/Businesses

The following Island buildings and businesses were cited by Monhegan residents and stakeholders as priorities:

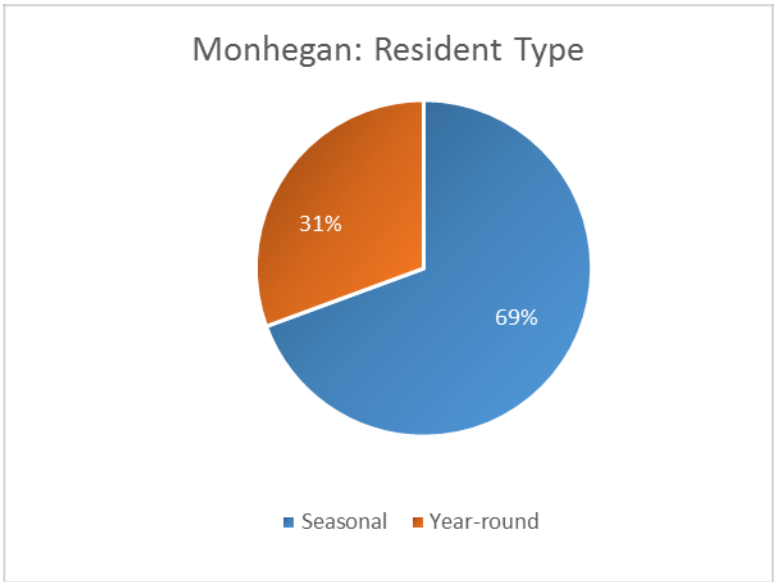
- The Monhegan School (Primarily because student videoconferencing needs are not currently being met.)
- The Museum
- The Island Inn (Currently served by GWI at 15 Mbps)
- Power Company Building
- Town Office (residents viewed this as "adequately" served for now but could envision a need for teleconferencing with off-island residents/people in the winter time)
- The Community Land Trust (Has conducted its winter meetings via videoconference, but has been utilizing the School's connection/equipment to do so)
- Monhegan House
- Shining Sails
- John Sterling Harbor House
- Monhegan Brewery
- Fish House Restaurant
- L. Brackett & Sons (Grocery Store)
- Monhegan Wellness (Skype and streaming needs—currently using DSL from FairPoint)
- Local Carpenters (For photo/file uploads, communication with clients)

As for public areas that community residents and stakeholders believe could be served by free Wi-Fi service, the following were mentioned:

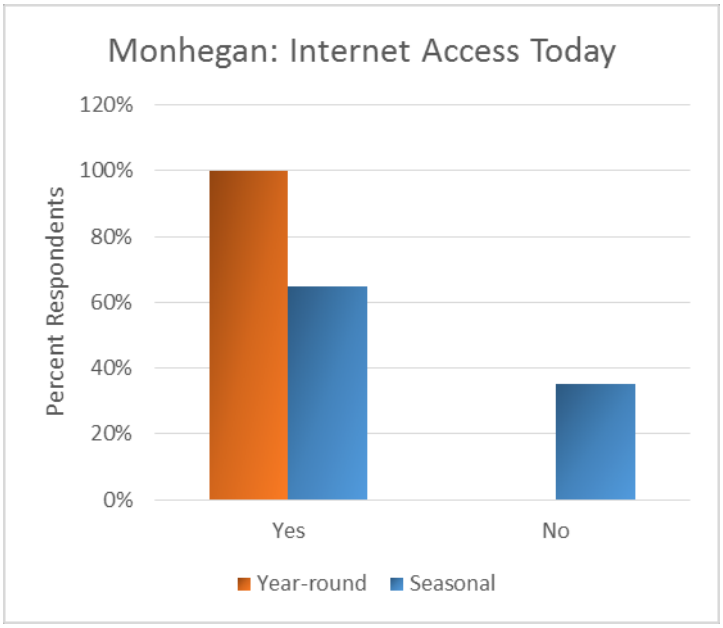
- The Grocery Store
- The area outside of the School
- The Wharf
- The Post Office
- The Brewery

Survey Results

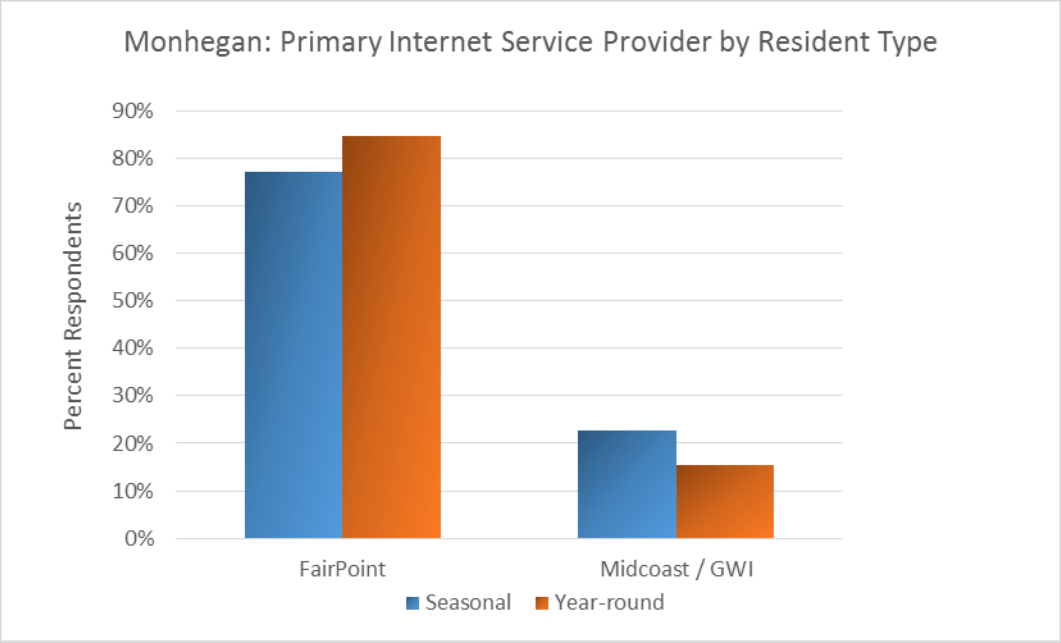
Tilson conducted a randomized survey of the 139 property owners on Monhegan Island. Of the 139 surveys sent out, 49 respondents from Monhegan completed and returned the survey. This group was comprised of 34 seasonal residents and 15 year-round residents.



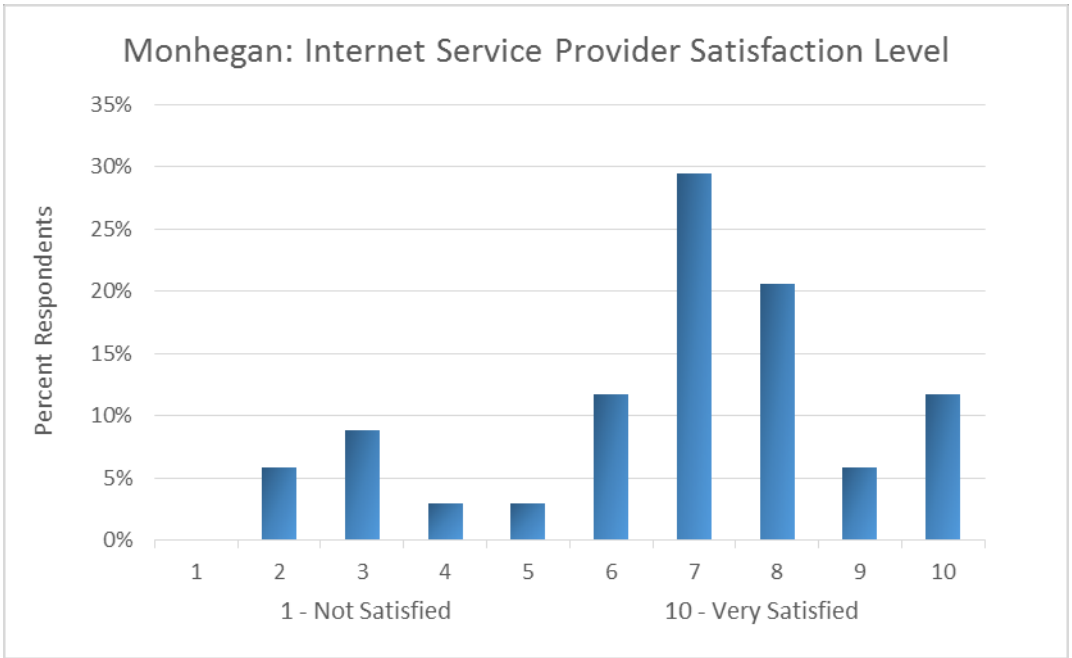
100% of year-round and 65% of seasonal respondents to the survey indicated that they currently had internet service, as shown by the following chart.



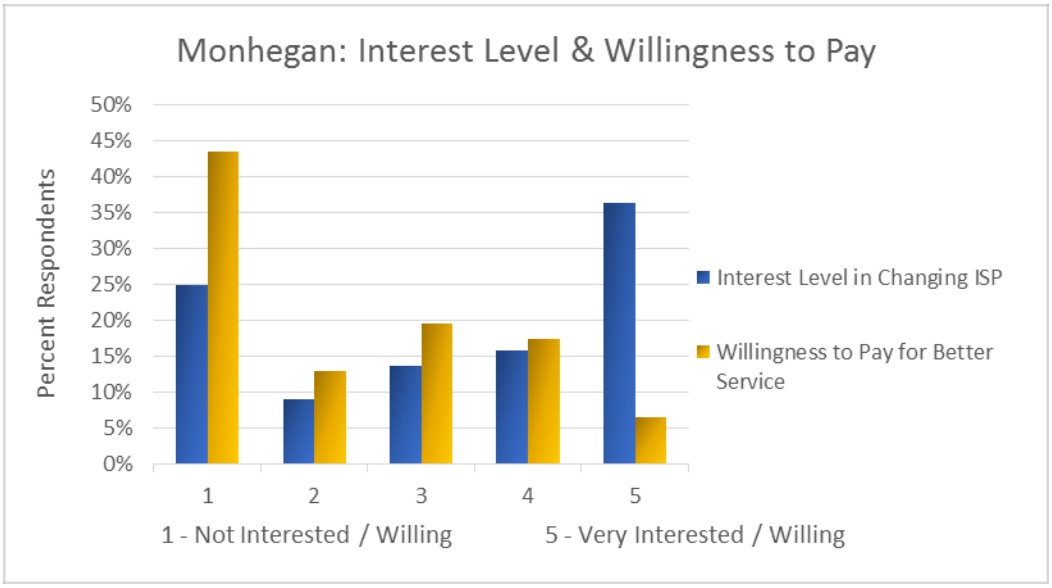
FairPoint is the primary ISP for 77% of seasonal and 85% of year-round residents on the island, with a handful of respondents indicating that Midcoast/GWI is their primary ISP.



In terms of satisfaction level towards the ISP, on a scale of 1 to 10, 27 respondents (79%) indicated satisfaction (a score between 6 and 10) with their ISP, with 6 respondents (18%) indicating that they were not satisfied with the current ISP. 3% of respondents indicated that they were neither satisfied nor dissatisfied.

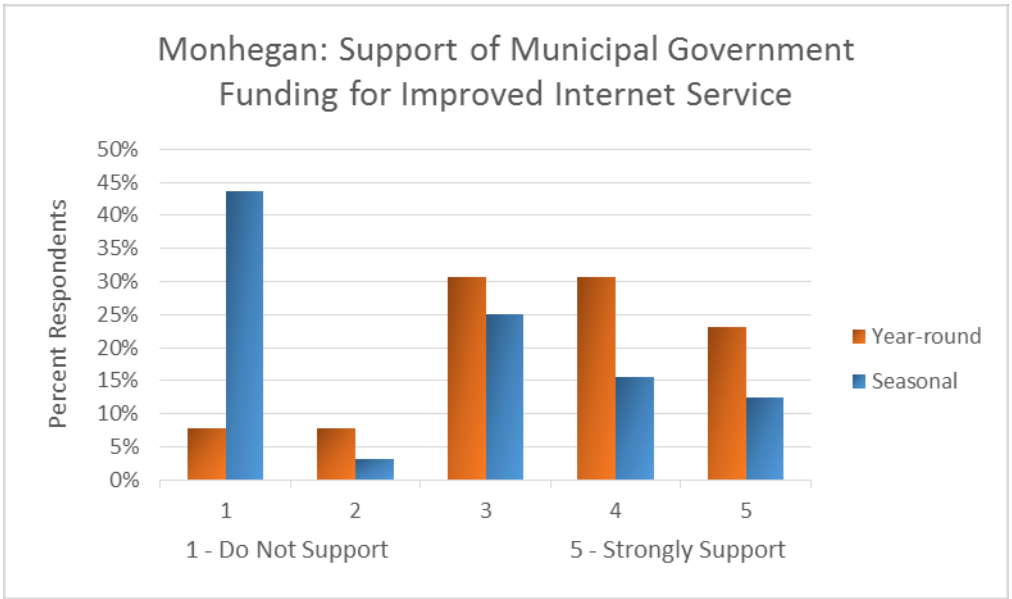


The survey also attempted to gauge islanders' attitudes toward change. Fifty two percent of Monhegan survey respondents indicated that they would be willing to switch ISPs if it meant being able to have faster connectivity. Despite this clear interest, only 24% of this same group of respondents indicated that they would be willing to pay more money to obtain that service, with 56% being unwilling to do so, and 20% not sure one way or the other. These two metrics—interest and willingness to pay—can be compared side-by-side in the following graph. It should be noted that while the willingness to pay results emphasize the importance of a cost effective solution, the survey did not collect information regarding the current Internet costs being paid by respondents.

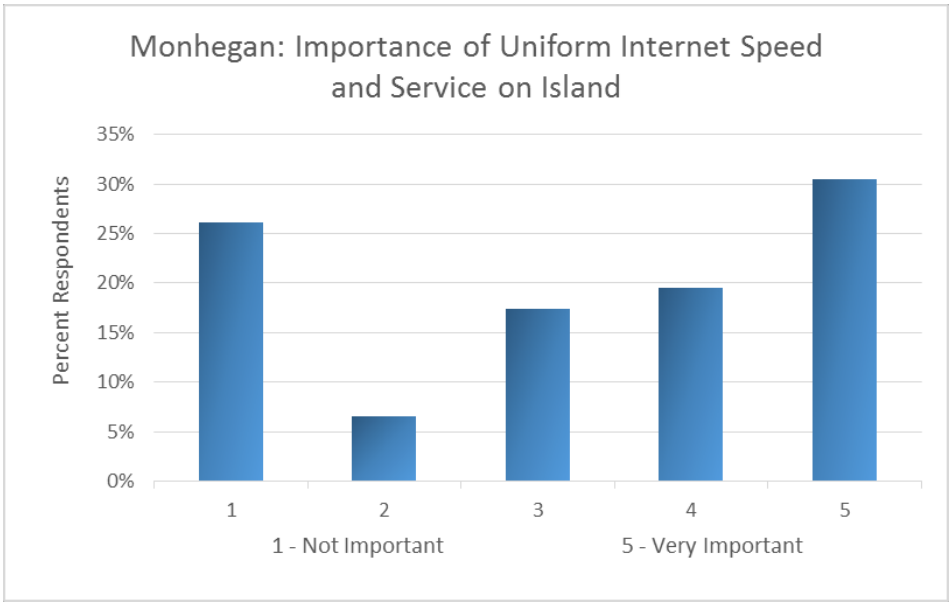


In terms of Monhegan respondents' support for municipal government funding an improvement of Internet service on the island, an average of about 37% of respondents would either support or strongly

support their municipal government funding an improvement in better Internet, with 47% of seasonal respondents and 16% of year-round respondents who would not support this. The remaining 28% of respondents indicated that they neither would not support nor support municipal government funded Internet improvement.

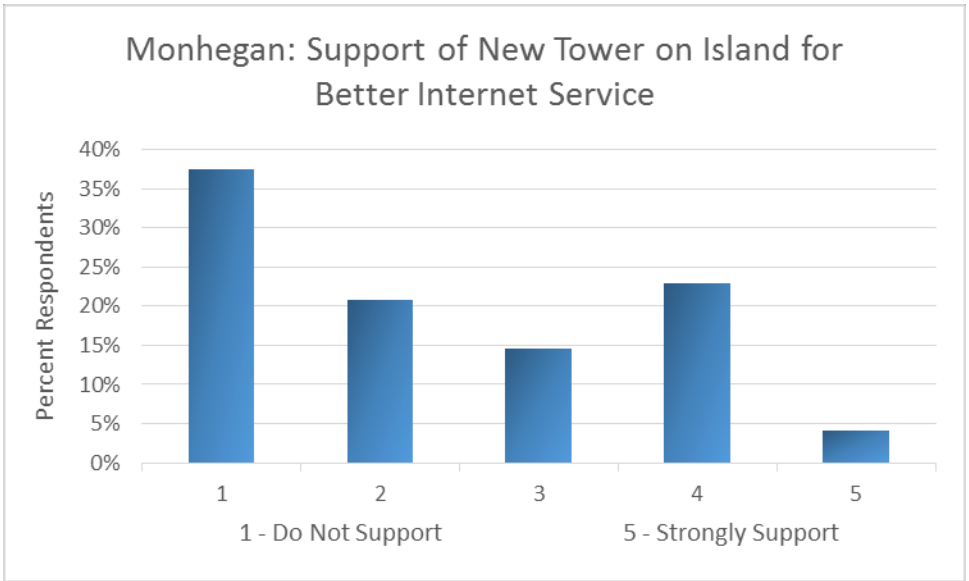


As for uniformity of a connectivity solution and the importance of everyone on the island having access to the same level of Internet speed and service, half of all respondents (50%) agreed that this was very important to them, with 15 respondents (33%) indicating that it was not important to them. Eight respondents (17%) considered uniformity neither important nor unimportant to them.



Finally, Monhegan Island residents were asked their opinion of how they would feel about a new telecommunications tower being built on the island so as to enable better internet service. 28

respondents (59%) indicated that they would not support this at all, with only 13 respondents (27%) indicating that they would. 15% of respondents did not express support or opposition for a new tower on Monhegan.



Potential Solutions

Tilson examined three options for Monhegan to consider: improving existing DSL service[35]; Redzone's wireless LTE service; and a fiber to the premise (FTTP) network. These options range in meeting to exceeding the community's short term needs. Taking no action to address the lack of broadband is also an option: however, it would prevent the town from achieving stated goals like enabling business, attracting new families, and the ability to minimize off-island trips.

Fiber Network Design

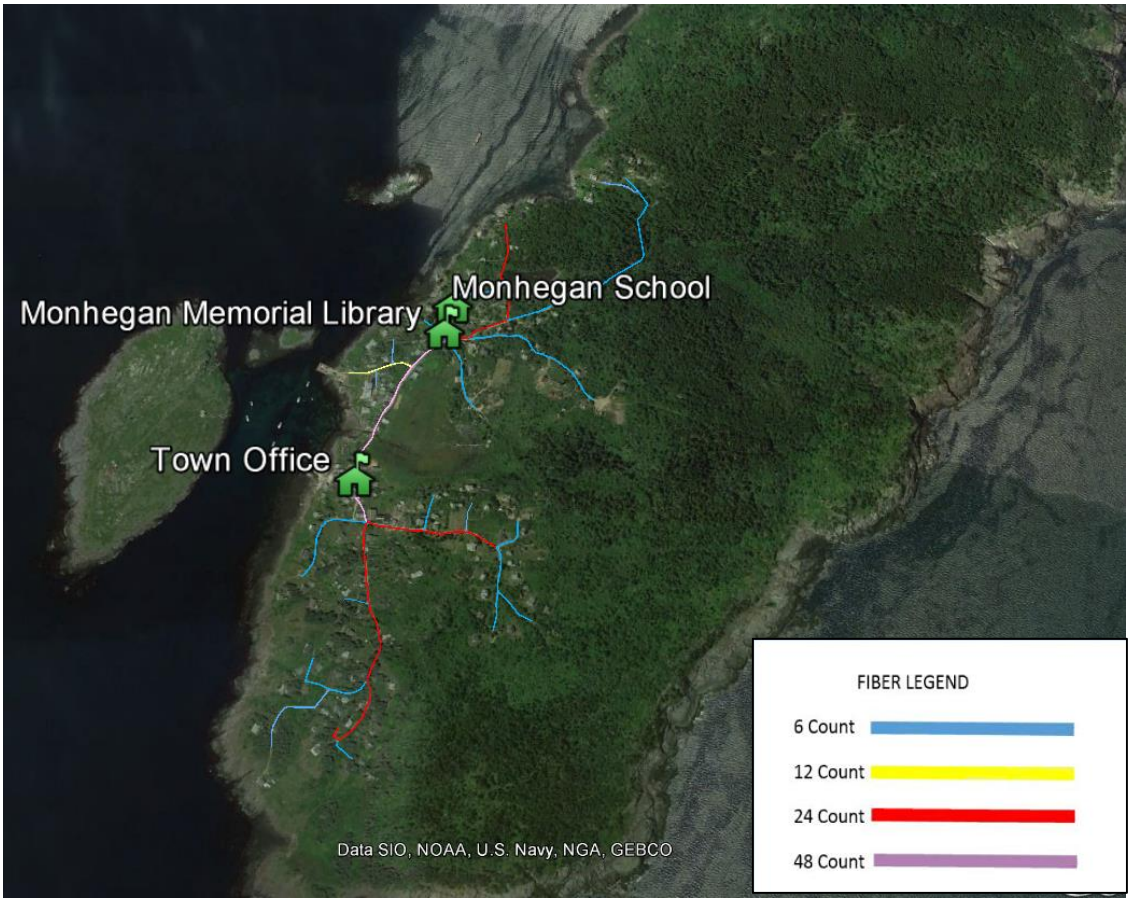
A fiber to the premise (FTTP) network is the gold standard in municipal network design: it is the most upgradeable, the least expensive to operate on a whole-island basis, the fastest, the most reliable, but also the most expensive to build. Because an FTTP network is so reliable, it requires less customer support and is less expensive to operate than DSL, hybrid fiber/coax, or wireless networks. The largest operating disadvantage to fiber is that if it is cut, it requires a technician skilled in fiber repair (and typically a bucket truck) to fix. Fiber networks can be configured to provide 1 Gigabit (Gbps) speed upload and download—100 times faster than the current ConnectME standard.

Tilson designed a FTTP solution that would pass and connect to all 186 premises on the island. Fiber counts were specified for each segment to optimize for current building distribution, and with future growth in mind. Tilson designed multi-port service terminals (MST's) throughout the network to enable easy and short interconnections with existing and future premises.

[35] This option may meet the needs of the community in the near term, but does not meet the ConnectME or FCC definition of broadband.

To complete the local access portion of this network, electronics are needed at the customer premise and at the traffic collection node, or end. In addition, an ISP would need to place its own electronics and microwave backhaul to the mainland. There are various operating models whereby these network elements could be owned and operated either by the town, a network operator, or the ISP. [36]

Fiber Network Design - Monhegan



Fiber Capital Cost Estimate

Tilson's detailed cost estimate included all of the design, application, materials and labor costs associated with the fiber to the curb network.[37] For all of the islands, Tilson assumed that 90% of the route miles were aerial, and 10% were underground. The estimate also assumes that all of the fiber drops are built at once, rather than on-demand. An island premium of 10% on materials, and 20% on labor was added onto all of Tilson's standard estimates, and is reflected in the numbers below.

[37] Tilson's detailed cost estimate is based on the known cost of the network components of its high level fiber design, plus estimates for labor costs, engineering and margin. A firm estimate is obtained when a project is put out to bid. Projects can be separated into engineering design and build, or put out to bid as a combined design/build.

FTTP Capital Cost Estimate - Monhegan

Project Miles		2.5
Aerial Miles		2.3
Poles		73
Premise Count		186
Application and Make Ready	$	22,077
Materials	$	62,914
Labor	$	183,358
Engineering	$	12,224
Margin/Profit (20%)	$	56,115
Service Provider Tax (6% Labor and Engineering)	$	15,102
Sales Tax (5.5% Materials)	$	3,460
Total	$	355,251
Per Premise Cost	$	1,910

Wireless LTE Design

Tilson engaged Redzone,[38] the only company offering fixed wireless LTE in Maine, to design a network that would provide universal access to all premises on the island. This means that all island users would have access to the same speed offerings, which are fast enough to meet both the FCC and ConnectME definition of broadband.[39]

Redzone's design deployed 150' tall towers, placed in optimal locations to provide universal coverage with the fewest number of towers. The red on the map represents areas of indoor LTE coverage, meaning that an external antenna is not necessary to have access to all of Redzone's speed offerings. The green areas represent locations where an outdoor antenna is needed to access to Redzone's full service offerings. Across the islands for which Redzone designed a network, 91% of the households will have access via indoor router, and 98.7% will have access via outdoor router.

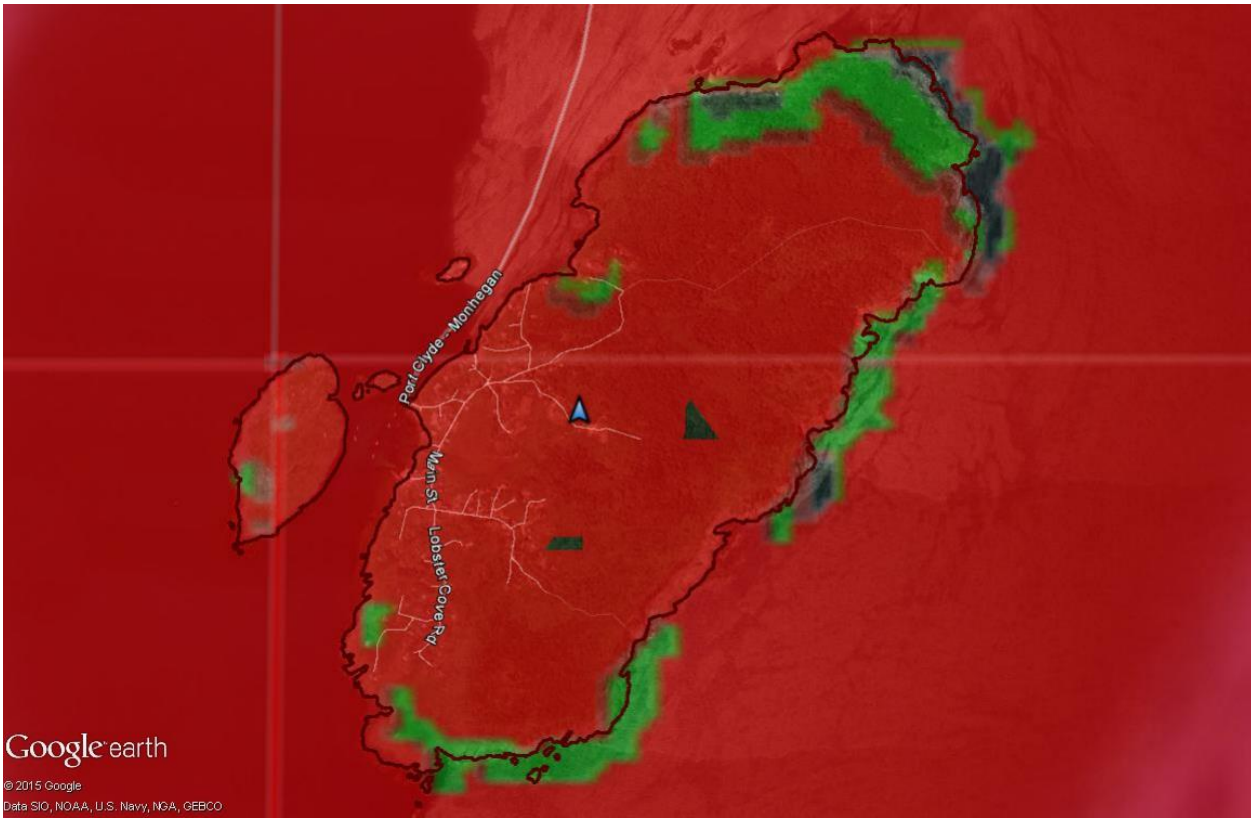
Redzone would backhaul its traffic to the mainland via microwave.

The following image shows the wireless LTE design for Monhegan Island. The red on the map represents indoor LTE coverage for households on the island. The green areas represent outdoor LTE coverage on the island given for colocation of Wireless LTE infrastructure on the existing tower on Monhegan (blue placemark).

[38] Design work performed for Redzone by 4G Unwired, Indialantic, FL.

[39] Current speed and pricing information in the Service Offering Overview section near the end of this report

Wireless LTE Design - Monhegan



Legend – Wireless LTE Design

Indoor Router Coverage

Outdoor Router Coverage

Tower Location

Wireless LTE Cost Estimate

Redzone estimates that the capital cost of deploying equipment on a tower, plus microwave backhaul, is $125,000 per tower. Tilson estimates that the cost of building a 150' telecommunications tower on an island is an additional $200,000, although that can vary widely. Because Monhegan already has an existing tower, the cost for this contemplated wireless LTE solution would be $125,000.

In this model, the town would fund and likely own the tower infrastructure. New towers could potentially be used by other telecommunications carriers, like mobile providers. Redzone would retain ownership of its equipment and bill customers directly. In today's environment, it is unlikely that Redzone would deploy equipment on the island without an almost complete capital cost subsidy.

Redzone's business model and service offerings are further discussed in the "Service Offering Overview by Provider" section of this report.

ILEC Network Improvements

ILEC network improvements to the DSL infrastructure are the least expensive way to improve Internet service on the islands, but will not achieve speeds that meet the FCC or Connect ME definition of broadband. DSL improvements take two forms: existing DSL nodes can be upgraded to have faster maximum speeds, and/or DSL nodes can be added. As with all DSL, users closest to the nodes have access to the highest speeds. Users greater than four route miles from the node have no access. The more DSL nodes, the greater the proportion of islanders with access to the highest speeds.[40]

ILEC Improvements – Cost Estimate

The costs for adding remote terminals vary widely, and are determined by the ILEC. The ILEC's cost are a function of whether additional microwave backhaul capacity is needed, how much fiber needs to be run to reach the remote terminal, and how much rewiring of copper cables is necessary. On the mainland, the costs for adding a remote terminal are typically less than $100,000. Tilson estimates that a private provider might charge $30,000 for upgrading an existing microwave link, $45,000 for installing a new microwave link and one tower. However, it is likely that an ILEC might spend (and charge) more money putting up a microwave link than an alternate provider would due to company technology and process specifications and labor restrictions.

[40] See the Service Offering Review by Provider section at the end of this report for known speeds and pricing

Matinicus

Background

Matinicus is an 814-acre offshore island community south of Vinalhaven, Maine. The island sits approximately 25 miles offshore and, therefore, is one of the most remote communities in the lower 48 states. The 2010 census listed an annual population of 74. The island reported a population of 40 for 2014. Residents reported that only nine people remained on island through the 2014-2015 winter.

Current Infrastructure/Asset Inventory

The island has two Internet service providers. TDS Telecom provides DSL service of legacy twisted pair copper wire. Residents report speeds in the range of 5 Mbps download and 1 Mbps upload. TDS uses two microwave links to connect the island to the Internet. One between the island and a tower in Owls Head, and one between the island and a tower in Stonington.

GWI provides fixed wireless Internet service using unlicensed 900 mhz spectrum. Service is provided from one tower on the island that stands on private property. The product offers speeds of approximately 3 Mbps down and 1 Mbps up. GWI backhauls using a microwave link between their tower and Owls Head.

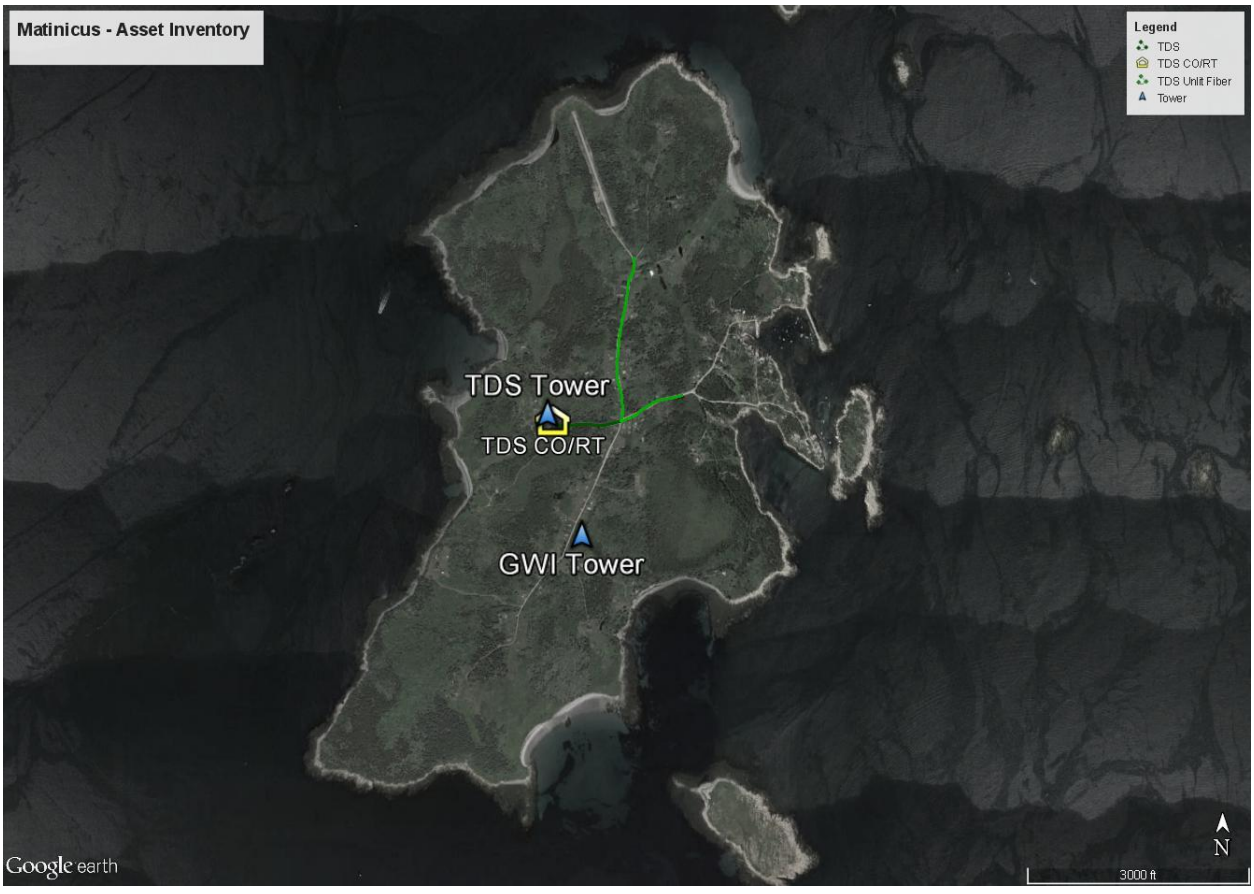
The Island also has an unlit fiber that runs from the TDS tower east for one mile and then north for half a mile. This fiber was part of a network upgrade but never put into service and is not currently in use. This may provide an asset that the Plantation could use for a solution. There are three microwave dishes on this tower: two for TDS; one for GWI.

TILSON

TDS Tower – Matinicus

TDS Central Office

Asset Inventory - Matinicus



Context

Despite the Island's distance from shore, the community's Internet service offerings are actually marginally better than many rural communities in the state.

Deer Island, Mt. Desert, Frenchboro, Waldo County, Hancock County, and much of Vinalhaven actually have less access than Matinicus. Tilson believes that the primary reason for this has to do with the size of the island. In this instance Matinicus's small size actually works to its advantage. This is because internet service using DSL technology degrades over distance. Customers more than 2 miles from a central office see dramatically weaker signals than customers closer to the central office.

As all Matinicus residents are within two miles of the central office at the foot of the TDS tower, they experience the best that DSL has to offer.

Current Service Offerings

The following table summarizes the various Internet, voice, video, and cellular service types, providers, and service notes related to resident experiences and prices. The table below demonstrates that only the school and library have potential access to broadband that meets the ConnectME definition; other locations have Internet access that falls short of that.

Current Service Offerings -Matinicus

Type	Provider	Service Quality
Voice	TDS	Residents characterized service as “good”
Video	Dish, Direct TV,	Residents characterized service as “good”
Internet	TDS DSL GWI Fixed Wireless	Basic DSL Internet package provides up to 5 Mbps down/ 1 up GWI: up to 3/1
Cellular	Verizon, US Cellular	Residents reported service was “very little” to “non-existent”
Public WiFi	Available at the school	Residents reported “strong” service

Public Internet Service - Matinicus

Type	Provider, Service	Service Notes
Library	T1 Line	• T1 is currently sufficient to meet streaming and video conferencing needs
School	T1 Line	• T1 is currently sufficient to meet streaming and video conferencing needs
Town Hall	DSL	• Streaming/videoconference needs
Public Safety	Weak Cellular TDS phone line	• Improved voice cellular coverage, particularly for fishermen
Doctor’s Offices	T1 Line at the ferry terminal	• Residents report that current medical service provided by the Maine Seacoast Mission is reliable and meets ongoing telemedicine needs.

Stakeholders' Stated Community Goals

The Matinicus community meeting revealed many potential broadband goals. Current service on Matinicus is characterized by slow and unreliable DSL speeds and residents voiced the need for reliable DSL-equivalent speeds, with some interest in DOCSIS 3.0 equivalent speeds as well. The central goal is to provide sufficient infrastructure to allow people to live on the island year round or at least to remain active members of the community. While residents want increased connectivity they also are very cost conscious and do not want to overburden their tax base. The community is also mindful that remoteness is part of Matinicus' identity and one of the reasons why people live there and travel there. While improved Internet service is key to sustaining the community, it must be balanced with maintaining the community's values.

Specific goals included:

- Access to broadcast television channels
- Reliability and consistency
- Voice cellular coverage, data would be a bonus but not critical
- Giving businesses enough bandwidth to process credit cards and use basic cloud computing
- Ensuring low cost service

There is a current need for broadband everywhere on Matinicus. Even wireless and cellular service over water is valuable for reasons of safety.

Community Priority Buildings/Businesses

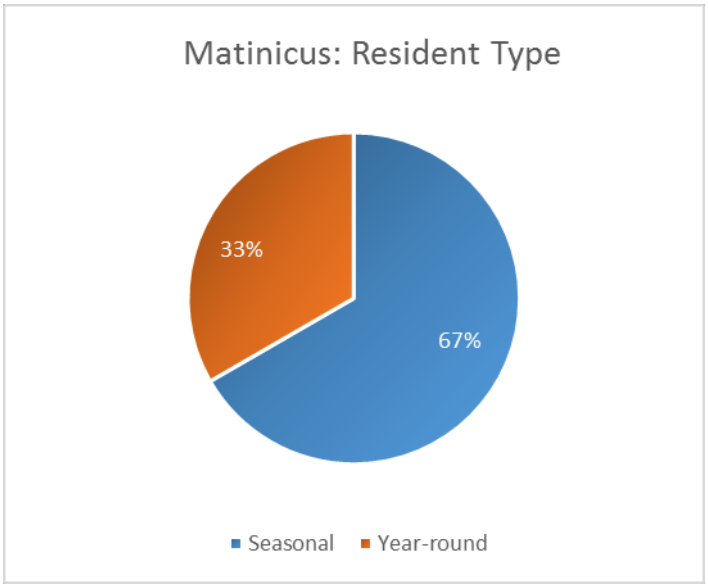
All of the small business entities on Matinicus are small businesses consisting of one or two employees. Most of these businesses expressed a need for reliable DSL-equivalent speeds as current DSL has slow speeds and low reliability.

The businesses that would benefit from improved connectivity on the island include:

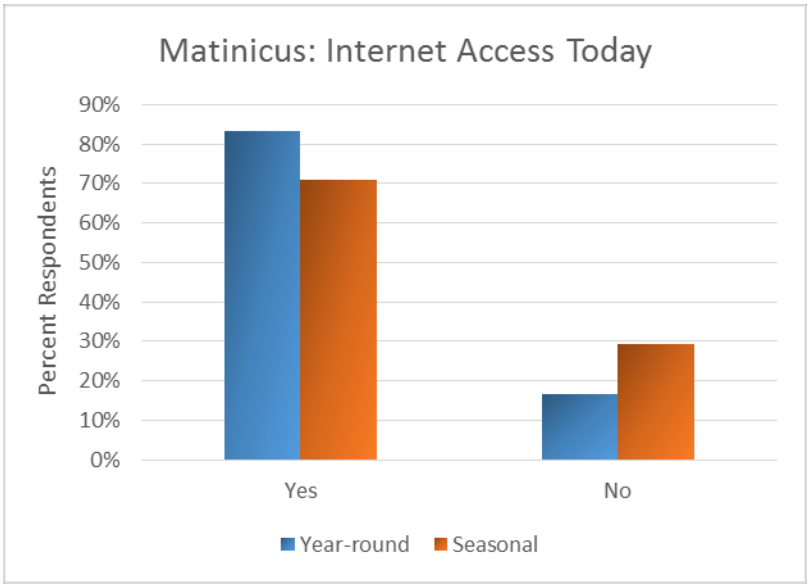
- Water taxi
- Lobster buyer
- Propane Business
- Merrill and John Libby
- Real Estate agents
- Gallery
- Telecommuters / Teleworkers
- Legal professionals. One judge and two lawyers work from the island in summer
- Accounting professionals
- Medical transcriptionist

Survey Results

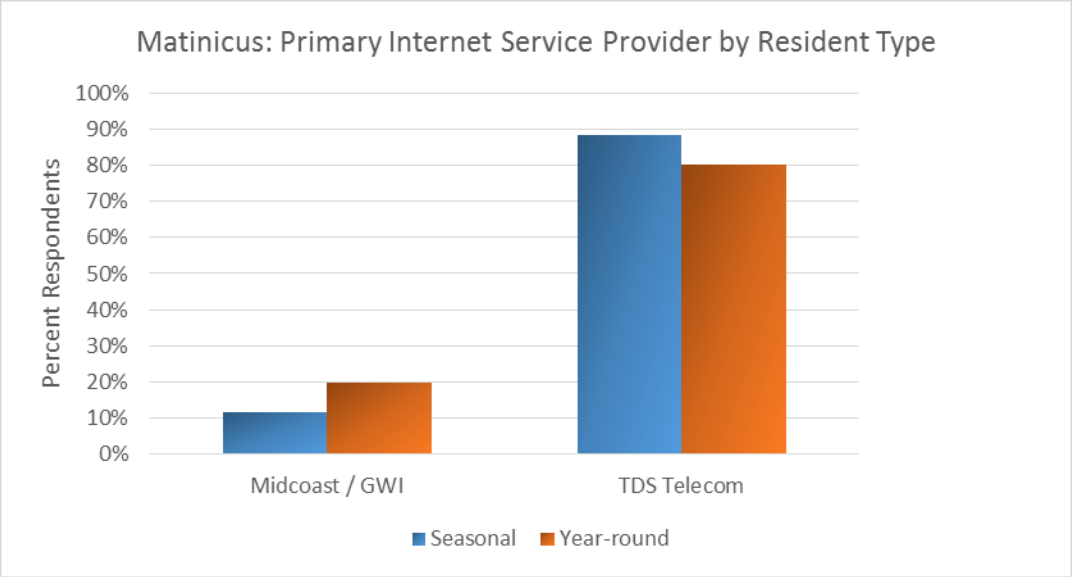
Tilson conducted a randomized survey of a subset of the 141 property owners on Matinicus. Of the 281 surveys sent out, 36 respondents (26%) completed and returned the survey. This group was comprised of 24 seasonal residents and 12 year-round residents.



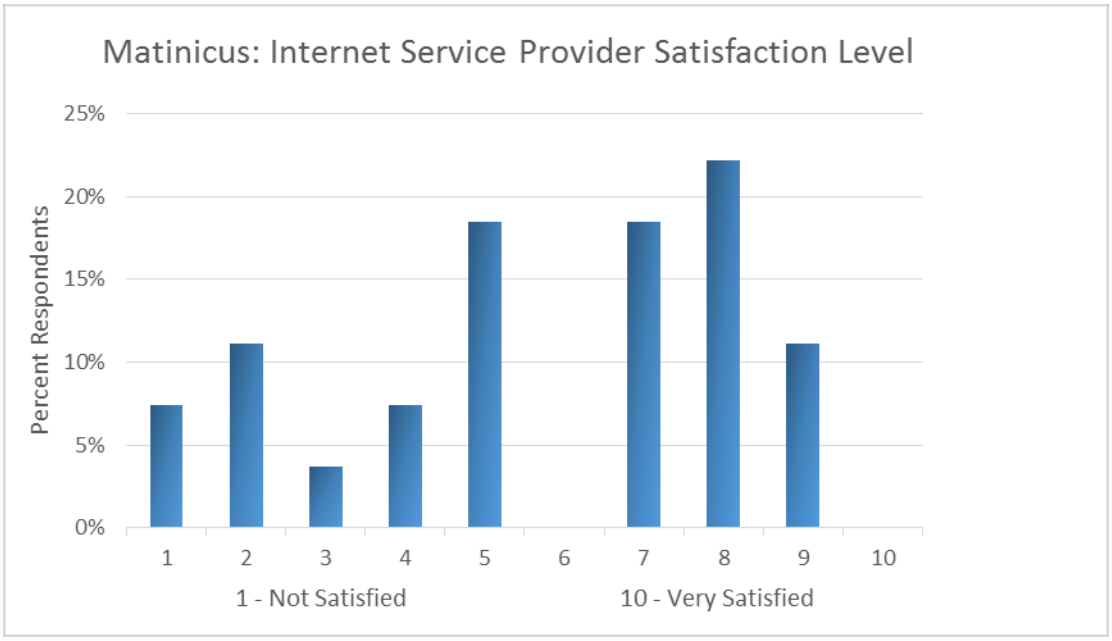
83% of year-round and 71% of seasonal respondents to the survey indicated that they currently had Internet service, as shown by the following chart.



For this group of respondents, TDS Telecom is the primary ISP for 88% of seasonal and 80% of year-round residents on the island, with a handful of respondents indicating Midcoast/GWI as their primary ISP.

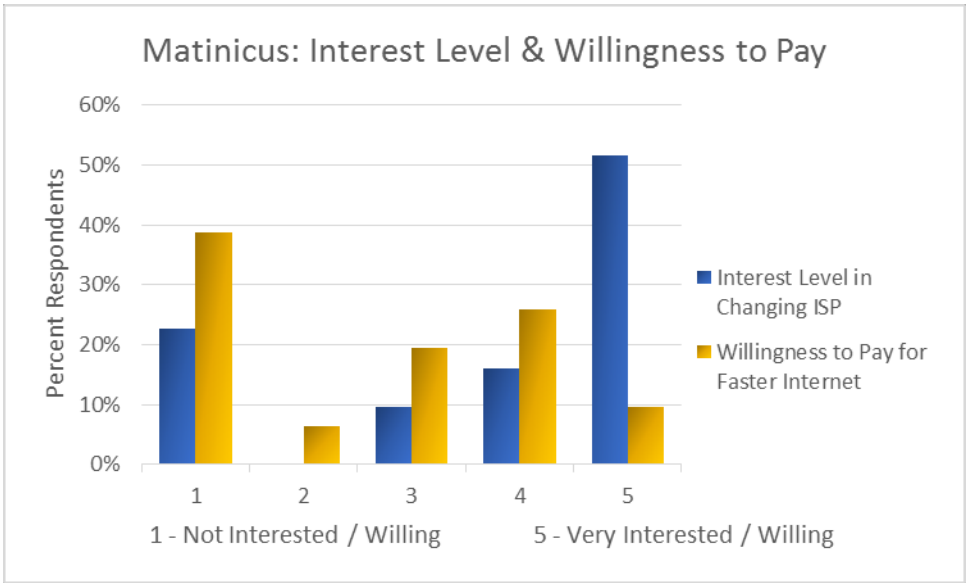


In terms of satisfaction level towards the ISP, on a scale of 1 to 10, 14 respondents (52%) indicated satisfaction (a score between 6 and 10) with their ISP, with 8 respondents (29%) indicating that they were not satisfied with the current ISP. 19% of respondents indicated that they were neither satisfied nor dissatisfied.

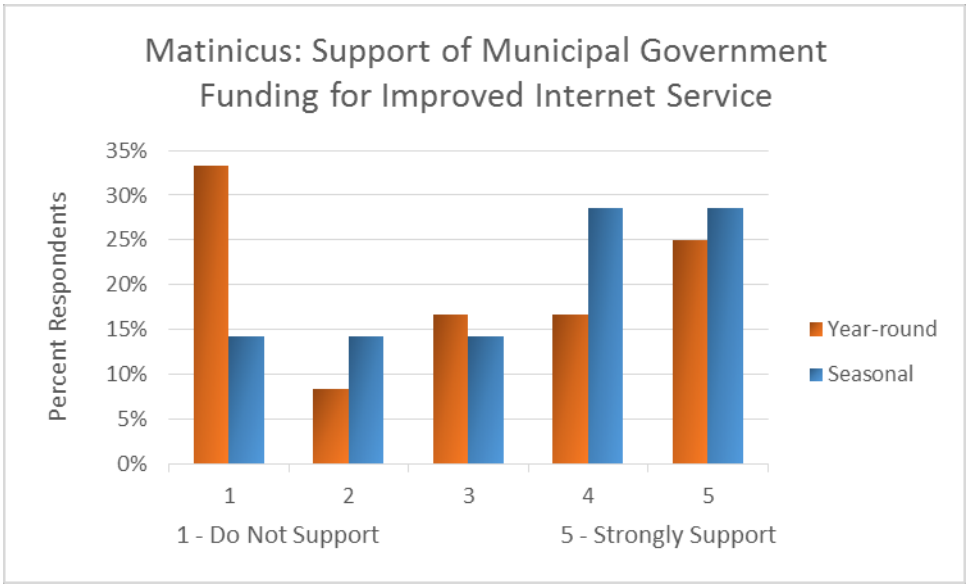


The survey also attempted to gauge islanders' attitudes toward change. 68% of Matinicus survey respondents indicated that they would be willing to switch ISPs if it meant being able to have faster connectivity. Despite this clear interest, only 36% of this same group of respondents indicated that they would be willing to pay more money to obtain that service, with 45% being unwilling to do so, and 19% not sure one way or the other. These two metrics—interest and willingness to pay—can be compared side-by-side in the following graph. It should be noted that while the willingness to pay results

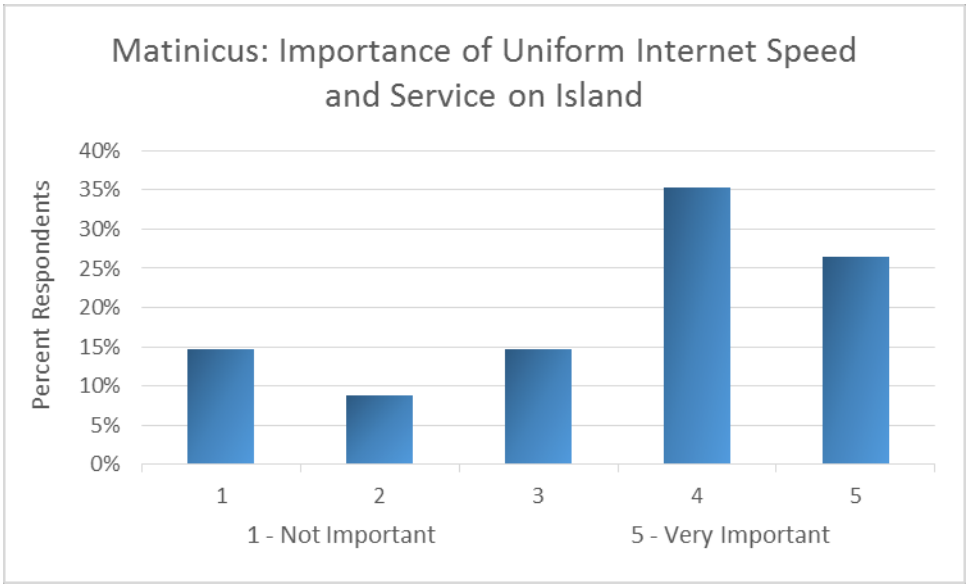
emphasize the importance of a cost effective solution, the survey did not collect information regarding the current Internet costs being paid by respondents.



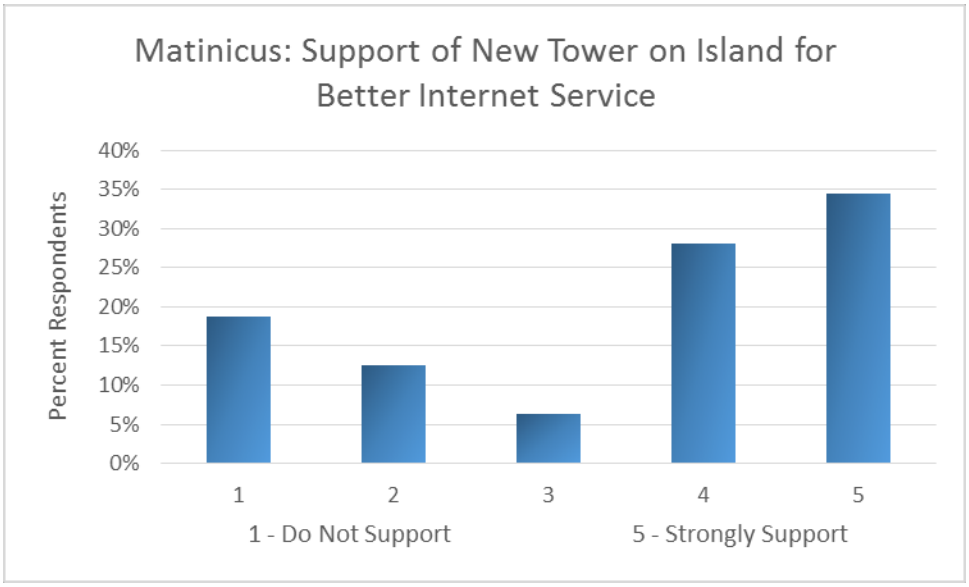
In terms of Matinicus respondents' support for municipal government funding an improvement of Internet service on the island, an average of about 50% of respondents would either support or strongly support their municipal government funding an improvement in connectivity, with an average of 35% (seasonal and year-round) respondents who would not support this. The remaining 15% of respondents did not indicate a strong support or lack of support for municipal government funded Internet improvement.



As for uniformity of a connectivity solution and the importance of everyone on the island having access to the same level of Internet speed and service, most respondents (61%) agreed that this was very important to them.



Finally, Matinicus Island residents were asked their opinion of how they would feel about a new telecommunications tower being built on the island so as to enable better Internet service. While a sizable contingent, 10 respondents (32%) would not support this at all, 20 respondents (62%) indicated that they would. 6% of respondents were ambivalent.



Possible Solutions

Tilson examined three options for Matinicus to consider: improving existing TDS DSL service[41]; Redzone's wireless LTE service; and a fiber to the premise (FTTP) network. These options range in

[41] This option may meet the needs of the community in the near term, but does not meet the ConnectME or FCC definition of broadband.

possibly meeting to exceeding the community's short term needs. Taking no action to address the lack of broadband is also an option: however it may prevent the community from achieving stated goals like enhancing entertainment options and enabling business.

Fiber Network Design

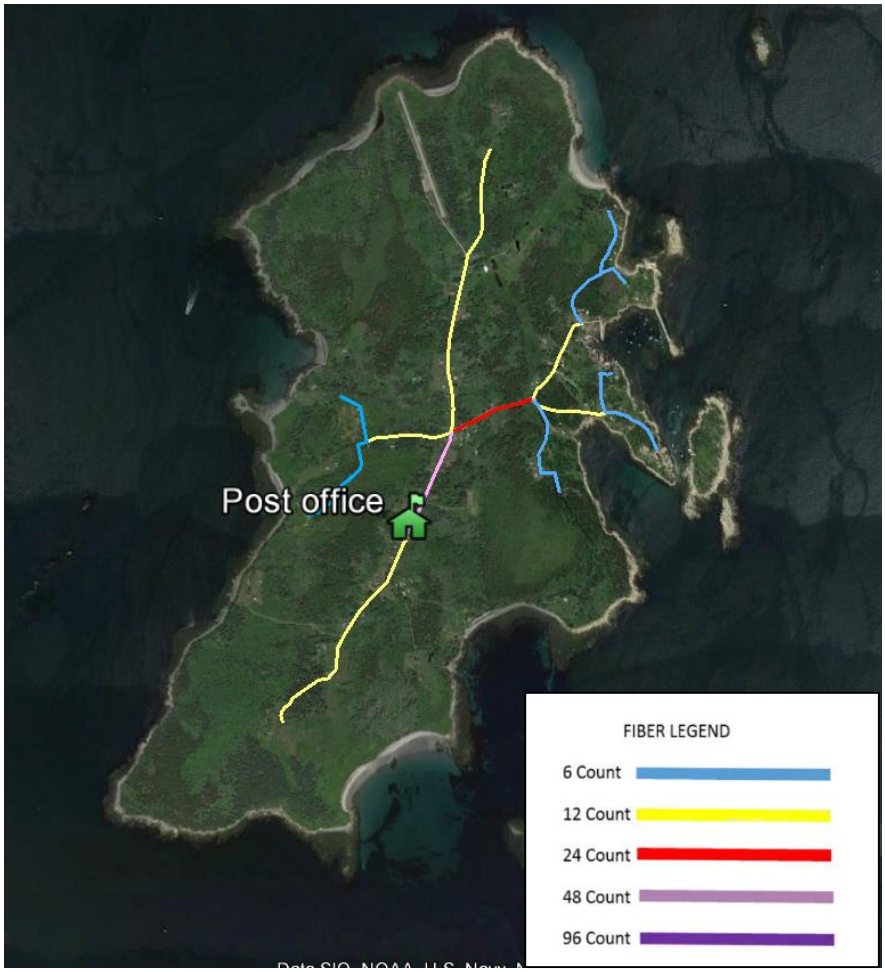
A fiber to the premise (FTTP) network is the gold standard in municipal network design: it is the most upgradeable, the least expensive to operate on a whole-island basis, the fastest, the most reliable, but also the most expensive to build. Because an FTTP network is so reliable, it requires less customer support and is less expensive to operate than DSL, hybrid fiber/coax, or wireless networks. The largest operating disadvantage to fiber is that if it is cut, it requires a technician skilled in fiber repair (and typically a bucket truck) to fix. Fiber networks can be configured to provide 1 Gigabit (Gbps) speed upload and download—100 times faster than the current ConnectME standard.

Tilson designed a FTTP solution that would pass and connect to all 111 premises on the island. Fiber counts were specified for each segment to optimize for current building distribution, and with future growth in mind. Tilson designed multi-port service terminals (MST's) throughout the network to enable easy and short interconnections with existing and future premises.

To complete the local access portion of this network, electronics are needed at the customer premise and at the traffic collection node, or end. In addition, an ISP would need to place its own electronics and microwave backhaul to the mainland. There are various operating models whereby these network elements could be owned and operated either by the town, a network operator, or the ISP.[42]

[42] Tilson will describe municipal models that include ownership of a greater proportion of the infrastructure in the "Business Model Overview" section of this report.

Fiber Network Design - Matinicus



Fiber Capital Cost Estimate

Tilson's detailed cost estimate included all of the design, application, materials and labor costs associated with the fiber to the curb network.[43] For all of the islands, Tilson assumed that 90% of the route miles were aerial, and 10% were underground. The estimate also assumes that all of the fiber drops are built at once, rather than on-demand. An island premium of 10% on materials, and 20% on labor was added onto all of Tilson's standard estimates, and is reflected in the numbers below.

[43] Tilson's detailed cost estimate is based on the known cost of the network components of its high level fiber design, plus estimates for labor costs, engineering and margin. A firm estimate is obtained when a project is put out to bid. Projects can be separated into engineering design and build, or put out to bid as a combined design/build.

Fiber Capital Cost Estimate - Matinicus

Project Miles		3.6
Aerial Miles		3.2
Poles		104
Premise Count		111
Application and Make Ready	$	31,561
Materials	$	51,012
Labor	$	155,626
Engineering	$	10,375
Margin/Profit (20%)	$	49,715
Service Provider Tax (6% Labor and Engineering)	$	12,943
Sales Tax (5.5% Materials)	$	2,806
Total	$	314,037
Per Premise Cost	$	2,829

The incremental capital cost of building out the network, which would be borne by either the ISP, the municipality, or a network operator - depending on the business model - are not included above.

To complete the local access portion of this network, electronics are required at the customer premise and the traffic collection node, or head end. These electronics cost about $570 per premise. In addition, an ISP would need to deploy network electronics, which are customarily paid for by the ISP, even though they may be housed in a municipal building.

The electronics described above need to be housed in a space with redundant power, heating and sufficient heat dissipation ("conditioned space"). That conditioned space can be provided by a stand-alone shelter for about $250,000, or a municipality can provide it in one of its buildings to deliver substantial cost savings.

If the network were to be connected to the mainland via microwave, the capital cost estimate for two microwave dishes and one new small tower on the island (this assumes the mainland microwave dish is mounted on an existing tower), is $45,000. While a microwave link will be necessary for every island without a subsea fiber cable, there are opportunities for islands collaborate to either save money in operating the link and/or increasing the redundancy and reliability of the links. These are highlighted in the "Opportunities for Regional Cost Savings" section near the end of this report.

Wireless LTE Design

Tilson engaged Redzone,[44] the only company offering fixed wireless LTE in Maine, to design a network that would provide universal access to all premises on the island. This means that all island users would

[44] Design work performed for Redzone by 4G Unwired, Indialantic, FL.

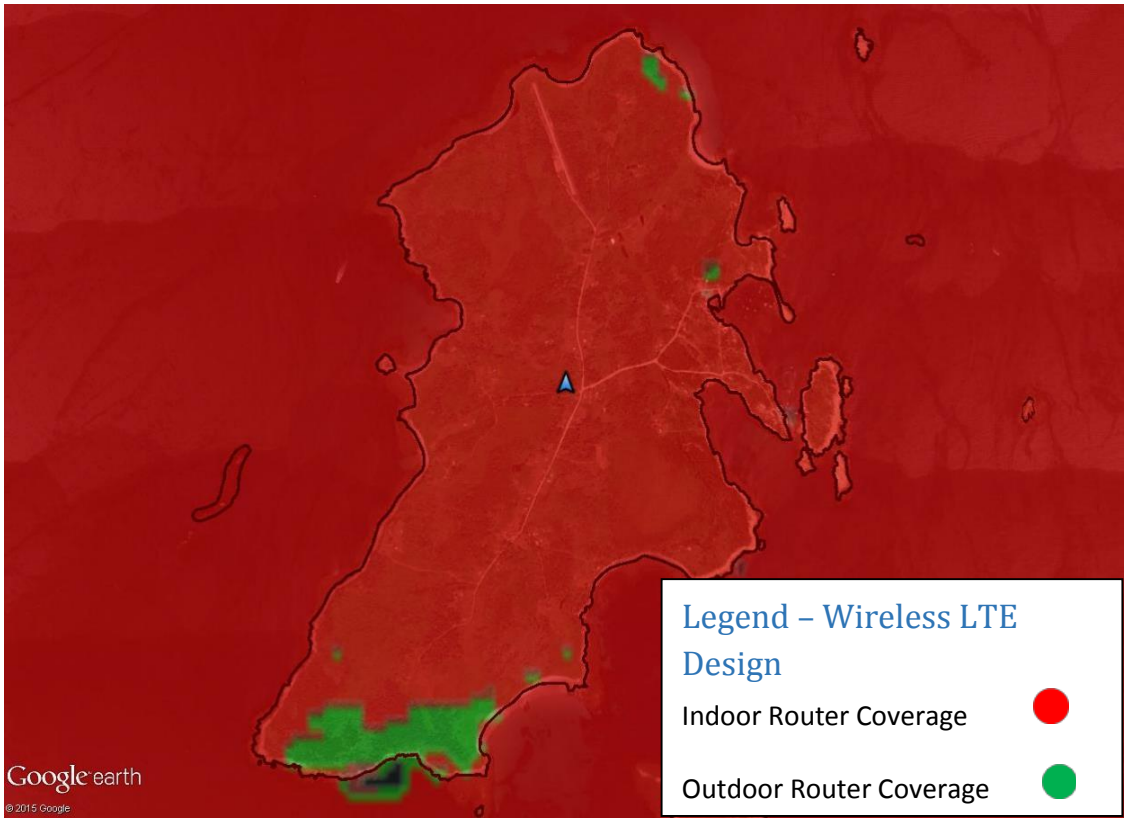
have access to the same speed offerings, which are fast enough to meet both the FCC and ConnectME definition of broadband.[45]

Redzone's design deployed 150' tall towers, placed in optimal locations to provide universal coverage with the fewest number of towers. The red on the map represents areas of indoor LTE coverage, meaning that an external antenna is not necessary to have access to all of Redzone's speed offerings. The green areas represent locations where an outdoor antenna is needed to access to Redzone's full service offerings. Across the islands for which Redzone designed a network, 91% of the households will have access via indoor router, and 98.7% will have access via outdoor router.

Redzone would likely backhaul its traffic to the mainland via microwave.

The following image shows the wireless LTE design for Matinicus. The red on the map represents indoor LTE coverage for households on the island. The green areas represent outdoor LTE coverage on the island given the tower build. The blue placemark represents an LTE tower build that would be needed to produce the results depicted.

Wireless LTE Design - Matinicus



[45] Current speed and pricing information is located in the "Service Offering Overview" section near the end of this report.

Wireless LTE Cost Estimate

Redzone estimates that the capital cost of deploying equipment on a tower, plus microwave backhaul, is $125,000 per tower. Tilson estimates that the cost of building a 150' telecommunications tower on an island is an additional $200,000, although that can vary widely. Because Matinicus does not currently have any existing telecommunications towers, the Redzone solution would require one LTE site, plus one tower for a total estimated cost of $325,000.

In this model, the town would fund and likely own the towers. New towers could potentially be used by other telecommunications carriers, like mobile providers. Redzone would retain ownership of its equipment and bill customers directly. In today's environment, it is unlikely that Redzone would deploy equipment on the island without an almost complete capital cost subsidy.

Redzone's business model and service offerings are further discussed in the "Service Offering Overview by Provider" section of this report.

ILEC Network Improvements

TDS Telecom is the incumbent DSL internet and phone service provider on Matinicus. Tilson has learned that TDS' Architectural Design team is undertaking a project to improve the microwave infrastructure on the islands of Frenchboro, Swan's Island, Matinicus, and Isle au Haut.[46] As service provider for the Maine Schools and Libraries Network (MSLN), FairPoint has contracted with TDS to upgrade the bandwidth to the schools and libraries within TDS territory, providing each school and library with 100 Mbps symmetrical speeds.

The backhaul capacity upgrade triggered by the MSLN service will enable TDS to offer faster DSL speeds to Matinicus customers. Today, TDS Telecom offers DSL on Matinicus with speeds up to 5 Mbps download and .512 Mbps upload. After the upgrade, these speeds will increase to a maximum of 15 Mbps download and .768 Mbps upload for customers within 10,000 route feet (1.9 miles) of the DSLAM, or DSL node.[47] Because Matinicus is fairly small, and the TDS DSLAM is near the center of the island, Tilson believes that all customers will have access to the 15 Mbps download service.

The project is tentatively slated for completion at the end of the second quarter of 2016. Customers will be able to take advantage of the improved speeds by the end of the third quarter of 2016.

[46] Per communication from Scott Brooks, Manager – State Government Affairs, TDS Telecommunications Corporation, 10/14/2015.

[47] More information on current and projected TDS speeds and pricing can be found in the "Service Offering Overview" section of this report.

Funding

Residents and Town stakeholders expressed some interest in the Town partially or wholly funding a network but there are very limited resources available for this purpose as the total town budget is less than $1 Million. For this reason, the town has a strong preference for grants and private funding for any Internet connectivity solution.

Frenchboro

Background

Frenchboro is a small island community consisting of 2,500 acres in total, of which 1,000 acres are owned by Maine Coast Heritage Trust. The 2010 U.S. Census places Frenchboro's year-round population at 61 year round residents, with a summer population of 150. A more recent survey of the island places the current year-round population of Frenchboro at 40 residents.[48] There are approximately 57 premises located on this island, not including the Frenchboro Elementary School and the Frenchboro Public Library. The existing infrastructure on Frenchboro includes a subsea power cable that is part of the Swan's Island Electrical Cooperative which makes landfall on the west side of the Island in the outer harbor. A microwave tower on the high point of the west side of the island serves telephone landlines, and the nearest cellular assets are the cellular tower on Swan's Island. In total, there are two miles of paved roads on Frenchboro, with another two miles of unpaved trails stretching through wooded areas.

Community Goals

Tilson met with a handful of Frenchboro Town officials and residents at its community visit, conducted at the Frenchboro School in July. For some Frenchboro residents, TDS DSL service seems to meet immediate needs. Some residents reported 4 Mbps download .4 upload speeds via their current DSL service. For these residents, streaming video content can be accomplished without too much difficulty. For other residents who have teleconferencing needs, some employ a Tanberg dedicated video conferencing service. For these residents, some have had difficulties when one person uses the

[48] Island Institute Informal Survey, Spring 2015.

teleconferencing device and another person in the same residence uses another computer at the same time. Given this, scalability of the DSL service can be a problem for some residents with DSL on Frenchboro.

Current Internet access through the Maine School and Library Network program (MSLN) at the Frenchboro Elementary School has experienced outages for stretches of time within the past year. Through the MSLN program, the school will get a 100 Mbps symmetrical connection by June 2016. The school and library will be receiving 100 Mbps. A speedtest conducted at the school in August showed speeds of 21.44 Mbps download and 24.77 upload. A speedtest conducted at the Frenchboro Public Library showed speeds of 8.62 Mbps down and 3.75 up.

One of the primary problems voiced by Frenchboro residents was the observation that people who come to Frenchboro are not confident in the quality of education available for their children, and that if they could easily attend high school remotely, more kids would stay and perhaps more families would move to the island given that they would then have access to quality remote education. As for adult education, this seems less a priority because most Frenchboro retirees are seasonal residents only.

In terms of goals with regard to public services on Frenchboro, there does not appear to be a significant need for connectivity to serve these as Frenchboro has no organized fire or police services on the island.

Residents cited the harbor area as a place in Town where free public Wi-Fi would be most useful, and any such solution deployed there could serve the concurrent need of supporting the connectivity required by the Maine Seacoast Mission, which visits the Island on a weekly basis and has telemedicine capabilities. While there has been discussion in Frenchboro regarding building a health center on the island, there are no definite plans to do so as yet.

Community Priority Buildings/Businesses

Residents and stakeholders on Frenchboro emphasized the need for enhanced connectivity in order to serve the following priority Town buildings and businesses:

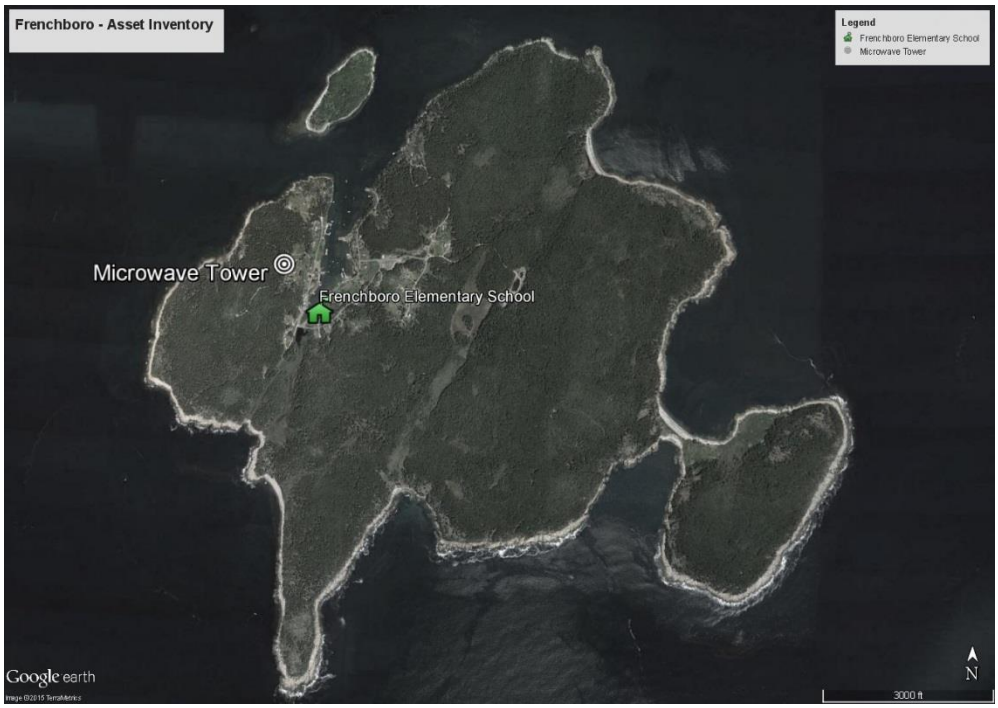
- Town Office: Residents expressed the need for a broadband solution for this Town building so as to serve the need for teleconferencing and remote meetings.
- Internet Crafts Businesses
- Woodworking memorabilia business
- Seasonal Restaurant business
- Lobster Wholesalers

Asset Inventory

There is no fiber optic infrastructure currently existing on Frenchboro. As mentioned in the background section, the existing infrastructure on Frenchboro includes a subsea power cable that is part of the Swan's Island Electrical Cooperative which makes landfall on the west side of the Island in the outer harbor. A microwave tower on the high point of the west side of the island serves telephone landlines, and the nearest cellular assets are the cellular tower on Swan's Island. Frenchboro is currently served by

TDS DSL. In total, there are two miles of paved roads on Frenchboro, with another two miles of unpaved trails stretching through wooded areas.

Frenchboro Asset Inventory



Current Service Offerings

The following table summarizes the various Internet, voice, video, and cellular service types, providers, and service notes related to resident experiences and prices on Frenchboro. Only the school had tested speeds that met or neared the ConnectME and FCC definition of broadband.

Type	Provider	Service Notes
Internet	TDS (DSL)	• Basic DSL Internet package provides up to 5 Mbps down/1 up

Voice	TDS	
Video	Satellite (DirectTV)	
Cellular	Verizon, U.S. Cellular	• Cellular service is not meeting most Frenchboro residents' needs

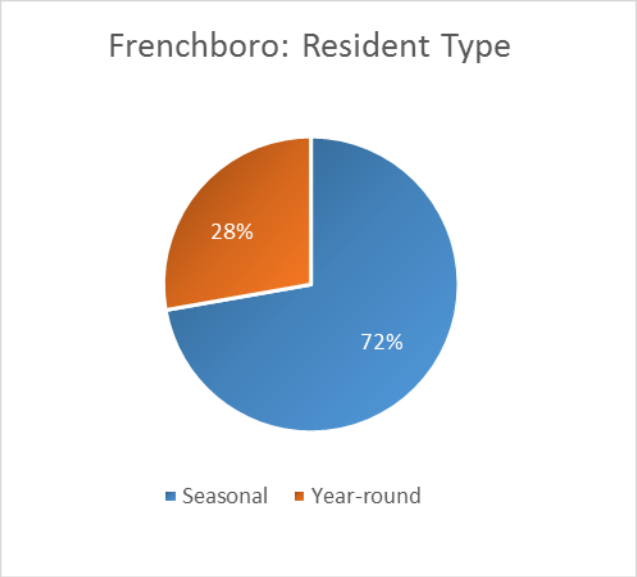
Public Internet Service – Frenchboro

Type	Provider, Service	Service Notes
Library	TDS	• Lacks a separate circuit to the Maine School and Libraries Network (MSLN) Speedtest.net (conducted by Island Fellow: 8.62 Mbps down/3.75 up
School	TDS	• Speedtest.net (8/5/15) 21.44 Mbps down/24.77 up[49]
Public WiFi	N/A	• No Public WiFi currently on Frenchboro

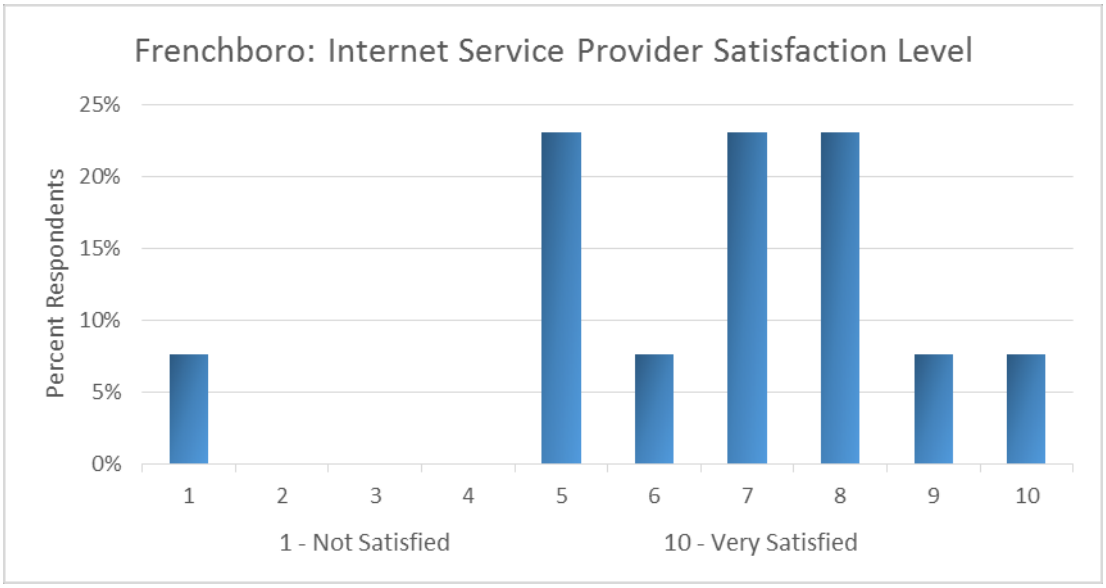
Survey Results

Tilson mailed paper surveys to the full list of 65 year-round and seasonal property owners in Frenchboro, and received 18 responses back (28% response rate) prior to closing the survey. The respondents consisted of 13 seasonal and 5 year round residents. The following chart shows this breakdown.

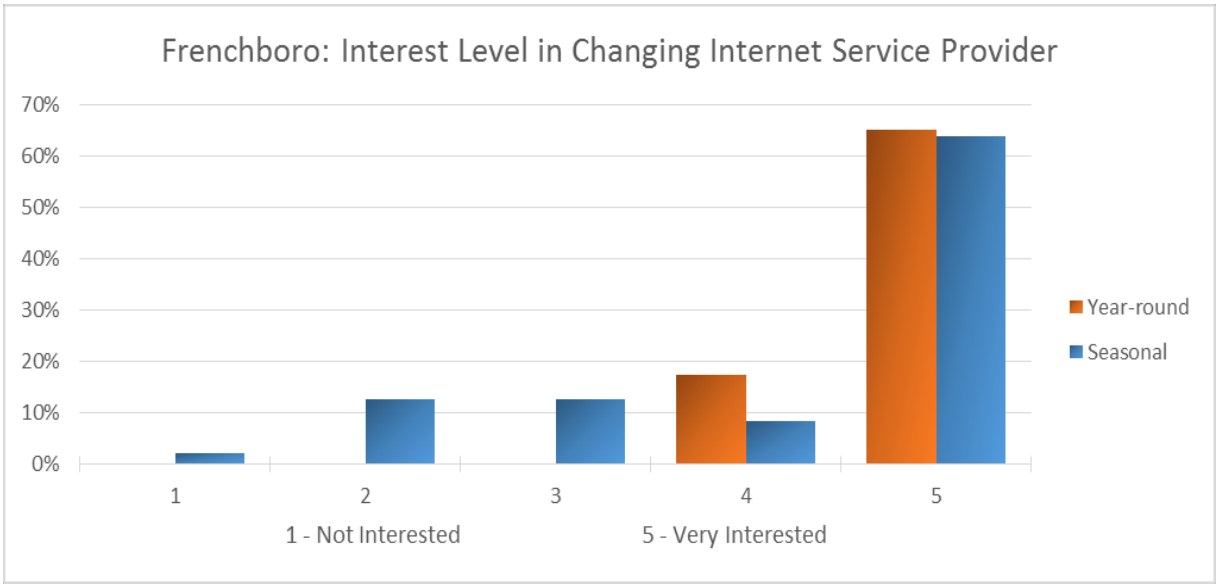
[49] Per speed test conducted by island resident, 8/7/15.



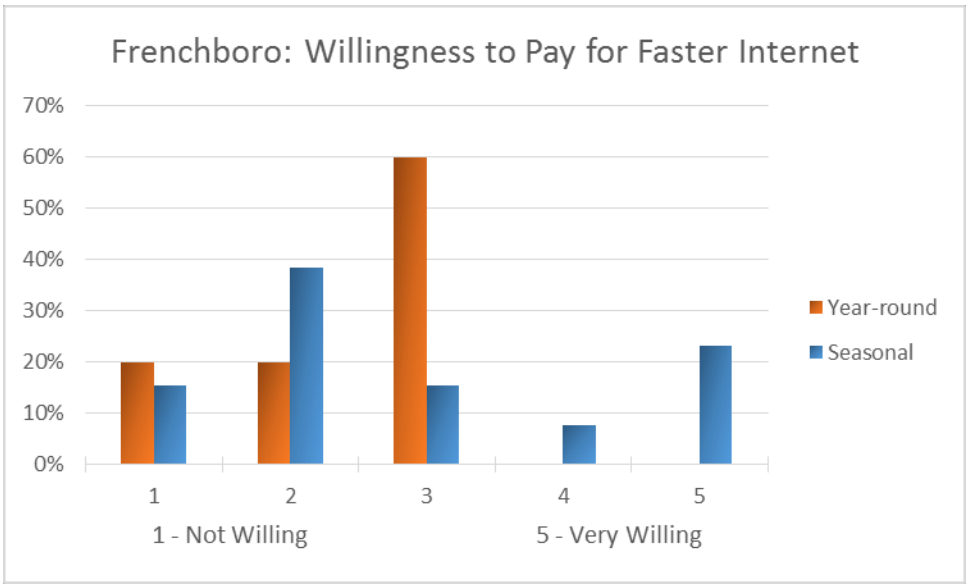
Of these respondents, all year-round residents (5) who answered the survey indicated that they currently had Internet access on the island, with seven out of 13 (58%) of seasonal residents reporting that they currently have Internet on Frenchboro. All respondents to the survey stated that they have TDS Telecom as their primary ISP, and nine out of 13 (70%) reported being satisfied with TDS as a provider, with nearly 50% (six out of 13) giving a satisfaction rating of 7 or 8 out of 10 to the provider.



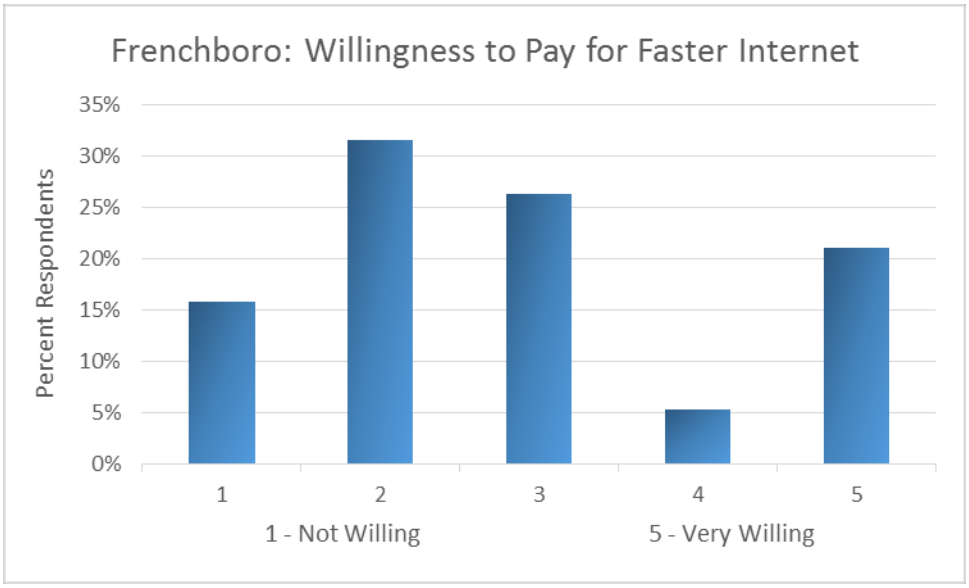
Despite the overall satisfaction Frenchboro survey respondents indicated towards TDS as an Internet provider, 73% of seasonal and 82% of year-round respondents conveyed that they would be interested in changing providers if it would mean a better level of service and connectivity.



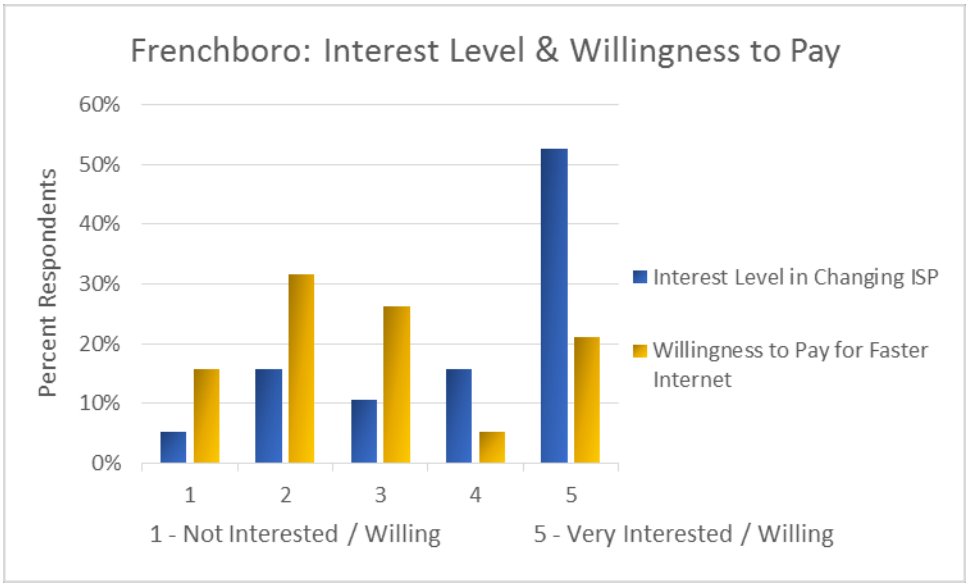
Despite the clear interest in better connectivity however, most Frenchboro respondents are averse to paying more for better, faster Internet, as only 31% (4 out of 13) of seasonal respondents and no (0 out of 5) year round respondents indicated a willingness to do so. Fifty three percent of seasonal and 40% of year-round respondents indicated an unwillingness to pay for faster Internet.



As for grand totals, of the 19 total respondents to the survey, 48% indicated that they would not be willing to pay more for better connectivity, with just 26% of all respondents indicating a willingness to pay more. The remaining 26% (5 respondents) indicated neither a willingness nor unwillingness to pay more for better Internet service, as illustrated in the following chart.

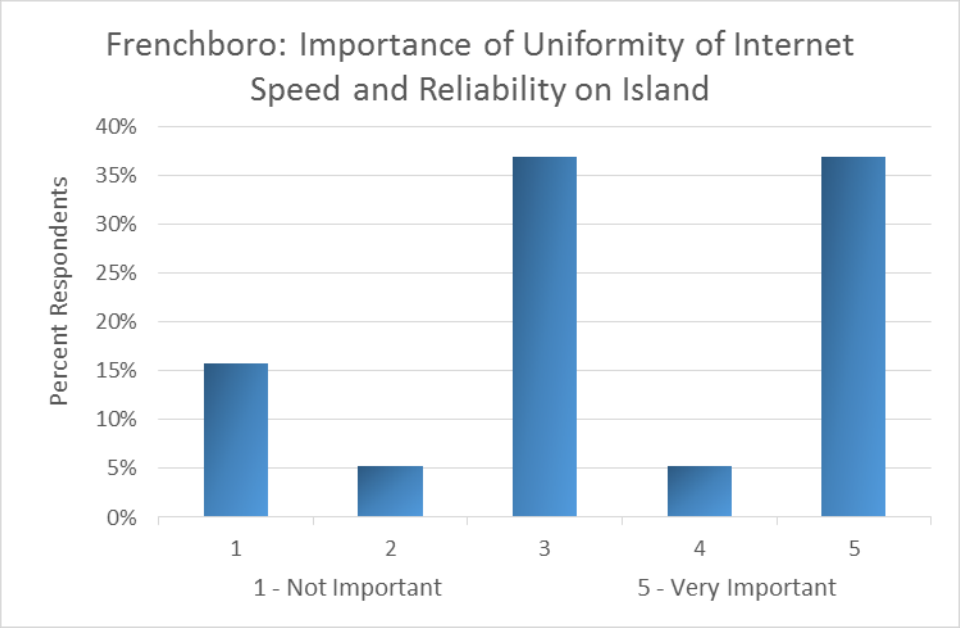


The following chart shows the interest level and willingness to pay more for improved connectivity as indicated by Frenchboro survey respondents.



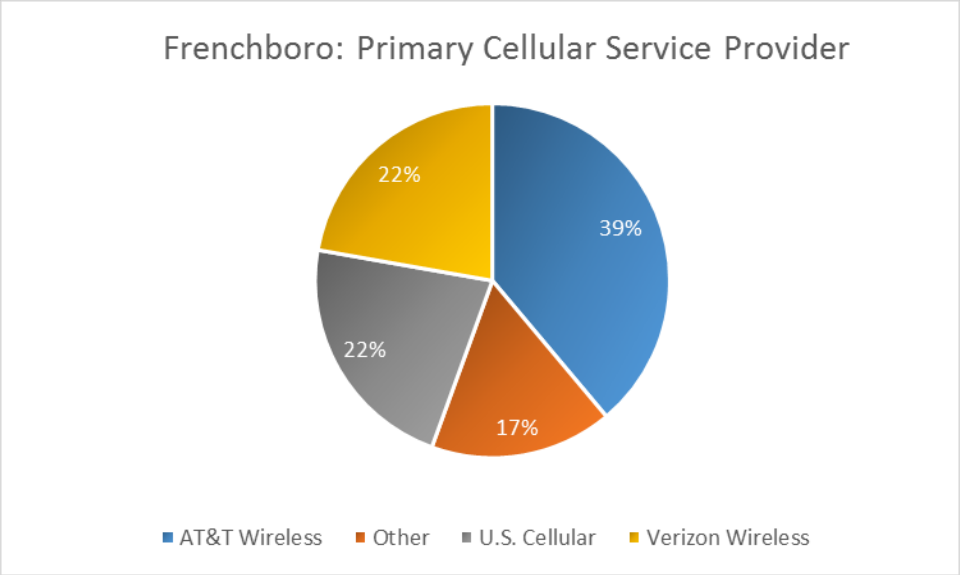
The survey conducted also attempted to gauge Frenchboro residents' support of municipal government paying for improved Internet service. Of those who responded to the survey, it was a fairly even split as an average of 39% of respondents indicated that they do not support government funding of Internet improvements, 39% indicating that they did support it, and the remaining 22% neither indicating unwillingness or strong support on this point.

On the question of whether it was important to residents that everyone on the island have access to the same level of Internet speed and service, twice as many respondents (8 versus 4) deemed this an important objective for the community, while seven respondents (37%) did not express a strong preference as to its importance.

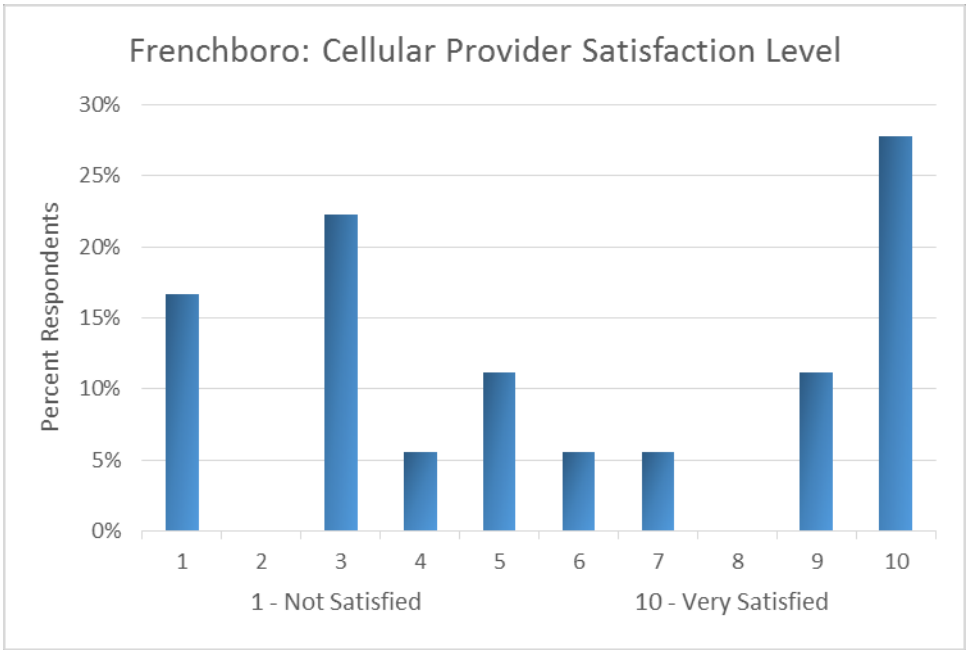


Finally, regarding the question of whether residents would support a new cellular tower on the island to enable better Internet service, the majority of respondents (58%) indicated that this was something that they would support, while 11% would not support it. The remaining 32% of respondents, neither indicated support nor opposition to the idea of a new tower build.

In terms of the primary cellular service provider for islanders, most respondents indicated their provider was AT&T (39%), with a fairly even split between U.S. Cellular, Verizon, and other providers for the remainder of respondents.



Of the respondents who indicated their primary cellular provider, satisfaction levels varied greatly, thus no discernable conclusion can be drawn from this data.



Possible Solutions

Tilson examined three options for Frenchboro to consider: improving existing DSL service[50]; Redzone's wireless LTE service; and a fiber to the premise (FTTP) network. These options vary in how well they either meet or the extent to which they exceed the community's short term needs. Taking no action to address the lack of broadband is also an option: however, absent planned TDS upgrades, it may prevent the community from achieving stated goals like enhancing educational opportunities, improving town governance and enabling business.

Fiber Network Design

A fiber to the premise (FTTP) network is the gold standard in municipal network design: it is the most upgradeable, the least expensive to operate on a whole-island basis, the fastest, the most reliable, but also the most expensive to build. Because an FTTP network is so reliable, it requires less customer support and is less expensive to operate than DSL, hybrid fiber/coax, or wireless networks. The largest operating disadvantage to fiber is that if it is cut, it requires a technician skilled in fiber repair (and typically a bucket truck) to fix. Fiber networks can be configured to provide 1 Gigabit (Gbps) speed upload and download—100 times faster than the current ConnectME standard.

Tilson designed a FTTP solution that would pass and connect to all 76 premises on the island. Fiber counts were specified for each segment to optimize for current building distribution, and with future growth in mind. Tilson designed multi-port service terminals (MST's) throughout the network to enable easy and short interconnections with existing and future premises.

To complete the local access portion of this network, electronics are needed at the customer premise and at the traffic collection node, or end. In addition, an ISP would need to place its own electronics and

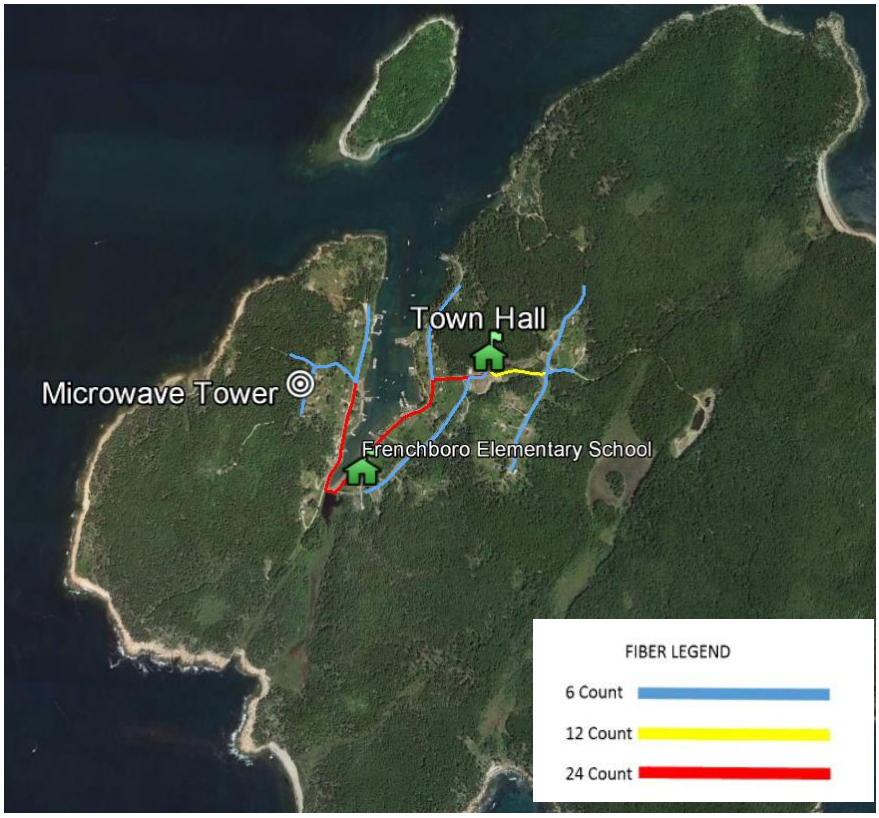
[50] This option may meet the needs of the community in the near term, but does not meet the ConnectME or FCC definition of broadband.

microwave backhaul to the mainland. There are various operating models whereby these network elements could be owned and operated either by the town, a network operator, or the ISP. [51]

Tilson understands that there is a possibility that Emera will assume provision of electricity from the Swan's Island Electric Cooperative. If this occurs, and Emera replaces existing cables with fiber optic strands for grid management, the town should negotiate access to additional strands for potential future use.

The following image shows what a fiber optic solution design would look like for the Town of Frenchboro. The different path colors indicate different strand counts of fiber.

Fiber Network Design - Frenchboro



Fiber Capital Cost Estimate

Tilson's detailed cost estimate included all the design, application, materials and labor costs associated with the fiber to the curb network.[52] For all the islands, Tilson assumed that 90% of the route miles

[51] Tilson will describe municipal models that include ownership of a greater proportion of the infrastructure in the "business model overview" section of this report.

[52] Tilson's detailed cost estimate is based on the known cost of the network components of its high level fiber design, plus estimates for labor costs, engineering and margin. A firm estimate is obtained when a project is put out to bid. Projects can be separated into engineering design and build, or put out to bid as a combined design/build.

were aerial, and 10% were underground. The estimate also assumes that all the fiber drops are built at once, rather than on-demand. An island premium of 10% on materials, and 20% on labor was added onto all of Tilson's standard estimates, and is reflected in the numbers below.

Fiber Design Capital Cost Estimate – Frenchboro

Project Miles		2.2
Aerial Miles		1.9
Poles		62
Premise Count		76
Application and Make Ready	$	17,059
Materials	$	34,660
Labor	$	109,387
Engineering	$	7,292
Margin/Profit (20%)	$	33,680
Service Provider Tax (6% Labor and Engineering)	$	9,022
Sales Tax (5.5% Materials)	$	1,906
Total	$	213,005
Per Premise Cost	$	2,803

The incremental capital cost of building out the network, which would be borne by either the ISP, the municipality, or a network operator - depending on the business model - are not included above.

To complete the local access portion of this network, electronics are required at the customer premise and the traffic collection node, or head end. These electronics cost about $570 per premise. In addition, an ISP would need to deploy network electronics, which are customarily paid for by the ISP, even though they may be housed in a municipal building.

The electronics described above need to be housed in a space with redundant power, heating and sufficient heat dissipation ("conditioned space"). That conditioned space can be provided by a stand-alone shelter for about $250,000, or a municipality can provide it in one of its buildings to deliver substantial cost savings.

If the network were to be connected to the mainland via microwave, the capital cost estimate for two microwave dishes and one new small tower on the island (this assumes the mainland microwave dish is mounted on an existing tower), is $45,000. While a microwave link will be necessary for every island without a subsea fiber cable, there are opportunities for islands to collaborate to either save money in operating the link and/or increasing the redundancy and reliability of the links. These are highlighted in the "Opportunities for Regional Cost Savings" section near the end of this report.

Wireless LTE Design

Tilson engaged Redzone,[53] the only company offering fixed wireless LTE in Maine, to design a network that would provide universal access to all premises on the island. This means that all island users would have access to the same speed offerings, which are fast enough to meet both the FCC and ConnectME definition of broadband.[54]

Redzone's design deployed 150' tall towers, placed in optimal locations to provide universal coverage with the fewest number of towers. The red on the map represents areas indoor LTE coverage, meaning that an external antenna is not necessary to have access to all of Redzone's speed offerings. The green areas represent locations where an outdoor antenna is needed to access to Redzone's full service offerings. Across the islands for which Redzone designed a network, 91% of the households will have access via indoor router, and 98.7% will have access via outdoor router.

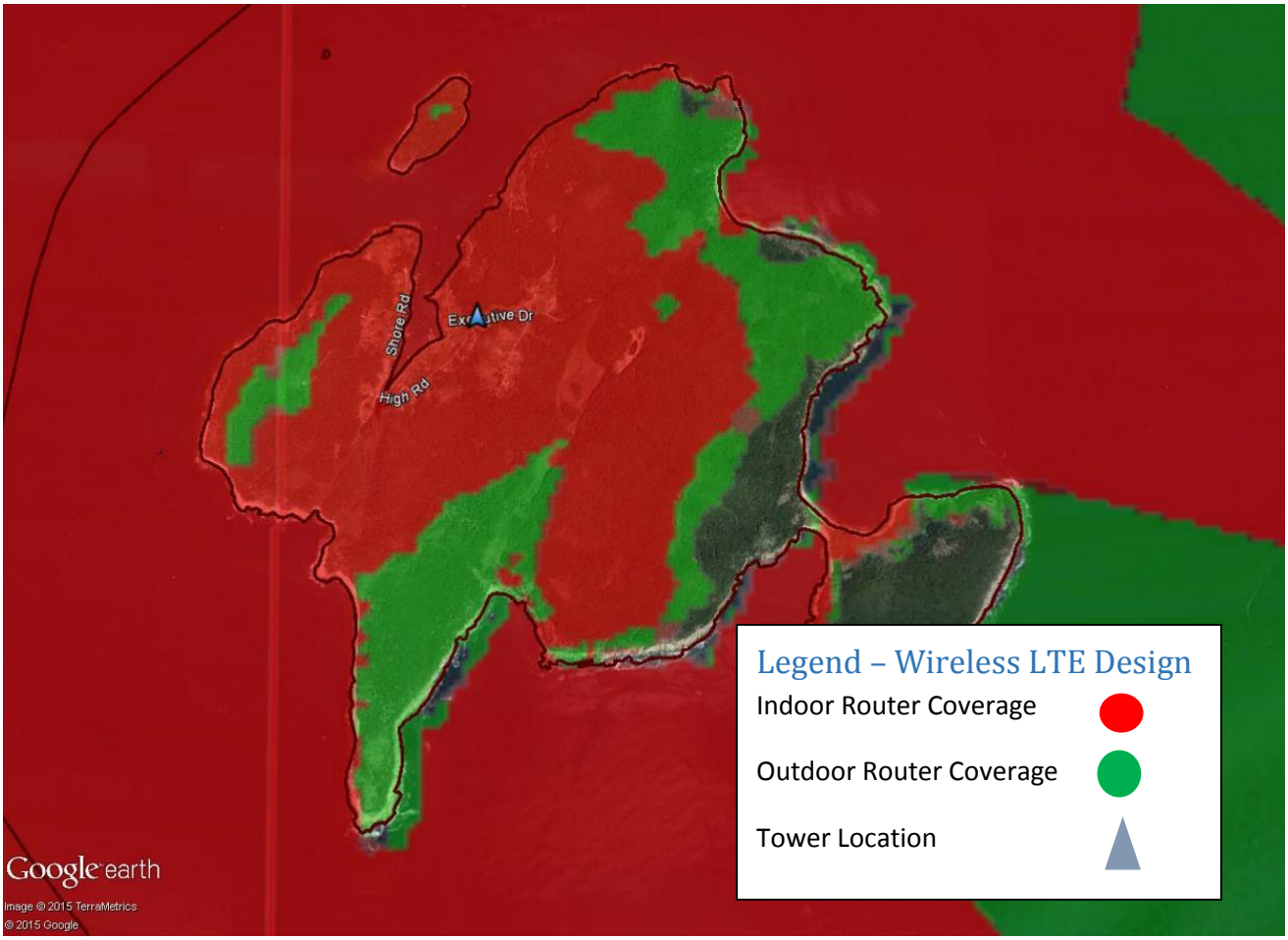
Redzone would likely backhaul its traffic to the mainland via microwave.

The following image shows the wireless LTE design for Frenchboro based on the installation of one tower location near High Rd. and Executive Drive. The red on the map represents indoor LTE coverage for households on the island. The green areas represent outdoor LTE coverage on the island given the tower build.

[53] Design work performed for Redzone by 4G Unwired, Indialantic, FL.

[54] Current speed and pricing information in the "Service Offering Overview" section near the end of this report

Wireless LTE Design - Frenchboro



Wireless LTE Cost Estimate

The capital cost estimate of a new tower build to serve an LTE Wireless solution designed above would be approximately $325,000. If a tower were already existing on the island, this could be done for $125,000, as LTE equipment can be colocated on existing tower infrastructure.

In this model, the town would fund and likely own the towers. New towers could potentially be used by other telecommunications carriers, like mobile providers. Redzone would retain ownership of its equipment and bill customers directly. In today's environment, it is unlikely that Redzone would deploy equipment on the island without an almost complete capital cost subsidy.

Redzone's business model and service offerings are further discussed in the "Service Offering Overview by Provider" section of this report.

Planned ILEC Network Improvements

TDS Telecom is the incumbent DSL internet and phone service provider on Matinicus. Tilson has learned that TDS' Architectural Design team is undertaking a project to improve the microwave infrastructure on

the islands of Frenchboro, Swan's Island, Matinicus, and Isle au Haut. [55] As service provider for the Maine Schools and Libraries Network (MSLN), FairPoint has contracted with TDS to upgrade the bandwidth to the schools and libraries within TDS territory, providing each school and library with 100 Mbps symmetrical speeds.

The backhaul capacity upgrade triggered by the MSLN service will enable TDS to offer faster DSL speeds to Frenchboro customers. Today, TDS Telecom offers DSL on Frenchboro with speeds up to 5 Mbps download and .512 Mbps upload. After the upgrade, these speeds will increase to a maximum of 15 Mbps download and .768 Mbps upload for customers within 10,000 route feet (1.9 miles) of the DSLAM, or DSL node.[56] Because Frenchboro is fairly small, and the TDS DSLAM is near the population center of the island, Tilson believes that all customers will have access to the 15 Mbps download service.

The project is tentatively slated for completion at the end of the second quarter of 2016. Customers will be able to take advantage of the improved speeds by the end of the third quarter of 2016.

Funding

Frenchboro representatives expressed that the Town is likely not prepared to make an investment in improving Internet connectivity itself at this point. Some potential opportunities for Frenchboro could involve a new subsea power cable's potential construction in the near future. Just as with Swan's Island, if Emera assumes electricity provision from the Swan's Island Electric Co-op, it will likely replace existing cables with fiber optic strands for grid management. If that happens, the town should negotiate access to additional strands for potential future use.

[55] Per communication from Scott Brooks, Manager – State Government Affairs, TDS Telecommunications Corporation, 10/14/2015.

[56] More information on current and projected TDS speeds and pricing can be found in the "Service Offering Overview" section of this report.

Swan's Island

Background

Swan's Island is an 8,000-acre island Down East with a year-round population of 332.[57] In the summer months, the island population increases to about 1,000. A more recent survey of the year-round island community placed the number of Swan's residents at 350.[58]

Current Infrastructure

[57] U.S. Census data, 2010.
[58] Island Institute Informal Survey, Spring 2015.

Asset Inventory – Swan's Island

The image above shows the two existing tower assets on Swan's island, as well as the TDS Telecom central office located near these towers.

TDS provides universal, or near universal, DSL service over the existing copper wire and has one central office on the island at the foot of its communications tower. The tower serves as a kind of hub in TDS's backhaul network for the coastal and island communities. The towns of Matinicus, Frenchboro, and Isle au Haut all connect to the Internet through Swan's Island.

TDS provides middle mile fiber and last mile DSL service over copper. TDS currently has three DSLAMs on the island, all of which are fiber-fed, but some residents who are still a significant distance from a DSLAM have reported speeds of 2.5 Mbps.

In terms of other improvements, Swan's schools and libraries are expected to receive a fiber optical service to the library through the Maine Schools and Libraries Network, but fiber will need to deployed to execute this.

Regarding the TDS Tower on the island, there is currently no room on the tower for additional infrastructure and TDS is not open to collating customers.

Current Service Offerings

The following table summarizes the various Internet, voice, video, and cellular service types, providers, and service notes related to resident experiences and prices. Only the school and library have access to broadband.

Type	Provider	Service Notes
Internet	TDS DSL	• DSL is served by a microwave link back to Trenton • 15 Mbps Internet and phone in most cases. • The primary complaint island residents have of the current service is that it is not consistent or reliable enough.
Video	TDS	• Consistency of service for resident Skype and FaceTime applications is needed.
Cellular	Verizon, U.S. Cellular	

Public Internet Service – Swan's Island

Type	Provider, Service	Service Notes
Library	FairPoint, 100 MBPS	• To be provided through FairPoint in July 2015 (MSLN has contracted with FairPoint, who will need to install fiber to meet this obligation.)
School	FairPoint, 100 MBPS	• To be provided through FairPoint in July 2015 (MSLN has contracted with FairPoint, who will need to install fiber to meet this obligation.)
Public WiFi		• Town office had public WiFi but no longer does due to overuse in summer (saturation) • pilothouse • Library is well served by WiFi • Ferry Terminal has free WiFi but it has a short range

Stakeholders' Stated Community Goals

Tilson met with Island stakeholders on Swan's on July 13th, 2015 and the group—comprised of both seasonal and year-round residents—expressed a number of community goals. Among these goals were a desire to build and strengthen the overall digital economy, to attract more residents, both year-round and seasonal. With regard to connectivity in particular, Swan's residents are aware of needs at the local school, which has some reliability issues with its current Internet service. However, it is important to note that this need may soon be addressed through FairPoint's expected provision of 100 megabit per

second symmetrical (download and upload) speed service which is expected to be resold by FairPoint, to the Island through the Maine School and Library Network program. In addition, stakeholders present at Tilson's site visit spoke of the desire for scalability of Internet speed, and that latency and reliability issues be addressed by any connectivity solution. Regarding the Island constituency of businesses, residents expressed a hope that any connectivity solution enable small business owners to better conduct their businesses. In terms of speeds desired, there was mention of a 5 Mbps download and upload symmetrical as an idea of a threshold. One individual telecommuter described his use of a virtual private network to do his work currently, which only provided upload speeds of less than 1 Mbps. Another island worker echoed the need for service speed in the vicinity of 5 Mbps symmetrical to meet his work needs. In general, while telecommuting is not a huge area of need for Swan's Island, people do frequently use Skype and FaceTime video. An additional Town-articulated goal was the desire for video streaming capability. In addition, while the clinic is currently adequately served, one Island health provider expressed the view that "seamless telemedicine from home" would be a goal for the future. As for Town public areas that could be served by free WiFi, these are the Town Office, on the ferry, and that each one of the three villages in town have an area with free WiFi.

In terms of framing a possible solution, Island stakeholders were interested in the potential of an LTE solution for Swan's Island, and what coverage was possible with such a solution, with an emphasis on the necessity of achieving reliability and consistency of service. Currently, some Island residents have Internet access which is constant and reliable, while others on the Island do not. A solution where every resident has similarly consistent, reliable access is a priority for Swan's stakeholders.

Community Priority Buildings/Businesses

While the library and school would normally be priority buildings, they are expected to be well-served shortly through the Maine School and Library Network, which should remedy current reliability issues.

The medical clinic in Swan's Island is satisfied with their current level of DSL/T1 service.

As for the Town Office, they are adequately served by 10 Mbps download speeds, but the view expressed was that public safety (located in the Town Office) could use something more, as well as the Fire Department.

As for areas of need, the Town expressed that the Ferry Terminal could use better connectivity than currently is the case.

A full list of public buildings where connectivity should be assessed was provided by a resident of the Island and included the following:

- Municipal Building/Post Office/Police Station
- Swan's Island Fire Station
- Atlantic Fire Station
- Rec Center
- Clinic
- Odd Fellow Hall (community center)

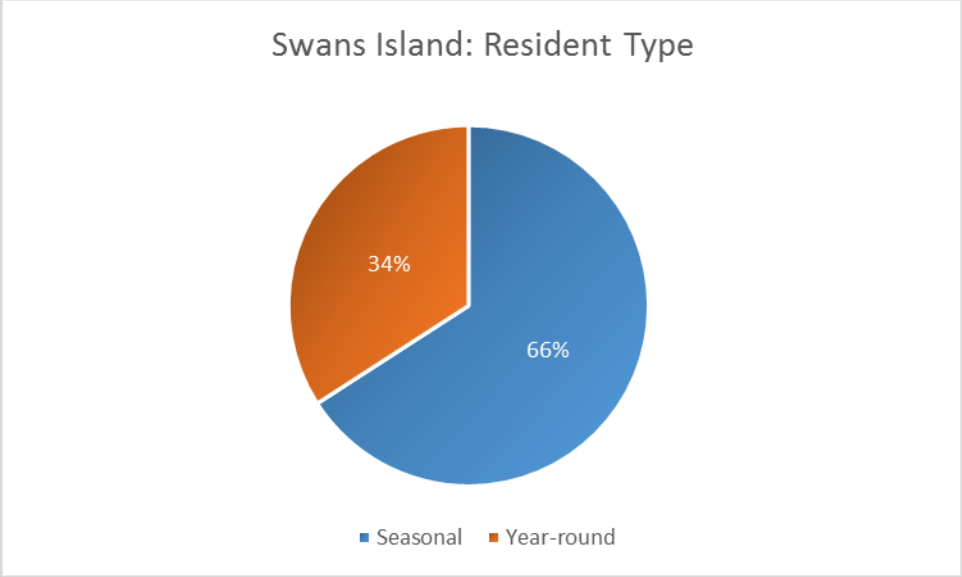
- Light House
- Ferry Terminal
- School
- Senior Housing (not really public)

The following are the business entities mentioned by Town residents that could be served by better Internet speeds. One small business owner stressed the difficulty of hiring new employees and growing a business as being infeasible with the current connectivity on the Island:

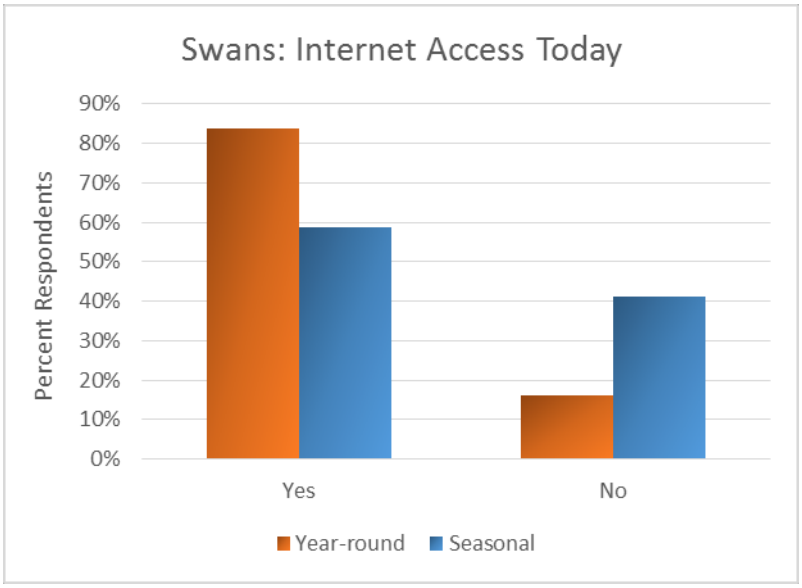
- -Saturn Press (Greeting Card business—however, they don't use computers)
- -Fishing Industry
- -Small Stores
- -Gift Shops
- -Underwater Taxi
- -Sea Salt business
- -Remote web developers

Survey Results

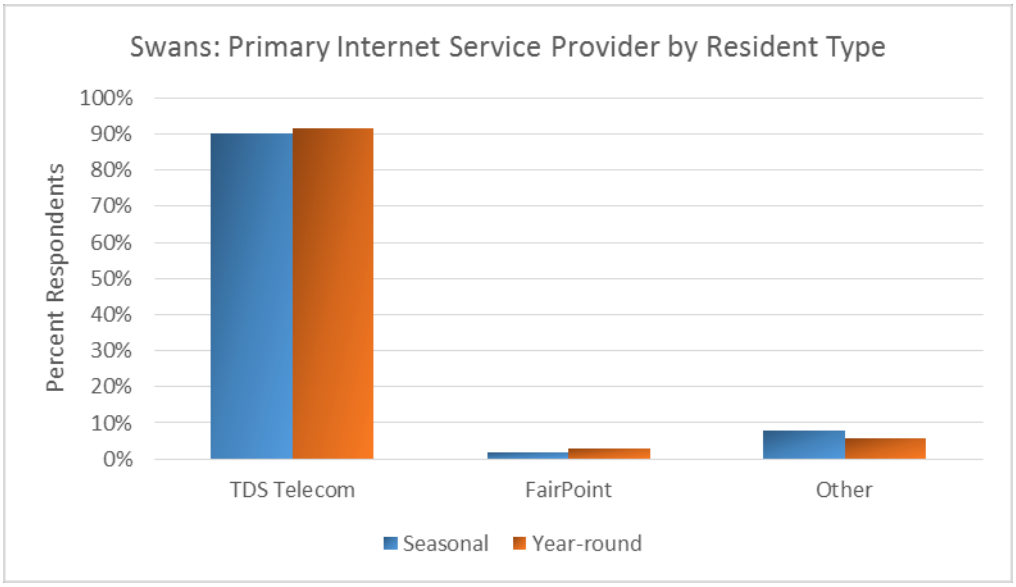
Tilson surveyed a random subset 403 out of 645 property owners on Swan's Island to gather information regarding current levels of internet and cellular service, satisfaction, and interest in funding improvements to those levels. 129 respondents returned completed surveys, equating to a 32% response rate. 85 respondents (66%) described themselves as seasonal residents, with the remaining 44 (34%) indicating that they were year-round residents of the island.



Of those who responded to the survey, 84% of year round respondents and 59% of seasonal indicated that they currently have Internet service, as shown in the following graphic.

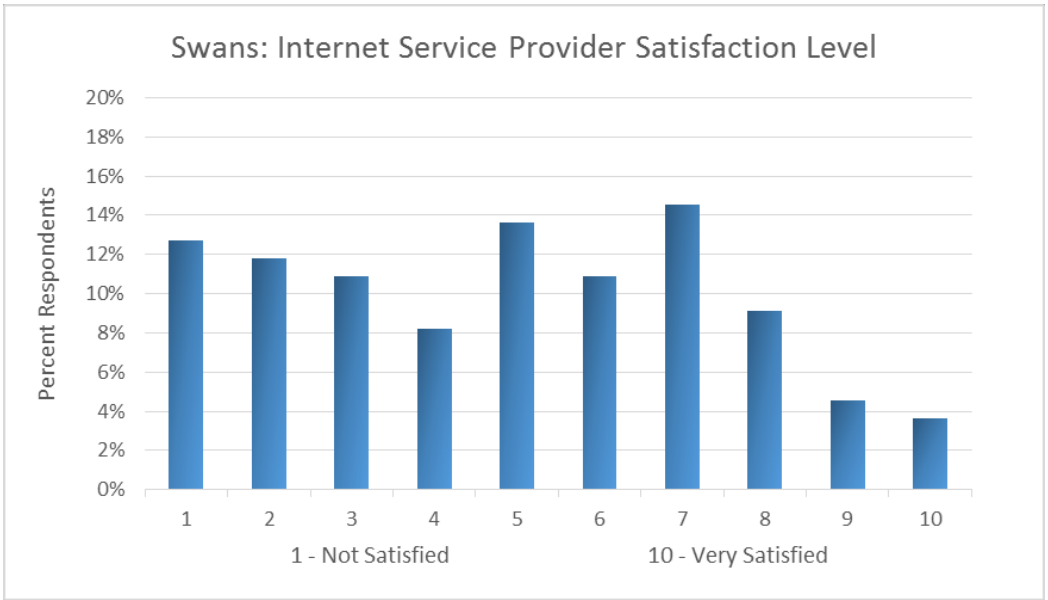


For these, 90% of seasonal and 92% of year-round respondents who have Internet service on Swan's, their primary Internet service provider (ISP) is TDS Telecom. A small percentage (2-3%) have FairPoint, and the remainder are served by other providers.

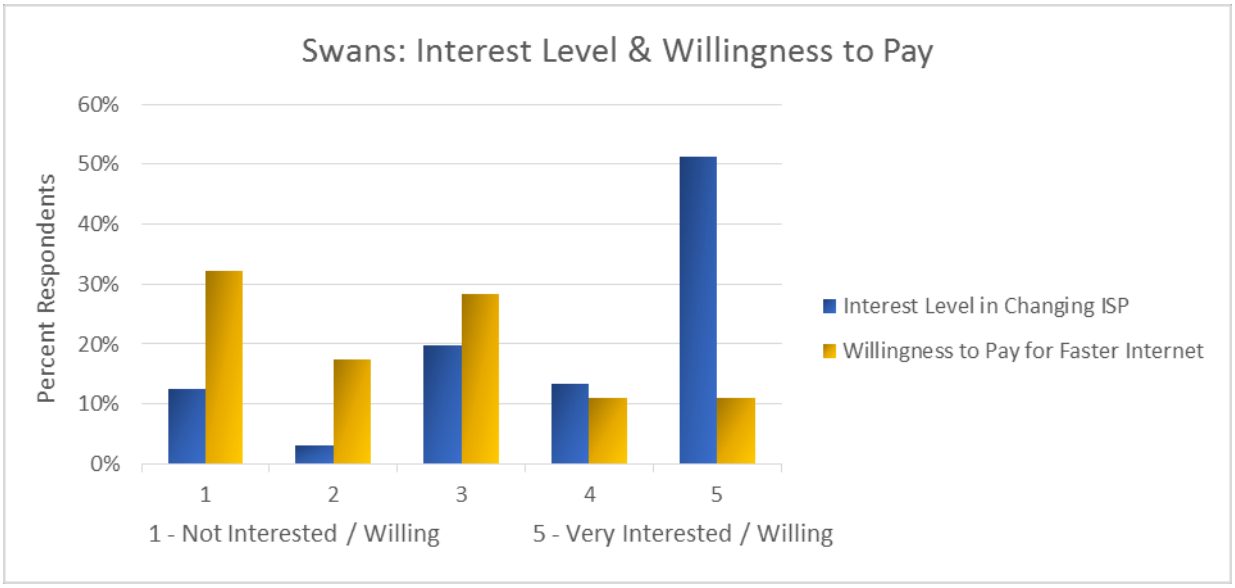


Satisfaction with current service providers gives some indication about users' willingness to switch vendors. The figure below shows the distribution, on a scale of 1 to 10, of respondents' satisfaction with their provider. 47 respondents (44%) gave their ISP a rating between 6 and 10, indicating satisfaction with current service; a slightly higher percentage (46%) gave their ISP a rating of between 1 and 4 out of 10, indicating dissatisfaction with current providers. According to the Institute for Customer Service, customers that rate a service provider at less than eight are often willing to switch if an alternate

offering is available.[59] Eighty-four percent (84%) of respondents were in this category, scoring their provider between 1 and 7.

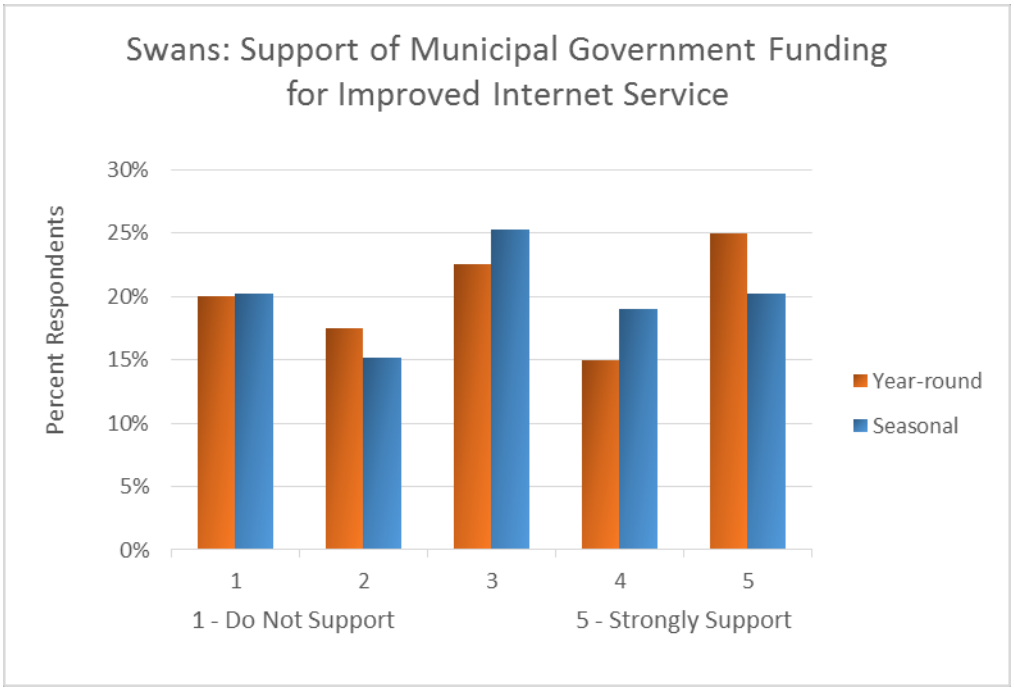


The last few questions of the survey gave an indication of islanders' attitudes towards change. The responses indicate that residents are willing to switch ISPs for faster service, but are value sensitive, and not as enthusiastic about paying more for the service. It should be noted that while the willingness to pay results emphasize the importance of a cost effective solution, the survey did not collect information regarding the current Internet costs being paid by respondents.

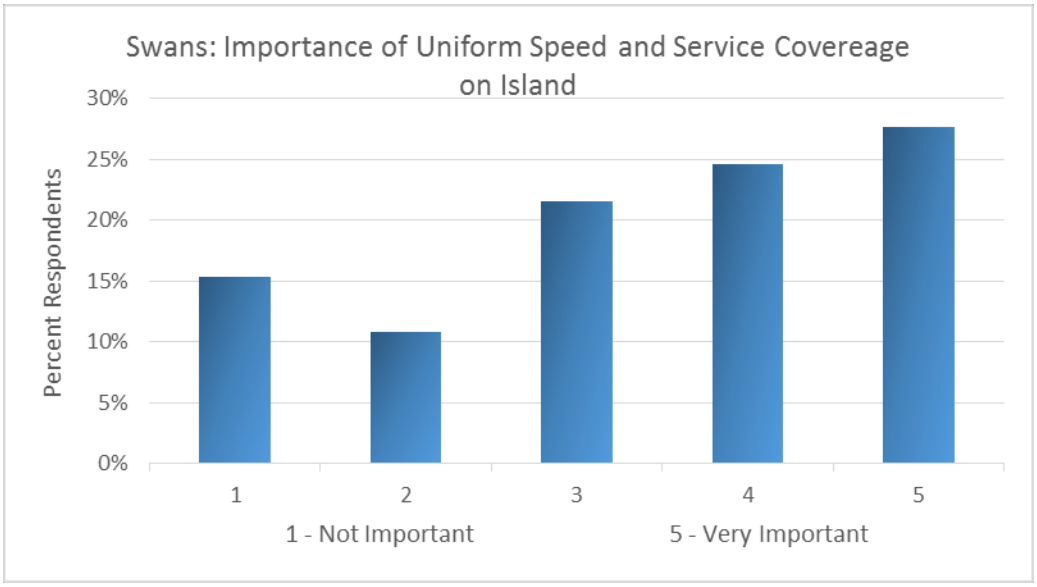


[59] Institute of Customer Service. *UK Customer Satisfaction Index.* July 2015.

Support for municipal government funding was evenly distributed, with a nearly even number of respondents who both supported and who were against municipal government funding for improved Internet service.



53% of respondents generally valued uniform speed and coverage for everyone on the island, while for 26% of respondents indicating that it was not important to them, and the remainder (22%) not indicating strongly one way or the other.



In terms of gauging support for a new tower build to improve Internet service, 45% of respondents would support a new tower build on Swan's while 36% would not, with the remainder falling somewhere in between these two positions.

Possible Solutions

Tilson examined three options for Swan's to consider: improving existing DSL service[60]; Redzone's wireless LTE service; and a fiber to the premise (FTTP) network. These options range in their ability to meet or exceed the community's short term needs. Taking no action to address the lack of broadband is also an option: however, it may prevent the town from achieving stated goals.

Fiber Network Design – Swan's Island

A fiber to the premise (FTTP) network is the gold standard in municipal network design: it is the most upgradeable, the least expensive to operate on a whole-island basis, the fastest, the most reliable, but also the most expensive to build. Because an FTTP network is so reliable, it requires less customer support and is less expensive to operate than DSL, hybrid fiber/coax, or wireless networks. The largest operating disadvantage to fiber is that if it is cut, it requires a technician skilled in fiber repair (and typically a bucket truck) to fix. Fiber networks can be configured to provide 1 Gigabit (Gbps) speed upload and download—100 times faster than the current ConnectME standard.

Tilson designed a FTTP solution that would pass and connect to all 501 premises on the island. Fiber counts were specified for each segment to optimize for current building distribution, and with future growth in mind. Tilson designed multi-port service terminals (MST's) throughout the network to enable easy and short interconnections with existing and future premises.

To complete the local access portion of this network, electronics are needed at the customer premise and at the traffic collection node, or end. In addition, an ISP would need to place its own electronics and microwave backhaul to the mainland. There are various operating models whereby these network elements could be owned and operated either by the town, a network operator, or the ISP. [61]

Tilson understands that there is a possibility that Emera will assume provision of electricity from the Swan's Island Electric Cooperative. If this occurs, and Emera replaces existing cables with fiber optic strands for grid management, the town should negotiate access to additional strands for potential future use.

[60] This option may meet the needs of the community in the near term, but does not meet the ConnectME or FCC definition of broadband.

[61] Tilson will describe municipal models that include ownership of a greater proportion of the infrastructure in the "Business Model Overview" section of this report.

Fiber Design – Swan's Island

Fiber Capital Cost Estimate

Tilson's detailed cost estimate included all the design, application, materials and labor costs associated with the fiber to the curb network.[62] For all the islands, Tilson assumed that 90% of the route miles were aerial, and 10% were underground. The estimate also assumes that all the fiber drops are built at once, rather than on-demand. An island premium of 10% on materials, and 20% on labor was added onto all of Tilson's standard estimates, and is reflected in the numbers below.

[62] Tilson's detailed cost estimate is based on the known cost of the network components of its high level fiber design, plus estimates for labor costs, engineering and margin. A firm estimate is obtained when a project is put out to bid. Projects can be separated into engineering design and build, or put out to bid as a combined design/build.

Fiber Network Capital Cost Estimate – Swan's Island

Project Miles		25.6
Aerial Miles		23.0
Poles		736
Premise Count		501
Application and Make Ready	$	208,330
Materials	$	329,156
Labor	$	844,686
Engineering	$	56,312
Margin/Profit (20%)	$	287,697
Service Provider Tax (6% Labor and Engineering	$	71,322
Sales Tax (5.5% Materials)	$	18,104
Total	$	1,815,606
Per Premise Cost	$	3,624

The incremental capital cost of building out the network, which would be borne by either the ISP, the municipality, or a network operator - depending on the business model - are not included above.

To complete the local access portion of this network, electronics are required at the customer premise and the traffic collection node, or head end. These electronics cost about $570 per premise. In addition, an ISP would need to deploy network electronics, which are customarily paid for by the ISP, even though they may be housed in a municipal building.

The electronics described above need to be housed in a space with redundant power, heating and sufficient heat dissipation ("conditioned space"). That conditioned space can be provided by a stand-alone shelter for about $250,000, or a municipality can provide it in one of its buildings to deliver substantial cost savings.

If the network were to be connected to the mainland via microwave, the capital cost estimate for two microwave dishes and one new small tower on the island (this assumes the mainland microwave dish is mounted on an existing tower), is $45,000. While a microwave link will be necessary for every island without a subsea fiber cable, there are opportunities for islands to collaborate to either save money in operating the link and/or increasing the redundancy and reliability of the links. These are highlighted in the "Opportunities for Regional Cost Savings" section near the end of this report.

Wireless LTE Design

Tilson engaged Redzone,[63] the only company offering fixed wireless LTE in Maine, to design a network that would provide universal access to all premises on the island. This means that all island users would have access to the same speed offerings, which are fast enough to meet both the FCC and ConnectME definition of broadband.[64]

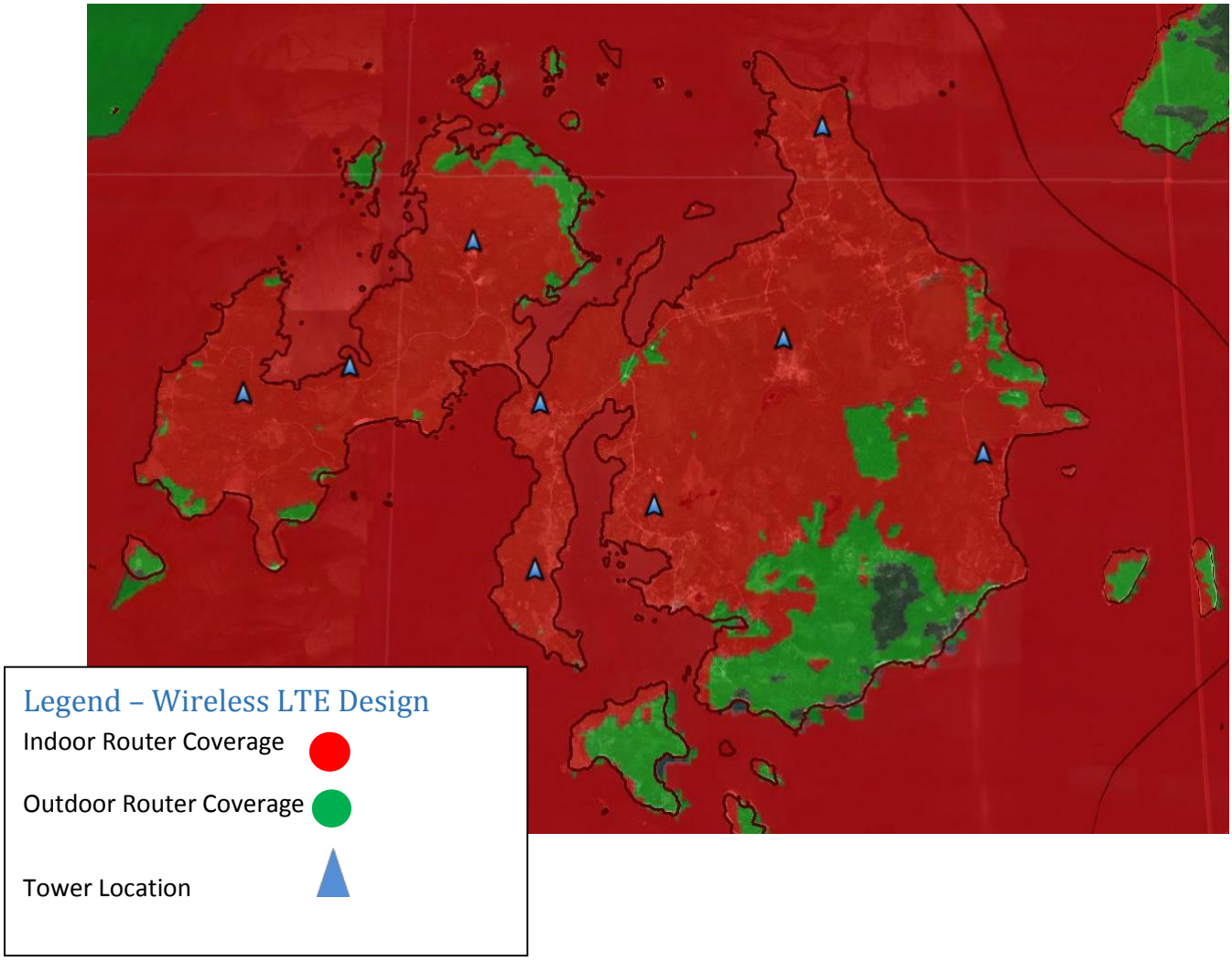
[63] Design work performed for Redzone by 4G Unwired, Indialantic, FL.

[64] Current speed and pricing information in the Service Offering Overview section near the end of this report

Redzone's design deployed 150' tall towers, placed in optimal locations to provide universal coverage with the fewest number of towers. The red on the map represents areas of indoor LTE coverage, meaning that an external antenna is not necessary to have access to all of Redzone's speed offerings. The green areas represent locations where an outdoor antenna is needed to access to Redzone's full service offerings. Across the islands for which Redzone designed a network, 91% of the households will have access via indoor router, and 98.7% will have access via outdoor router.

The following image shows the wireless LTE design for Swan's Island.[65] The red on the map represents indoor LTE coverage for households on the island. The green areas represent outdoor LTE coverage on the island given the tower build. The blue placemarks indicate proposed wireless LTE tower locations needed to produce the contemplated coverage.

Wireless LTE Design – Swan's Island



[65] Design work performed by 4G Unwired, Indialantic, FL.

Wireless LTE Cost Estimate

Redzone estimates that the capital cost of deploying equipment on a tower, plus microwave backhaul, is $125,000 per tower. Tilson estimates that the cost of building a 150' telecommunications tower on an island is an additional $200,000, although that can vary widely. Because Swan's only has one tower with no available space on it, the Redzone solution would require 9 LTE sites, plus 9 towers for a total estimated cost of $2,925,000.[66]

In this model, the town would fund and likely own the towers. New towers could potentially be used by other telecommunications carriers, like mobile providers. Redzone would retain ownership of its equipment and bill customers directly. In today's environment, it is unlikely that Redzone would deploy equipment on the island without an almost complete capital cost subsidy.

Redzone's business model and service offerings are further discussed in the "Service Offering Overview by Provider" section of this report.

ILEC Network Improvements

TDS Telecom is the incumbent DSL Internet and phone service provider on Swan's Island. Tilson has learned that since the community meeting this summer, TDS has undertaken a project to improve the microwave infrastructure on Swan's Island. [67] As service provider for the Maine Schools and Libraries Network (MSLN), FairPoint has contracted with TDS to upgrade the bandwidth to the schools and libraries within TDS territory, providing each school and library with 100 Mbps symmetrical speeds in 2016.

After the backhaul capacity is upgraded, TDS will be able to offer faster DSL speeds to Swan's customers near the DSLAM or DSL node. Currently, customers neares the node have access to maximum speeds of up to 15 Mbps download and .768 Mbps upload. After the upgrade, customers within one mile of the DSLAMs should be able to get speeds of up to 25 Mbps; customers within two miles of a DSLAM 15 Mbps; and customers three miles or closer to a DSLAM should have access to speeds up to 10 Mbps. Because Swan's has a large geographic area, not all customers will be able to access the maximum speeds, but most of the population should be able to access the 15 Mbps speed tier.

If Swan's wanted to give all residents access to the fastest DSL speed tiers, the solution would be to add DSLAMs to lower the distance from DSLAMs to customer premises.

ILEC Improvements – Cost Estimate

The costs for adding remote terminals vary widely, and are determined by the ILEC. The ILEC's cost are a function of whether additional microwave backhaul capacity is needed, how much fiber needs to be run to reach the remote terminal, and how much rewiring of copper cables is necessary. On the mainland,

[66] A Town selectman said that the current U.S. Cellular tower is owned by U.S. Cellular and is at capacity and that AT&T was recently not allowed to lease space on this tower.

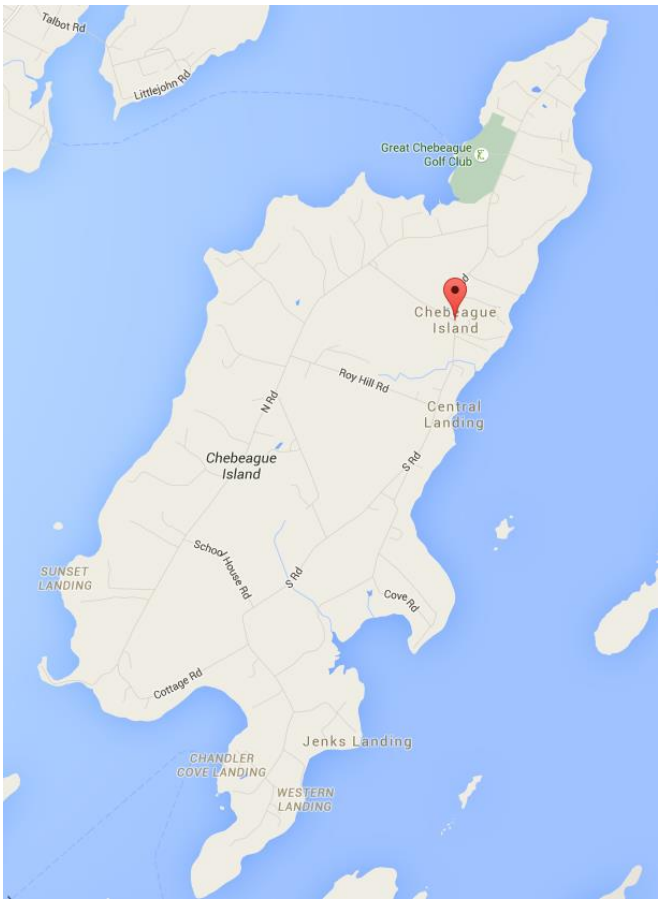
[67] Per community meeting expectations and communication from Scott Brooks, Manager – State Government Affairs, TDS Telecommunications Corporation, 10/14/2015.

the costs for adding a remote terminal are typically less than $100,000. Tilson estimates that a private provider might charge $30,000 for upgrading an existing microwave link, $45,000 for installing a new microwave link and one tower. However, it is likely that an ILEC might spend (and charge) more money putting up a microwave link than an alternate provider would due to company technology and process specifications and labor restrictions.

Funding

There is a general lack of public funding wherewithal in the Swan's Island community to support an expensive Internet investment. However, the community would be willing to pay slightly more if TDS could make the current DSL coverage slightly better.

Chebeague Island



Background

Chebeague Island is a 1,900-acre island located in Casco Bay. It has a year-round population of 341 residents according to 2010 U.S. Census figures, with a summer population estimate of 1,600.[68] A recent informal poll by the Island Institute put the year round population estimate at 395.[69] Tilson visited Chebeague Island July 28,th 2015 and met with approximately 30 island residents and stakeholders.

Current Infrastructure

Chebeague's current infrastructure consists of the Cheabugue.net assets to deliver DSL to the island: a microwave link to Portland (provisioned capacity of 100 Mbps, and maximum capacity of about 225 Mbps); fiber optic cable connecting the microwave link to Chebeague.net's DSL node, or DSLAM; and a DSLAM capable of serving users maximum speeds of 6.0/1.5 Mbps. Chebeague.net's DSLAM uses FairPoint's telephone lines to deliver Internet access. Users that want both wireline voice and Internet access must order two services – a telephone line from FairPoint, and a DSL connection from

[68] 2010 U.S. Census.
[69] Island Institute Informal Survey, 2015.

Chebeague.net. These dual services consume the island's copper infrastructure at a high rate. In some parts of the island, there is a shortage of copper lines available for use.

There are no towers on the island suitable for cellular coverage. FairPoint currently serves the school and library on the island with T-1's, a technology that uses the company's voice infrastructure, but is not scalable.

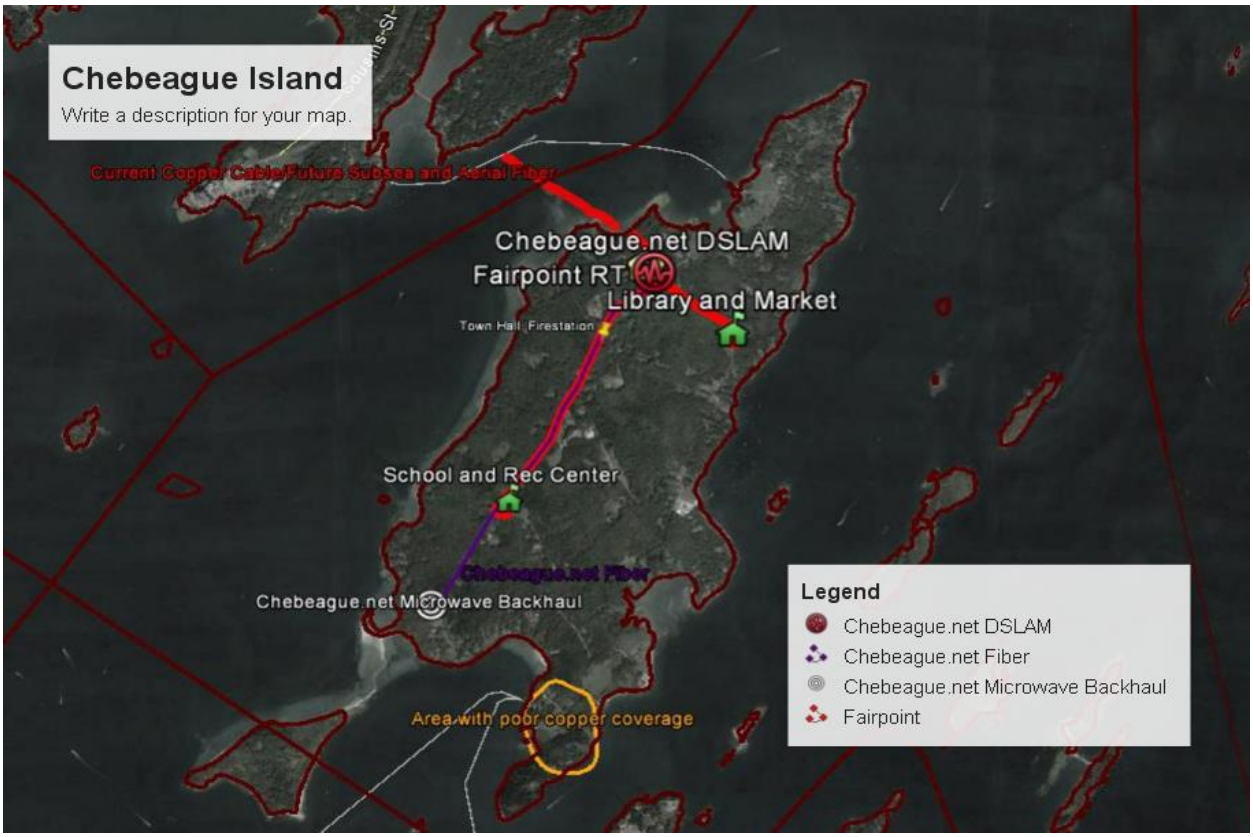
Chebeague Island's infrastructure is about to change dramatically. FairPoint is in the process of establishing Internet access to Chebeague Island via a subsea fiber cable and a FairPoint-owned DSL node. The service will offer speeds of up to 15/1 Mbps for locations closest to node. Outlying locations will receive speeds up to 3/1 Mbps. FairPoint will deliver voice and Internet access over one line, which will have a lower total monthly cost than the combined Chebeague.net DSL and FairPoint voice lines for current users. FairPoint will also deploy aerial fiber and connect the school and library through its fiber-fed Carrier Ethernet Service (the school and library will initially have 100/100 Mbps service). When this is complete, businesses on Chebeague will have access to the Carrier Ethernet Service, although higher speeds would require a costly fiber build to extend the network to the premise.

Chebeague.net's DSLAM

Source: www.Chebeague.net

The diagram below includes FairPoint's planned upgrades. Construction of the subsea cable commenced in October 2015. The schools and libraries are expected to be connected by the close of 2015, and the DSL enabled by the end of 1Q 2016.

Chebeague Asset Inventory



Current Service Offerings

Tilson was able to obtain a lot of information from Chebeague.net, the island's current service provider. The below table summarizes the various Internet, voice, video, and cellular service types, providers, and service notes related to resident experiences and prices. Only the school and library currently have speeds that meet the ConnectME broadband definition (although they do not meet the federal definition). A detailed discussion of Chebeague.net service follows.

Type	Provider	Service Notes
Internet	Chebeague.net	• Legacy Wireless .5/.5 and DSL (1.0/.5; 3.0/1.5; 6.0/1.5) • Variable speeds depending on island location. Some residents have no access, others can get 6 Mbps down (and 48 ms ping) • Low reliability – more of a problem than speed. • Recent microwave backhaul upgrade to 100 Mbps alleviates previous summer congestion • Two islanders providing service as a part time job. Ample, free on-island support
	Hughes Satellite	• Some people reportedly have it and not happy
	Verizon or Sprint aircards	• Expensive and location dependent. Useful for uploading material.
Video	DirectTV, Dish	• Common
Cellular	Verizon Wireless, AT&T Wireless, Sprint	• Signal strength variable -- dependent on location, room within a building, weather, time of year – inconsistent. Many theories on what affects it.

Public Internet Service - Chebeague

Type	Provider, Service	Service Notes
Library	MSLN, 10/10 MBPS	bonded T1's, via FairPoint Q4/Q12016 to be 100 Mbps via FairPoint Wi-fi slow speeds. Hard-wired computers get faster speed
School	MSLN, 10/10 MBPS	bonded T1's, via FairPoint Q4/Q1 2016 to be 100 Mbps via FairPoint Wi-fi
Ferry	Casco Bay lines Chebeague Transportation Company	Residents described service as "weak" LTE solution
Firehouse, Boat Yard, Rec Center	Chebeague.net	Public Access via Wi-Fi

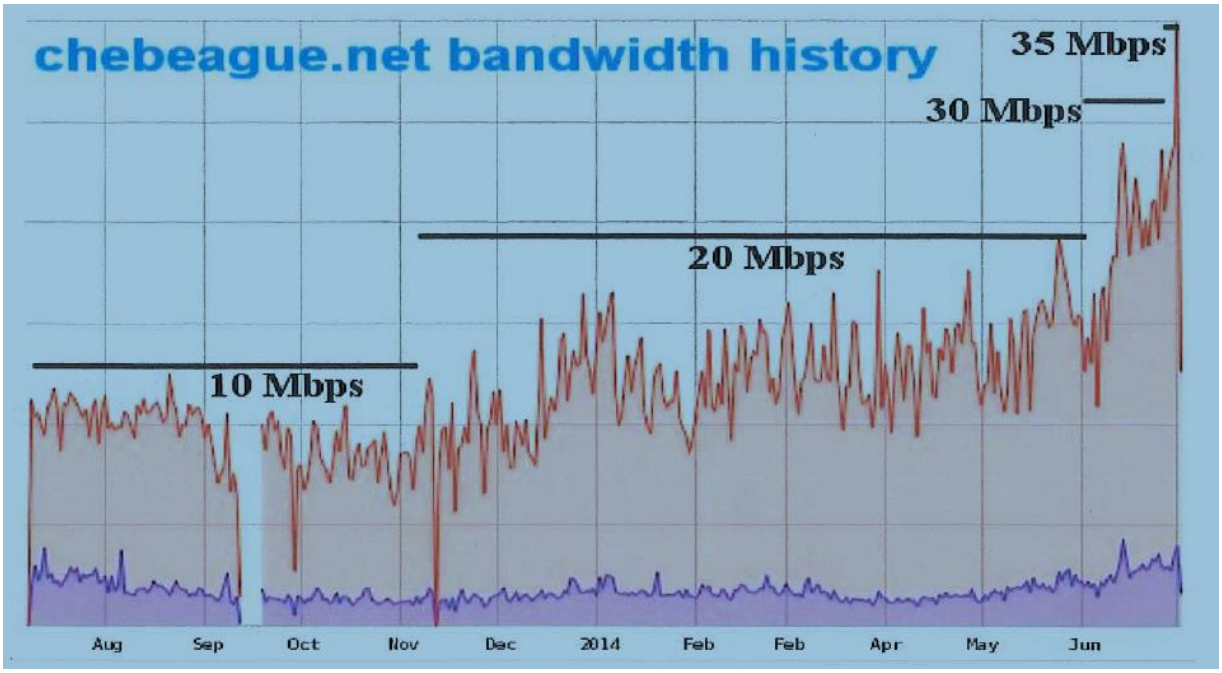
Chebeague.net

Chebeague.net is a municipal network with a private operating model. The company was founded and funded by islanders and summer residents, and built out a network with the aid of various grants, including $150,000 from ConnectME. The company offers DSL service by leasing the copper lines from FairPoint to distribute its service. While Chebeague.net service offerings are constrained by its reliance on FairPoint's copper plant, it is able to offer amenities that many providers cannot. Chebeague.net offers seasonal rates, provides a subsidy for low-income families, and gives free service to non-profits in town. In addition, Chebeague.net provides on-island, on-demand service as the staff of the company reside on island.[70] As such, the availability of service staff for support is much more consistent and reliable than off-island service providers. Some summer residents subscribe to the service on a year-round basis to lend support to the organization. Only about 10% of Chebeague.net's subscribers subscribe to the highest speed tier offered. Reasons for not subscribing to the 6/1 Mbps speed tier were the $73/month price and the fact that in some parts of town maximum speeds cannot be realized. According to David Hill of Chebeague.net, Chebeague.net could offer speeds in excess of 6 Mbps download to locations near the DSL node, but prefers to cap the maximum rate at 6 Mbps in order to minimize achievable speed differentials across its service territory.

[70] Chebeague.net lists a $50/hour charge for requested on-site technical support that is not a result of Chebeague.net technical problems. Chebeague.net does not assess this charge. This fact is perhaps emblematic of the island culture, which while being highly supportive proves difficult for service providers to make money.

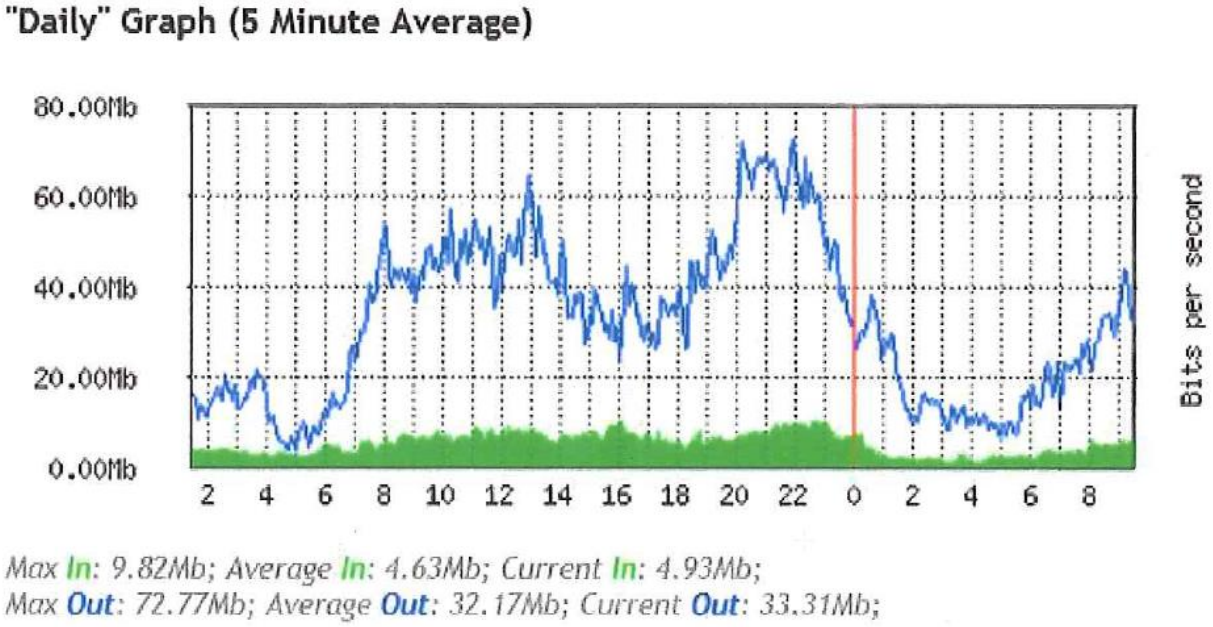
Chebeague.net shared some interesting data with Tilson about its traffic patterns that have implications for any island community doing broadband planning. The graph below shows the aggregate bandwidth demand of Chebeague Island, for download Mbps (orange) and upload Mbps (purple). The graph shows that traffic is growing over time, that annual growth of traffic may more important for capacity planning then seasonality, and (assuming that uploads were not more bandwidth constrained than downloads), that users download far more traffic then they upload.

Intra-Year Pattern (July 2013-July 2014); Aggregate Download and Upload



The graph of a day of traffic in July 2015 is notable for three reasons: July 21, 2015's peak of 70 Mbps was much higher than the 35 Mbps peak in July 2014 (above); the evening hour download peak coincides with the hours in which users are likely downloading video content from the Internet; and the average download demand was 8 times higher than the upload demand.

Intra-Day Pattern (July 21, 2015); Aggregate Download and Upload ("Out" = Download, "In" = Upload)



Stakeholders' Stated Community Goals

For the Town of Chebeague, both seasonal and year-round residents agreed on the importance of sustaining the year-round community. Specifically, residents stated that their goals were to sustain the schools, enable telecommuting, access to government services, and telemedicine, with the goal of attracting young families to the island as well. For Chebeague residents, maintaining geographic isolation while having convenient access to the rest of the world was articulated as an overarching goal by those present at the meeting. Chebeague residents perceive a growing technological gap between the Internet connectivity available elsewhere and what is currently available on the island and expressed a desire to reverse this trend, as they fear that such a growing technological divide may deter new residents from coming to Chebeague. Concurrent with these goals, the objective of the Town having local control of critical infrastructure was also expressed at the meeting.

Another articulated goal from those present at the community meeting was regarding cellular coverage—many residents would like to have this coverage improved, both within homes as well as around the island as a whole, as residents expressed a desire to "cut the cord" with respect to landline phone use. Further, Chebeague's comprehensive plan contains the goals of major improvements to Internet and cell phone coverage on the island.

In addition to those goals already mentioned, residents would like any broadband solution to enable live streaming of Town government gatherings, as residents would like the ability to both view meetings and then attend and participate when the need arises.

In terms of educational goals, Chebeague residents would like to maintain their ability to home school as well as to be able to pursue online educational opportunities.

As part of any upgrade or broadband investment transition, residents conveyed that any solution should ensure that the founders of the incumbent provider, Chebeague.net are considered, and that provision be made for the founders financially and while being honored for the services that they have provided the island.

Final stated goals of the community on Chebeague Island were the desire that any investment in Internet connectivity create uniformity of coverage—in particular, avoiding situations in which "haves" and "have-nots" develop due to varying distances from critical Internet infrastructure (such as Digital Subscriber Link Access Multiplexers (DSLAMs)). In addition, the goals of being able to access a full suite of online entertainment, empowerment of small businesses, minimization of trips to mainland and subsidized pricing of the new service for lower income and non-profit entities were voiced as goals for Chebeague residents.

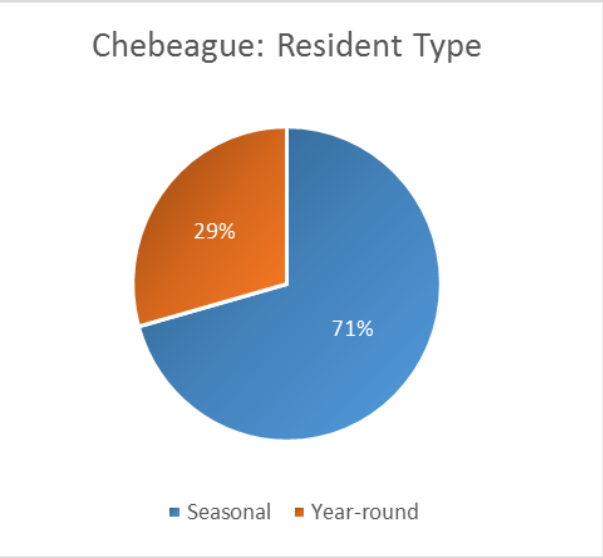
Community Priority Buildings/Businesses

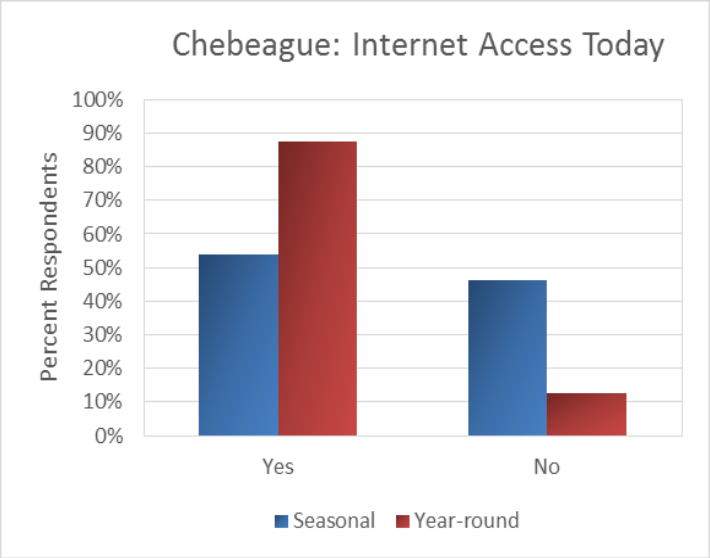
The stakeholders at the meeting felt like all buildings and businesses were a priority for the community.

Survey Results

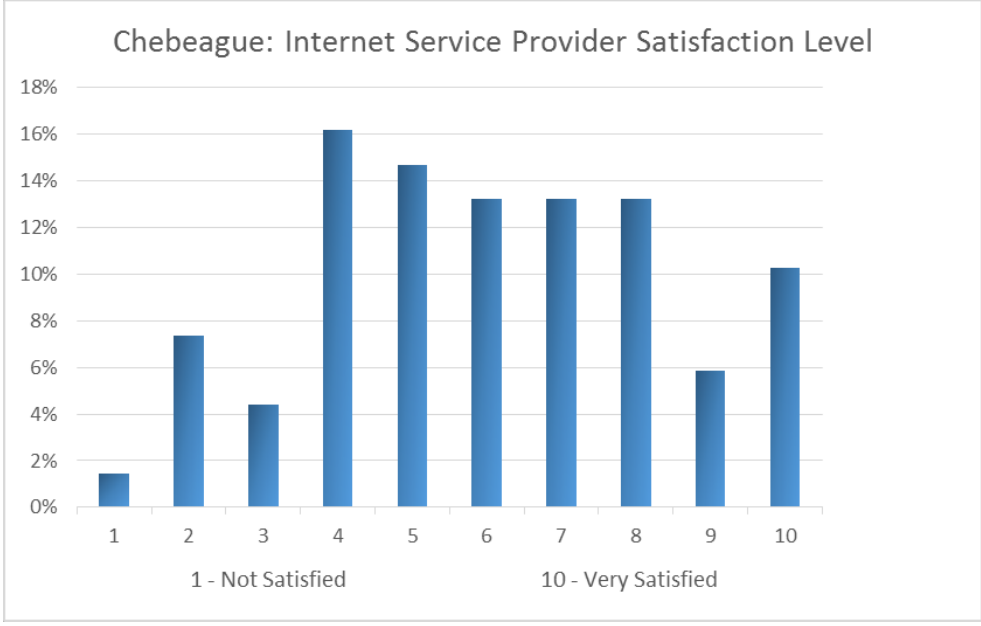
Tilson surveyed a random subset 348 out of 515 property owners on Chebeague Island to gather information regarding current levels of Internet and cellular service, satisfaction, and interest in funding improvements to those levels.

109 respondents (29%) provided information. The majority of respondents described themselves as seasonal residents. These seasonal residents were less likely than year round residents to subscribe to wireline Internet access; those not subscribing likely utilize with cell phone access or public Wi-Fi at the school or library. Close to 90% of year round respondents have wireline Internet access, which is consistent with Chebeague.net's assertion that they serve 89% of year-round households.





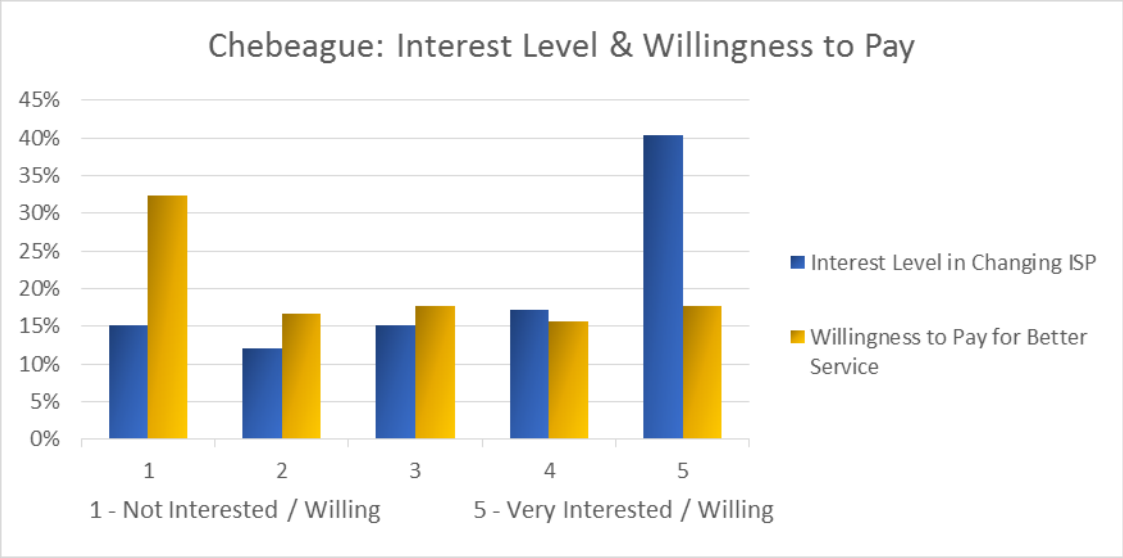
Satisfaction with current service providers gives some indication about users' willingness to switch vendors. The figure below shows the distribution, on a scale of 1 to 10, of respondents' satisfaction with their provider.[71] Very few users were dissatisfied, although the majority were neutral. According to the Institute for Customer Service, customers that rate a service provider at less than eight are often willing to switch if an alternate offering is available.[72] Seventy one percent (71%) of respondents were in this category, scoring their provider between 1 and 7.



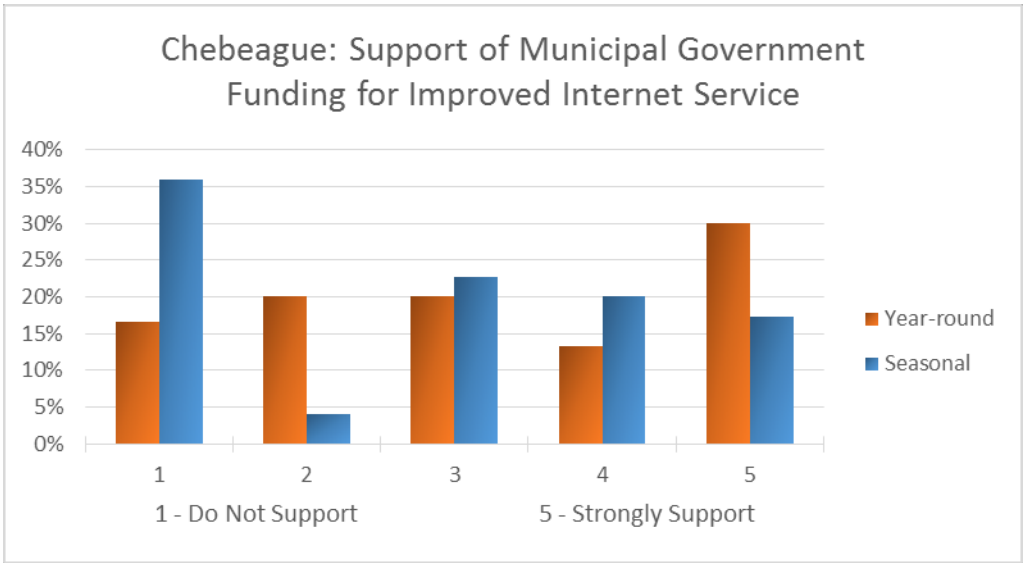
The last few questions of the survey gave an indication of islanders' attitudes towards change. The responses indicate that residents are willing to switch ISPs for faster service, but are value sensitive, and not as enthusiastic about paying more for the service.

[71] It should be noted that 12% of respondents claimed to have "other" as residential Internet access, and were therefore likely reflecting their satisfaction with their cell phone service in this question. Cell phone use was closely split between AT&T and Verizon.

[72] Institute of Customer Service. *UK Customer Satisfaction Index.* July 2015.

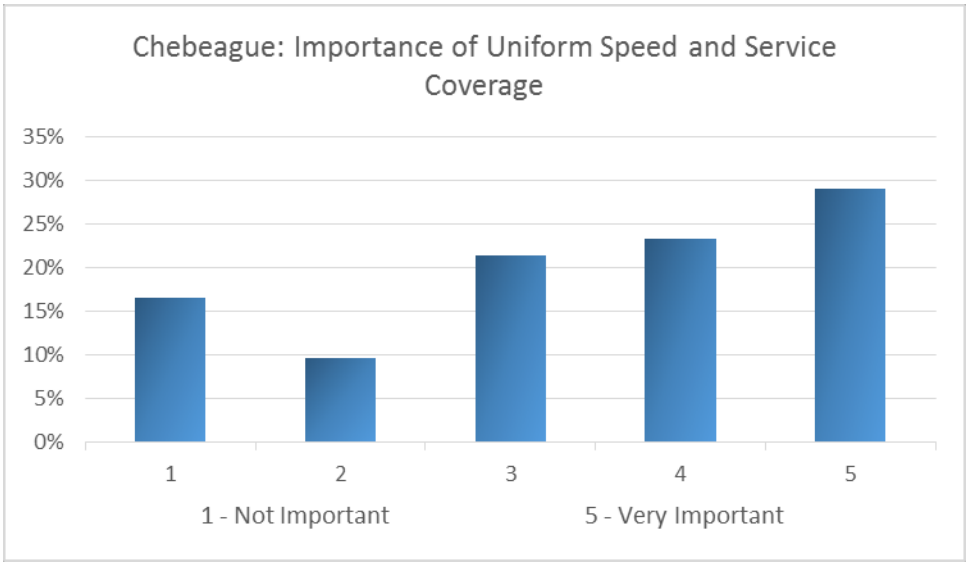


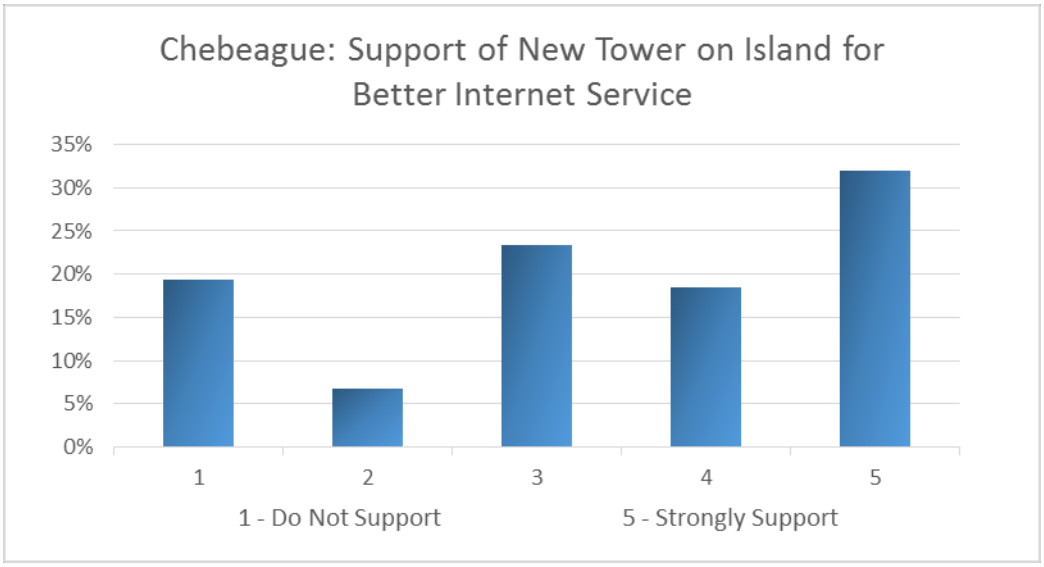
Support for municipal government funding an Internet improvement was evenly distributed, with two notable exceptions – a cluster of strong support from year round residents, and no support from seasonal residents.



Respondents generally valued uniform speed and coverage, and would support a new tower on the island for better Internet service.[73]

[73] The survey question asked about only one tower, not four towers, which would be necessary to provide uniform LTE coverage on the island.





Possible Solutions

Tilson examined three options for Chebeauge: improving existing DSL service[74]; Redzone's wireless LTE service; and a fiber to the premise (FTTP) network. These options range in the extent to which they meet or exceed the community's short term needs. Taking no action to address the lack of broadband is also an option: however it will prevent the town from achieving stated goals like enhancing telecommuting capabilities, supporting education at home, enabling business, attracting new families, and minimizing off-island trips.

[74] This option may meet the needs of the community in the near term, but does not meet the ConnectME or FCC definition of broadband.

Fiber Network Design

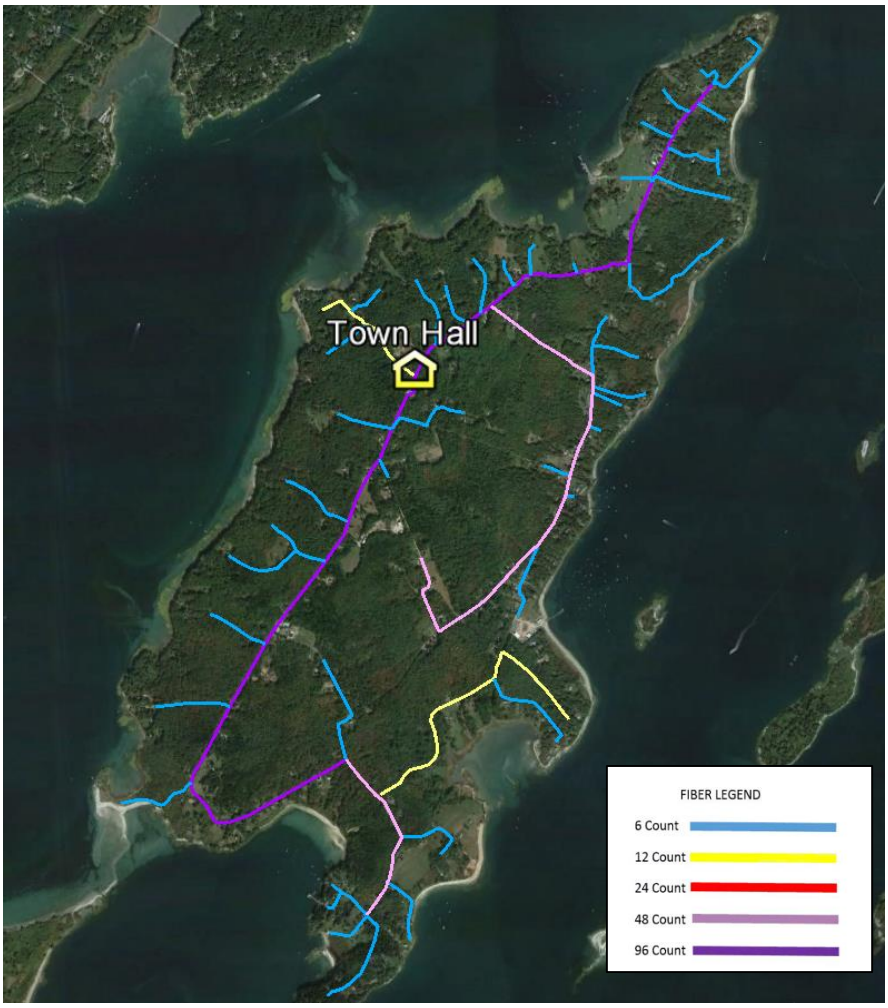
A fiber to the premise (FTTP) network is the gold standard in municipal network design: it is the most upgradeable, the least expensive to operate on a whole-island basis, the fastest, the most reliable, but also the most expensive to build. Because an FTTP network is so reliable, it requires less customer support and is less expensive to operate than DSL, hybrid fiber/coax, or wireless networks. The largest operating disadvantage to fiber is that if it is cut, it requires a technician skilled in fiber repair (and typically a bucket truck) to fix. Fiber networks can be configured to provide 1 Gigabit (Gbps) speed upload and download—100 times faster than the current ConnectME standard.

Tilson designed a FTTP solution that would pass and connect to all 466 premises on the island. Fiber counts were specified for each segment to optimize for current building distribution, and with future growth in mind. Tilson designed multi-port service terminals (MST's) throughout the network to enable easy and short interconnections with existing and future premises.

To complete the local access portion of this network, electronics are needed at the customer premise and at the traffic collection node, or end. In addition, an ISP would need to place its own electronics and backhaul to the mainland. On Chebeague, backhaul could be purchased from FairPoint, or done through a microwave link (as it is done today by Chebeague.net). There are various operating models whereby these network elements could be owned and operated either by the town, a network operator, or the ISP. [75]

[75] Tilson will describe municipal models that include ownership of a greater proportion of the infrastructure in the "Business Model Overview" section of this report.

Fiber Network Design – Chebeague



Fiber Capital Cost Estimate

Tilson's detailed cost estimate included all the design, application, materials and labor costs associated with the fiber to the curb network.[76] For all the islands, Tilson assumed that 90% of the route miles were aerial, and 10% were underground. The estimate also assumes that all the fiber drops are built at once, rather than on-demand. An island premium of 10% on materials, and 20% on labor was added onto all of Tilson's standard estimates, and is reflected in the numbers below.

[76] Tilson's detailed cost estimate is based on the known cost of the network components of its high level fiber design, plus estimates for labor costs, engineering and margin. A firm estimate is obtained when a project is put out to bid. Projects can be separated into engineering design and build, or put out to bid as a combined design/build.

Capital Cost Estimate – Chebeague

Project Miles		16.3
Aerial Miles		14.7
Poles		471
Premise Count		466
Application and Make Ready	$	132,108
Materials	$	274,109
Labor	$	636,521
Engineering	$	42,435
Margin/Profit (20%)	$	217,034
Service Provider Tax (6% Labor and Engineering)	$	53,759
Sales Tax (5.5% Materials)	$	74,578
Total	$	1,430,544
Per Premise Cost	$	3,070

The incremental capital cost of building out the network, which would be borne by either the ISP, the municipality, or a network operator - depending on the business model - are not included above.

To complete the local access portion of this network, electronics are required at the customer premise and the traffic collection node, or head end. These electronics cost about $570 per premise. In addition, an ISP would need to deploy network electronics, which are customarily paid for by the ISP, even though they may be housed in a municipal building.

The electronics described above need to be housed in a space with redundant power, heating and sufficient heat dissipation ("conditioned space"). That conditioned space can be provided by a stand-alone shelter for about $250,000, or a municipality can provide it in one of its buildings to deliver substantial cost savings.

If the network were to be connected to the mainland via microwave, the capital cost estimate for two microwave dishes and one new small tower on the island (this assumes the mainland microwave dish is mounted on an existing tower), is $45,000. While a microwave link will be necessary for every island without a subsea fiber cable, there are opportunities for islands to collaborate to either save money in operating the link and/or increasing the redundancy and reliability of the links. These are highlighted in the "Opportunities for Regional Cost Savings" section near the end of this report.

Wireless LTE Design – Chebeague

Tilson engaged Redzone,[77] the only company offering fixed wireless LTE in Maine, to design a network that would provide universal access to all premises on the island. This means that all island users would have access to the same speed offerings, which are fast enough to meet both the FCC and ConnectME definition of broadband.[78]

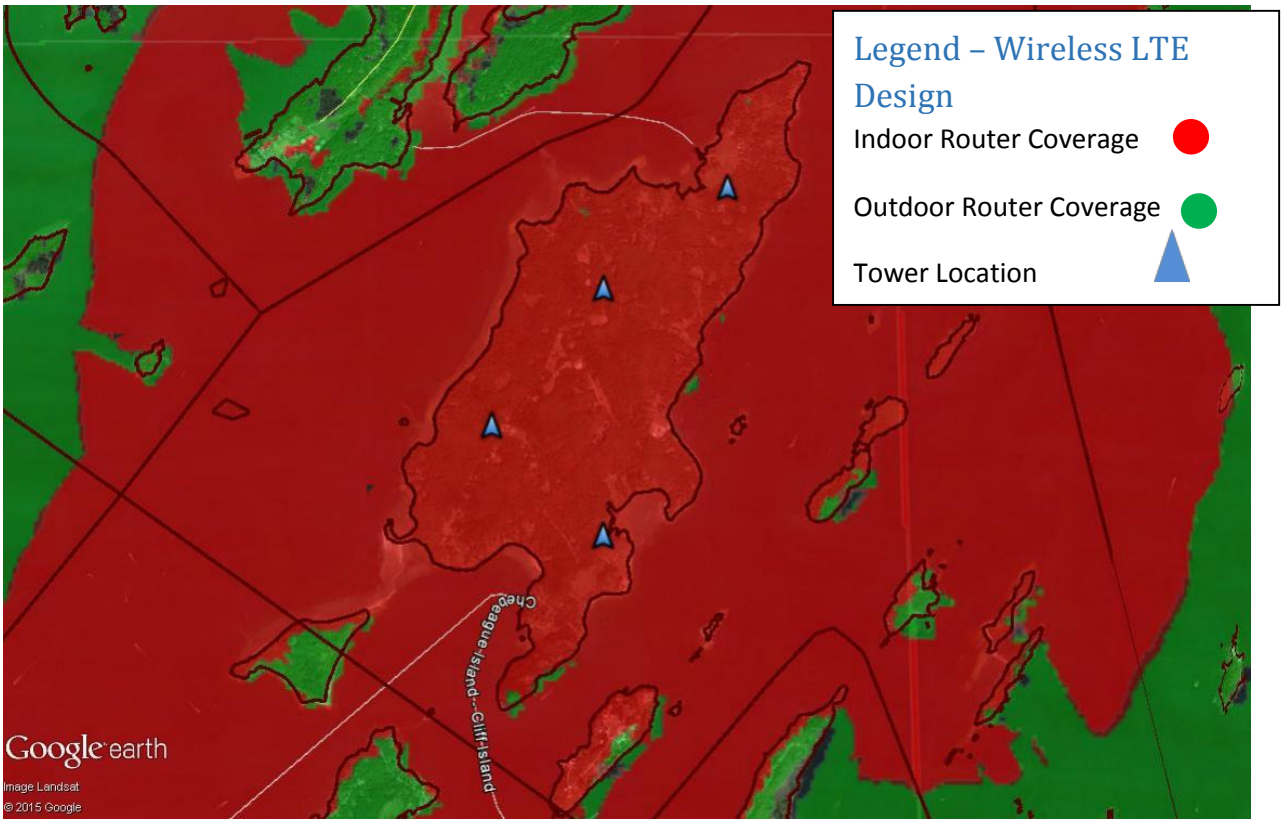
[77] Design work performed for Redzone by 4G Unwired, Indialantic, FL.
[78] Current speed and pricing information in the "Service Offering Overview" section near the end of this report.

Redzone's design deployed 150' tall towers, placed in optimal locations to provide universal coverage with the fewest number of towers. The red on the map represents areas of indoor LTE coverage, meaning that an external antenna is not necessary to have access to all of Redzone's speed offerings. The green areas represent locations where an outdoor antenna is needed to access to Redzone's full service offerings. Across the islands for which Redzone designed a network, 91% of the households will have access via indoor router, and 98.7% will have access via outdoor router.

If Redzone's wireless service were to be deployed in this configuration, neighboring islands, such as Hope Island to the southeast, would benefit from coverage.

Redzone would likely backhaul its traffic to the mainland via microwave.

Redzone Wireless LTE Design - Chebeague



Wireless LTE Cost Estimate

Redzone estimates that the capital cost of deploying equipment on a tower, plus microwave backhaul, is $125,000 per tower. Tilson estimates that the cost of building a 150' telecommunications tower on an island is and additional $200,000, although that can vary widely. Because Chebeague doesn't have any existing telecommunications towers, the Redzone solution would require 4 LTE sites, plus 4 towers for a total estimated cost of $1,300,000.

In this model, the town would fund and likely own the towers. New towers could potentially be used by other telecommunications carriers, like mobile providers. Redzone would retain ownership of its

equipment and bill customers directly. In today's environment, it is unlikely that Redzone would deploy equipment on the island without an almost complete capital cost subsidy.

Redzone's business model and service offerings are further discussed in the "Service Offering Overview by Provider" section of this report.

ILEC Network Improvements

ILEC network improvements to the DSL infrastructure are the least expensive way to improve Internet service on the islands, but will not achieve speeds that meet the FCC or Connect ME definition of broadband. DSL improvements take two forms: existing DSL nodes can be upgraded to have faster maximum speeds, and/or DSL nodes can be added. As with all DSL, users closest to the nodes have access to the highest speeds. Users greater than four route miles from the node have no access. The more DSL nodes, the greater the proportion of islanders with access to the highest speeds.[79]

Practical upgrades to the FairPoint service, beyond what is currently in process, include adding remote DSL terminals and connecting them via fiber. As a point of comparison, Long Island, with a smaller land mass and lower population, has three DSL remote terminals. Additional remote terminals on Chebeague would shorten the distance of the copper wire between users and fiber-fed DSL terminals, meaning that a greater percentage of the population could access the maximum speeds offered at each terminal. Shorter copper wire distances would also enable a different DSL configuration with speeds up to 50/2 Mbps. With the subsea cable in place, FairPoint will have ample backhaul to the mainland. In addition, the fiber connectivity to the school and library provides a significant fiber footprint from which to expand the spatial distribution of remote terminals.

ILEC Improvements – Cost Estimate

The costs for adding remote terminals vary widely, and are determined by the ILEC. The ILEC's cost are a function of whether additional microwave backhaul capacity is needed, how much fiber needs to be run to reach the remote terminal, and how much rewiring of copper cables is necessary. On the mainland, the costs for adding a remote terminal are typically less than $100,000. Tilson estimates that a private provider might charge $30,000 for upgrading an existing microwave link, $45,000 for installing a new microwave link and one tower. However, it is likely that an ILEC might spend (and charge) more money putting up a microwave link than an alternate provider would due to company technology and process specifications and labor restrictions.

Funding

The FCC's Connect America Fund (CAF II) program is funded by the Federal Universal Service Charge on phone bills, and in Maine, that money is redistributed through the ILECs to broaden coverage of at least 10 Mbps download speeds. Eligible communities are outlined on the FCC's CAF II maps.[80] Not all eligible communities will necessarily receive improved service through this program due to limited funding. FairPoint is in the process of determining which municipalities will yield the greatest return on their CAF

[79] See the "Service Offering Review by Provider" section at the end of this report for known speeds and pricing.
[80] https://www.fcc.gov/maps/fcc-connect-america-fund-phase-ii-initial-eligible-areas-map

II subsidized investment. A portion of Chebeague is eligible for CAF II subsidy according to the CAF II eligibility map.

Long Island

Background

Long Island is another community in Casco Bay. 805 acres in size, as of the 2010 census it had a year round population of 230 residents, with a summer population of 1,000. An Island Institute survey conducted earlier this year placed the number of year-round residents on Long Island at 200.[81] Tilson held a community meeting with approximately a dozen Long Island residents and stakeholders on July 30th. The group consisted of four summer residents and 9 year-round residents.

Current Infrastructure

All of the homes and businesses on Long Island have DSL service, which is provided by three FairPoint remote terminals on the island. Users on the north and south of the island have access to maximum speeds of 10/1 Mbps, and users in the middle of the island are served by an older remote terminal with maximum speeds of 3/1 Mbps.[82]

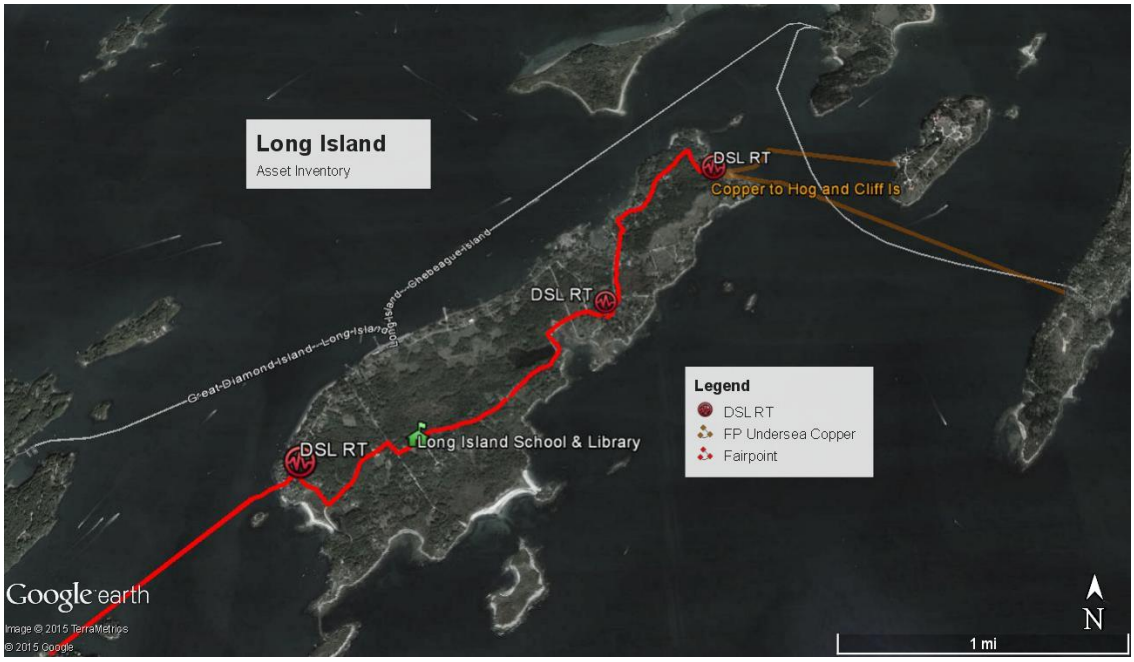
[81] Island Institute Informal Survey, Spring 2015.

[82] During Tilson's review of Long Island with FairPoint, a potential error in FairPoint's data was identified. It is possible that because of this error, residents in the northern part of the island may be told that the maximum speed available is 3/1 Mbps, when it is actually 10/1 Mbps. FairPoint is aware of this *potential* error.

FairPoint connects to the school library building through its fiber-fed Carrier Ethernet Service. This same service is available to businesses on the island, although higher speeds would require a costly fiber build to extend the network to the premise.

FairPoint DSLAM on Southern Long Island (left); and FairPoint Fiber Entrance to School and Library Building (right)

Long Island Asset Inventory



Current Service Offerings

The following table summarizes the various Internet, voice, video, and cellular service types, providers, and service notes related to resident experiences and prices. Only the school and library have broadband service that meets the FCC and ConnectME definition.

Type	Provider	Service Notes
Internet	FairPoint	• DSL up to 15 Mbps on east and west ends. 3 Mbps in the middle of the island • Not fast enough or reliable enough for certain educational and business needs • Middle of the island – reset three times/day • Middle of the island – Residents reported that DSL service via Verizon was "good", but that service has worsened in recent years with FairPoint.
	Red Zone	• TBD. Signal on the south and west end of the island so far
	Verizon AT&T	• Residents reported LTE signal "very good" in some parts – NW end of island characterized as "good" • Excellent coverage observed at ferry dock
Video	DirectTV, Dish	• FairPoint bundles DirectTV with phone and DSL packages

Cellular	Verizon Wireless, AT&T Wireless	• Residents reported that LTE signal ranges from "very good" to "bad" -- NW end of island characterized as "good" • Excellent Verizon LTE coverage observed at ferry dock

Public Internet Service – Long Island

Type	Provider, Service	Service Notes
Library	MSLN, 100/100 MBPS	• via FairPoint fiber • open access Wi-Fi • Discussion of medical facility in basement to share network
School	MSLN, 100/100 MBPS	• Same location as school
Ferry	Casco Bay lines	• Residents described signal as "weak" • LTE solution
Town Hall	FairPoint DSL	• No public Wi-Fi • Service described by residents as "marginal" • New, large recreational center being built near town hall

Community Priority Buildings/Businesses

Long Island stakeholders identified the following buildings as areas where improved Internet connectivity were particularly needed:

- Public Safety
- Town Hall (for purposes of having town meetings via video conference so as to involve seasonal residents in island meetings during the off-season)
- Docks – Particularly security cameras at Casco Bay lines and lobster docks
- Businesses (data uploading) – lobster businesses in particular on the island have upload needs regularly

Stakeholders' Stated Community Goals

At Tilson's community visit to Long Island, residents and stakeholders present articulated a number of community goals as well as ideas regarding how an improvement in Internet connectivity could improve life on the island.

One of the larger issues identified was the psychology of the majority of islanders and complacency due to unfamiliarity with the connectivity options available. For some islanders, broadband Internet is not something that they believe is necessary on the island. Those present at the meeting expressed the concern that current speeds and reliability, while not far below the norm in comparison to other Maine island communities today, will not be adequate in the future.

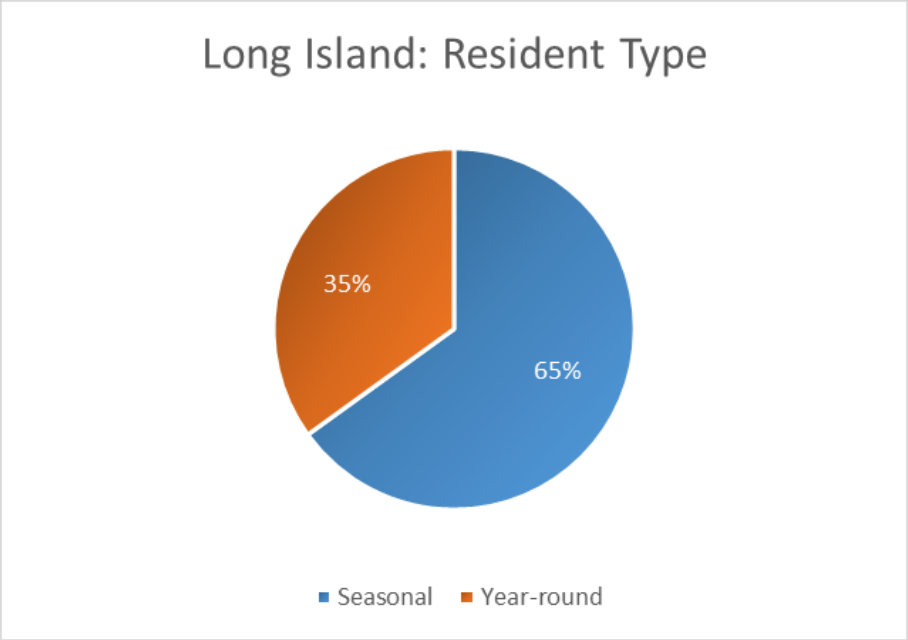
Some residents pointed to current Internet slow speed and unreliability as affecting the amount of time that they wish to spend on the island. For a contingent of the summer residents on Long Island, they would like to spend more time on the island, but connectivity is a barrier to doing so. Residents who work from home find it challenging to do so in the summer as slow speeds are a hindrance to accomplishing both business and educational goals online. For some residents, working from home on cloud based programs is challenging. In addition, some residents' children rely on connectivity in order to complete online educational enrichment.

Among some of the general community goals stakeholders expressed for the island were:

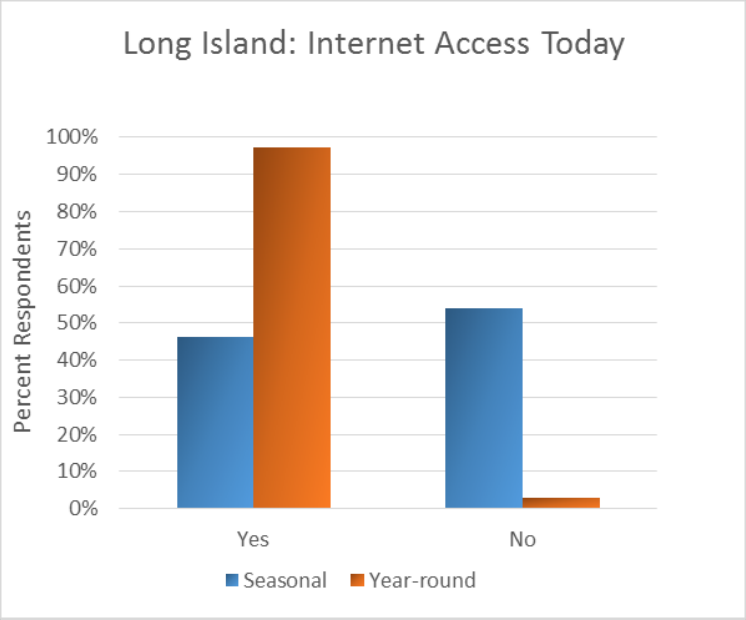
- Increasing the number of people who choose to live on Long Island year-round;
- Maintain the ability to rent homes out to tenants, who in general require Internet access;
- Videoconferencing for Town meetings;
- Telemedicine facilitation—the use of videoconferencing for non-emergency related healthcare visits;
- Educational needs: Residents conveyed that there is an increasing expectation on the mainland that kids have access to the Internet at home. This is a difficult expectation for islanders to meet when living on an island with maximum download speeds of 3 Mbps.
- Finally, the empowerment of existing small businesses on Long was an expressed community objective—in particular, lobster businesses which are run from the island. For this segment of business, there are significant needs to communicate with both vendors as well as customers that would be greatly facilitated by an improvement in the island's Internet service.

Survey Results

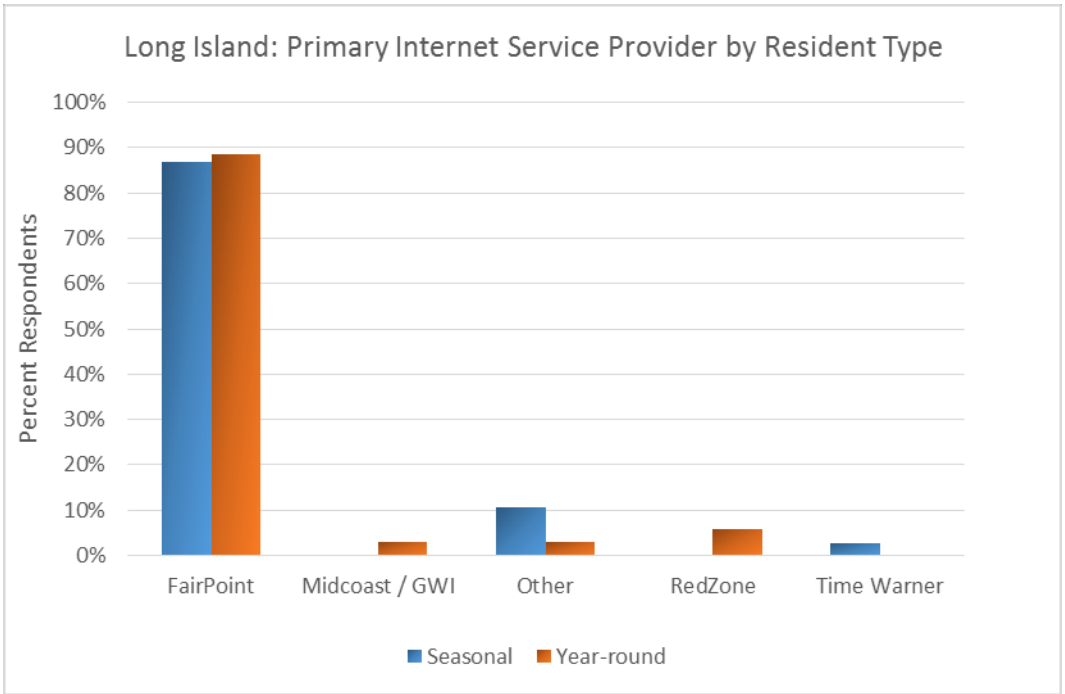
Tilson conducted a randomized survey of a subset of the 363 property owners on Long Island. Of the 273 surveys sent out, 103 respondents from Long Island completed and returned the survey (39% response rate) and were comprised of 65 seasonal residents and 36 year-round residents.



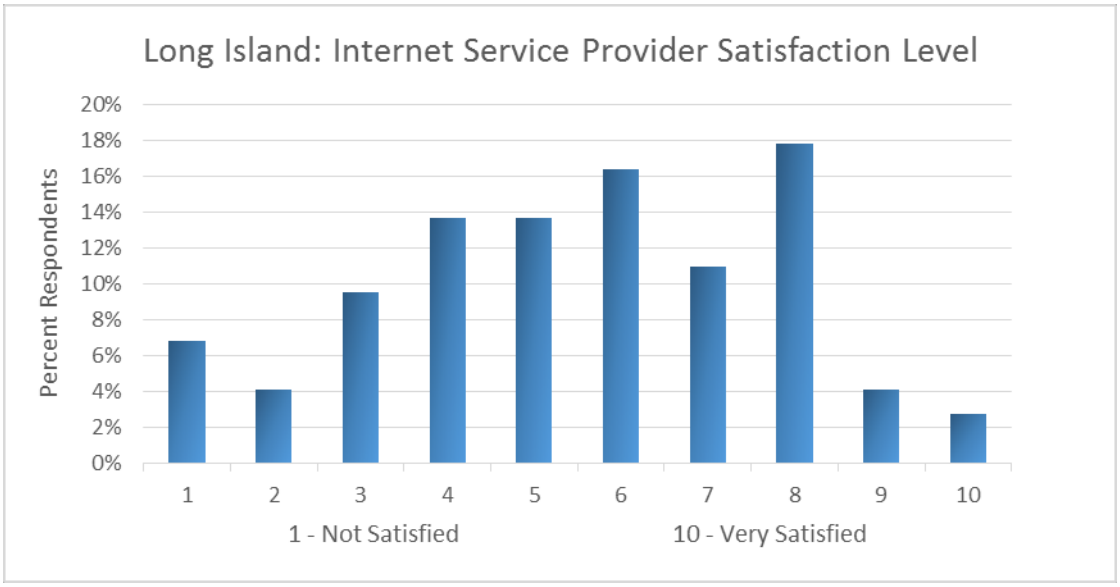
97% of year-round and 46% of seasonal respondents to the survey indicated that they currently had Internet service, as shown by the following chart.



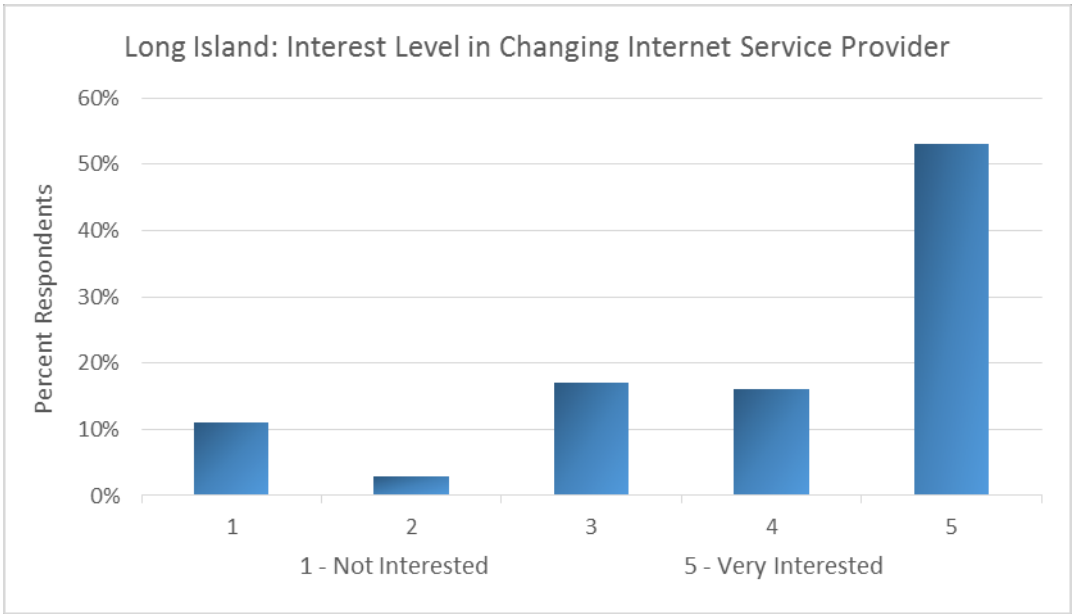
For this group of respondents, FairPoint was the primary ISP for 87% of seasonal and 89% of year-round residents on Long Island, with a handful of respondents indicating that Midcost/GWI, Redzone, or Time Warner, was their primary ISP. A handful of other respondents indicated that they had another ISP.



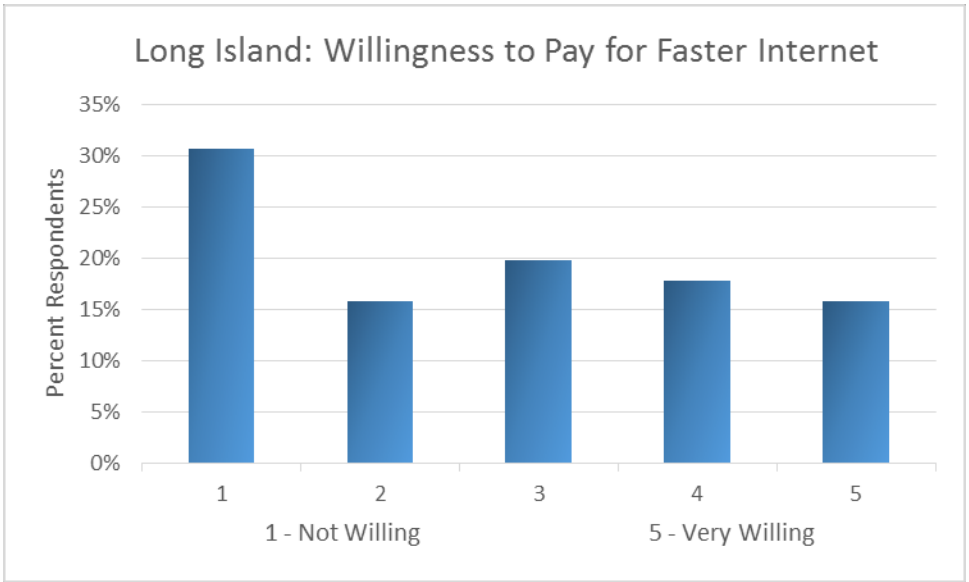
In terms of satisfaction level towards the ISP, on a scale of 1 to 10, 38 respondents (52%) indicated satisfaction (a score between 6 and 10) with their ISP, with 25 respondents (35%) indicating that they were not satisfied with the current ISP (a score between 1 and 4). 14% of respondents indicated that they were neither satisfied nor dissatisfied.



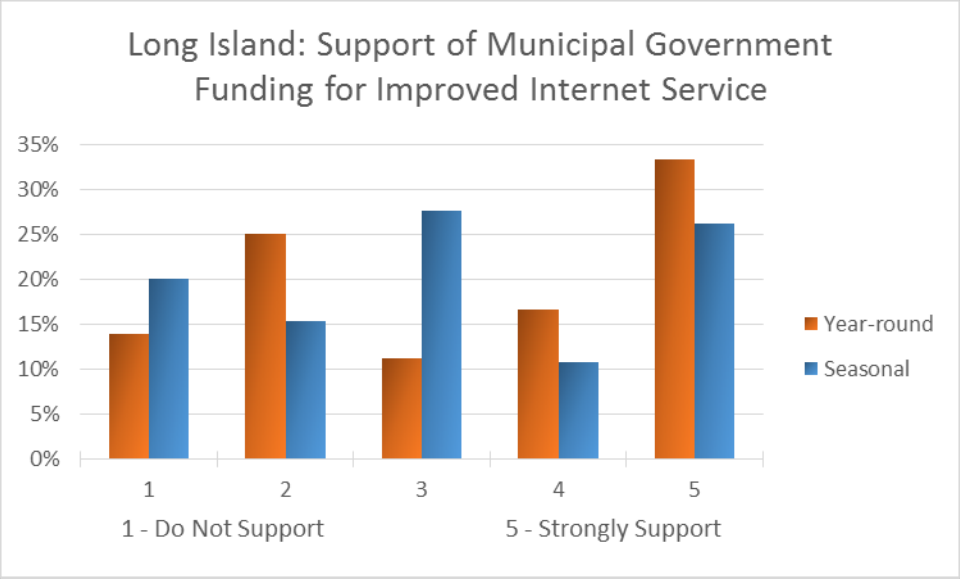
The survey also attempted to gauge islanders' attitudes toward change. 69% of Long Island survey respondents indicated that they would be interested in switching ISPs if it meant being able to have faster connectivity.



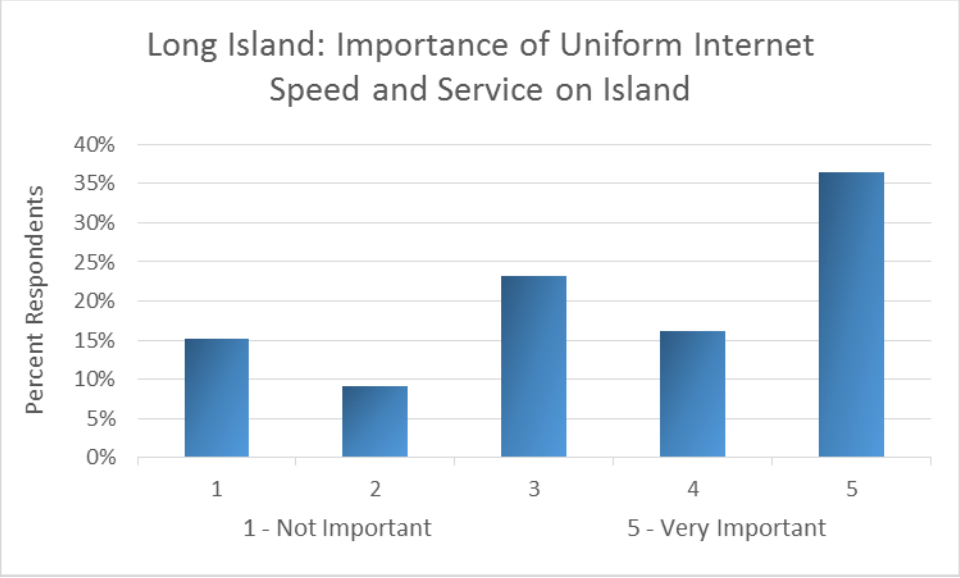
Despite this clear interest, only 34% of this same group of respondents indicated that they would be willing to pay more money to obtain that service, with 47% being unwilling to do so, and 20% not sure one way or the other.



In terms of Long Island respondents' support for municipal government funding an improvement of Internet service on the island, an average of about 44% of respondents would either support or strongly support their municipal government funding an improvement in Internet connectivity, with an average of 37% (seasonal and year-round) respondents who would not support this. The remaining 19% of respondents indicated that they neither strong support nor lack of support for municipal government funded Internet improvement.



As for uniformity of a connectivity solution and the importance of everyone on the island having access to the same level of Internet speed and service, about half of respondents (52%) agreed that this was very important to them.



Finally, Long Island residents were asked their opinion of how they would feel about a new telecommunications tower being built on the island so as to enable better Internet service. While a sizable contingent, 27 respondents (27%) would not support this at all, 53 respondents (53%) indicated that they would. 19% of respondents were ambivalent.

Possible Solutions

Tilson examined two options for Long Island to consider: improving existing DSL service,[83] and a fiber to the premise (FTTP) network. The first option may fall short of meeting the community's medium-term goals, while the FTTP option would exceed Long Island's goals. Taking no action to address the lack of broadband is also an option: however, it would likely prevent the town from achieving stated goals like enhancing telecommuting capabilities, expanding participation in municipal public meetings, enabling businesses, attracting new families, and minimizing off-island trips.

Fiber Network Design

A fiber to the premise (FTTP) network is the gold standard in municipal network design: it is the most upgradeable, the least expensive to operate on a whole-island basis, the fastest, the most reliable, but also the most expensive to build. Because an FTTP network is so reliable, it requires less customer support and is less expensive to operate than DSL, hybrid fiber/coax, or wireless networks. The largest operating disadvantage to fiber is that if it is cut, it requires a technician skilled in fiber repair (and typically a bucket truck) to fix. Fiber networks can be configured to provide 1 Gigabit (Gbps) speed upload and download—100 times faster than the current ConnectME standard.

Tilson designed a FTTP solution that would pass and connect to all 366 premises on the island. Fiber counts were specified for each segment to optimize for current building distribution, and with future growth in mind. Tilson designed multi-port service terminals (MST's) throughout the network to enable easy and short interconnections with existing and future premises.

To complete the local access portion of this network, electronics are needed at the customer premise and at the traffic collection node, or end. In addition, an ISP would need to place its own electronics and microwave backhaul to the mainland. There are various operating models whereby these network elements could be owned and operated either by the town, a network operator, or the ISP. [84]

The following diagram illustrates Tilson's FTTP design for Long Island.

[83] This option may meet the needs of the community in the near term, but does not meet the ConnectME or FCC definition of broadband.

[84] Tilson will describe municipal models that include ownership of a greater proportion on the infrastructure in the business model section of this report.

Fiber Network Design –Long Island

Fiber Capital Cost Estimate

Tilson's detailed cost estimate included all the design, application, materials and labor costs associated with the fiber to the curb network.[85] For all the islands, Tilson assumed that 90% of the route miles were aerial, and 10% were underground. The estimate also assumes that all the fiber drops are built at once, rather than on-demand. An island premium of 10% on materials, and 20% on labor was added onto all of Tilson's standard estimates, and is reflected in the numbers below.

[85] Tilson's detailed cost estimate is based on the known cost of the network components of its high level fiber design, plus estimates for labor costs, engineering and margin. A firm estimate is obtained when a project is put out to bid. Projects can be separated into engineering design and build, or put out to bid as a combined design/build.

Fiber Capital Cost Estimate – Long Island

Project Miles		7.9
Aerial Miles		7.1
Poles		228
Premise Count		366
Application and Make Ready	$	66,274
Materials	$	149,264
Labor	$	398,761
Engineering	$	26,584
Margin/Profit (20%)	$	128,176
Service Provider Tax (6% Labor and Engineering)	$	33,211
Sales Tax (5.5% Materials)	$	8,210
Total	$	802,270
Per Premise Cost	$	2,192

The incremental capital cost of building out the network, which would be borne by either the ISP, the municipality, or a network operator - depending on the business model - are not included above.

To complete the local access portion of this network, electronics are required at the customer premise and the traffic collection node, or head end. These electronics cost about $570 per premise. In addition, an ISP would need to deploy network electronics, which are customarily paid for by the ISP, even though they may be housed in a municipal building.

The electronics described above need to be housed in a space with redundant power, heating and sufficient heat dissipation ("conditioned space"). That conditioned space can be provided by a stand-alone shelter for about $250,000, or a municipality can provide it in one of its buildings to deliver substantial cost savings.

If the network were to be connected to the mainland via microwave, the capital cost estimate for two microwave dishes and one new small tower on the island (this assumes the mainland microwave dish is mounted on an existing tower), is $45,000. While a microwave link will be necessary for every island without a subsea fiber cable, there are opportunities for islands to collaborate to either save money in operating the link and/or increasing the redundancy and reliability of the links. These are highlighted in the "Opportunities for Regional Cost Savings" section near the end of this report.

ILEC Network Improvements

ILEC network improvements to the DSL infrastructure are the least expensive way to improve Internet service on the islands, but will not achieve speeds that meet the FCC or Connect ME definition of broadband. DSL improvements generally take two forms: existing DSL nodes can be upgraded to have faster maximum speeds, and/or DSL nodes can be added to shorten average distances to the nodes. As with all DSL, users closest to the nodes have access to the highest speeds. Users greater than four route

miles from the node have no access. The more DSL nodes, the greater the proportion of islanders with access to the highest speeds.[86]

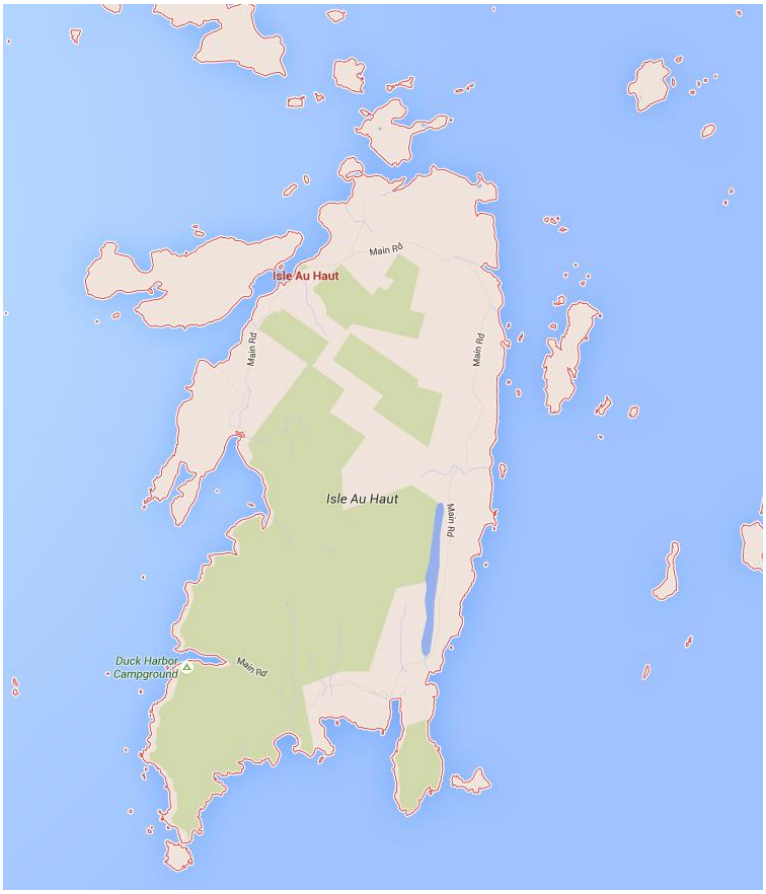
The most practical upgrade to the FairPoint service on the island is to replace the older DSL remote terminal in the middle of Long Island to offer a faster service there. Also, Tilson learned in a meeting with FairPoint that there may be an opportunity to perform some re-wiring that would enable some homes to be served by their closest DSLAM. Tilson also learned that it is possible (although not certain) that the homes served by the newer DSLAM on the north end of the island may not be offered the 15/1 Mbps service for which they are eligible, due to a data error in FairPoint's system.[87]

ILEC Improvements – Cost Estimate

The costs for adding remote terminals vary widely, and are determined by the ILEC. The ILEC's cost are a function of whether additional microwave backhaul capacity is needed, how much fiber needs to be run to reach the remote terminal, and how much rewiring of copper cables is necessary. On the mainland, the costs for adding a remote terminal are typically less than $100,000. Tilson estimates that a private provider might charge $30,000 for upgrading an existing microwave link, $45,000 for installing a new microwave link and one tower. However, it is likely that an ILEC might spend (and charge) more money putting up a microwave link than an alternate provider would due to company technology and process specifications and labor restrictions.

[86] See the "Service Offering Overview by Provider" section at the end of this report for known speeds and pricing.
[87] Tilson recommends calling FairPoint customer service and asking them what speed they can provision to a house on the northeast tip of the island. If this was a problem, it may have been fixed by FairPoint by the time of publication of this report.

Isle Au Haut



Background

Isle au Haut is an 8,000-acre offshore island community with a year round population of 73 people according to the 2010 U.S. Census. The Island estimated the year round population in the spring of 2014 to be 45 people.[88] In the summertime, the population on the island is approximately 300 people.

Isle Au Haut has many innate telecommunications challenges. The low population density, seasonal population, mountainous terrain, and offshore location make any broadband business model difficult. The seasonal population and low density make it very difficult for a provider to cover its costs. The mountainous terrain limit the effectiveness of any wireless technology, including cellular voice and data. The offshore location makes it highly expensive to connect to the Internet. There are only two options, submarine cable and microwave. Cable is extremely expensive and the Town is considering upgrading the existing cable. Microwave is significantly less expensive but the signal degrades over water and is somewhat hindered by fog. Both of these dynamics are problematic for an island.

[88] Island Institute Informal Survey, Spring 2015.

Current Infrastructure/Asset Inventory

The island has limited fiber presence to network the community facilities including the town office and library, which cohabitate the same building.

Isle Au Haut has one Internet service provider (ISP), TDS Telecom. TDS Telecom provides DSL service of legacy twisted pair copper wire (since fall 2001). TDS uses a 100 Mbps microwave circuit to connect to the Internet via a tower in Stonington, Maine. For middle mile service, TDS uses copper wire.

TDS provides universal DSL service on the island. The service was recently expanded to the southwestern side of the island with the assistance of a ConnectME grant.

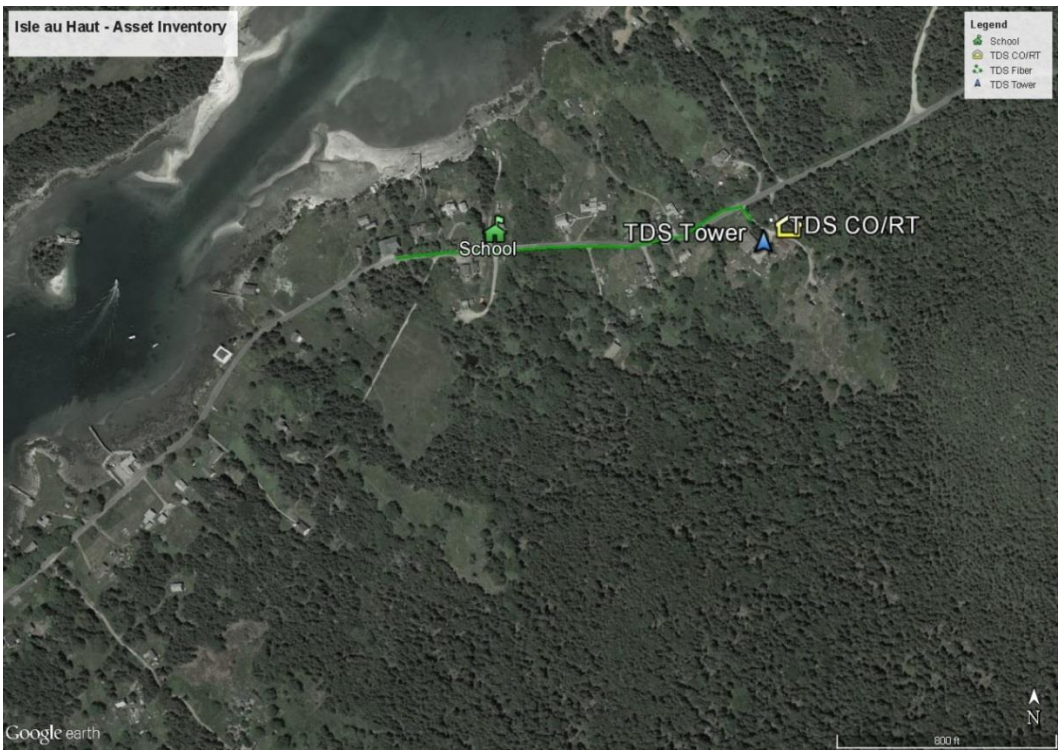
The Island has a limited fiber presence between the tower and the town hall. There is no cellular carrier present on the Island, however, some residents can pick up service from U.S. cellular or Verizon from the town center.

A submarine cable upgrade for the Power Company is being discussed. A new cable will likely include fiber for network management for distributed generation/microgrid. The Isles Au Haut Power Coop is warming up to the idea of providing Internet access as well.

Finally, fiber could be leased to TDS or MSLN.

Asset Inventory – Isle Au Haut

The following image illustrates the location of the aforementioned assets. In particular, the TDS infrastructure, remote terminal/CO and tower.



Current Service Offerings

The following table summarizes the various Internet, voice, video, and cellular service types, providers, and service notes related to resident experiences and prices. Only the school and library have broadband service that meets the FCC and ConnectME standards.

Type	Provider	Service Quality
Voice	TDS	Residents characterized service as "good"
Video	Dish, Direct TV,	Residents characterized service as "good"
Internet	TDS DSL	Basic DSL Internet package provides up to 5 Mbps down/ 1 up
Cellular	Verizon, US Cellular	Residents reported that service varies from limited to non-existent
Public WiFi	Available at the school, Town Hall, and Black Diamond Chocolate	Residents reported service ranging from "strong" to "weak"

Public Broadband and Internet Service – Isle Au Haut

Type	Provider, Service	Service Notes
Library	MSLN (100/100)	• Streaming and videoconference needs well-served by MSLN via fiber/microwave technology
School	MSLN (100/100 Mbps)	• Streaming and videoconference needs well-served by MSLN via fiber/microwave technology
Town Hall	MSLN Fiber	• Streaming and videoconference needs well-served by MSLN solution
Island Public Safety (Fire, Police)		• Two-Way radio meets needs

Community Priority Buildings/Businesses

Many of the businesses on the island would benefit from improved connectivity. These include:

- Teleworkers and commuters
- Video production company
- Financial planner
- Other white collar work
- Gift store
- General store
- Black Diamond Chocolates
- Lobstermen (mostly residential use)

Currently, the library, school, and town hall are have streaming and video conferencing needs which are served by fiber optic service via the MSLN project. As such, these community buildings do not have service goals with regard to improved broadband. In addition, island public safety (fire/police) currently utilize two-way radio service to meet their needs, with the additional goal of achieving 4G LTE service through the FirstNet program.

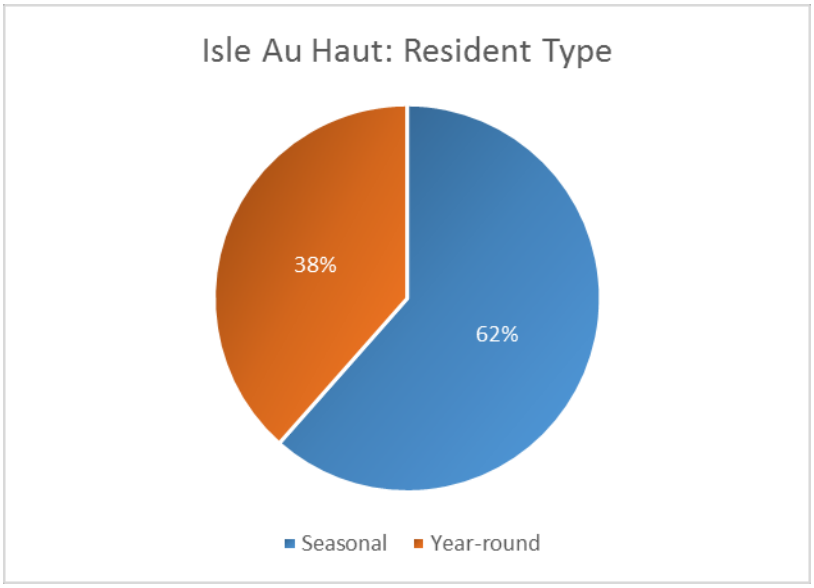
Stakeholders' Stated Community Goals

The Isle au Haut community meeting revealed many community goals where broadband might play a role. A leading goal was improved cellular service. The island effectively has none at present apart from isolated areas in the town center on the north side of the island. The residential and business goals centered on supporting existing business community and supporting telework and telecommuting. Attracting new businesses is also a goal, but secondary to supporting current residents and their endeavors. Part of this support includes providing for telemedicine and video communications.

The community is very cost sensitive. The community may face some large capital projects in the near to long term. These include a new transmission cable to the mainland. Also the desired service level improvement is relatively marginal. The community wishes for a near term solution that improves service levels to a double digit megabit threshold.

Survey Results

Tilson conducted an open source online survey of residents on Isle Au Haut. Of the 136 property owners on the island, 26 responded to the online survey—16 seasonal residents and 10 year-round residents, comprising 62% and 38% of total respondents.

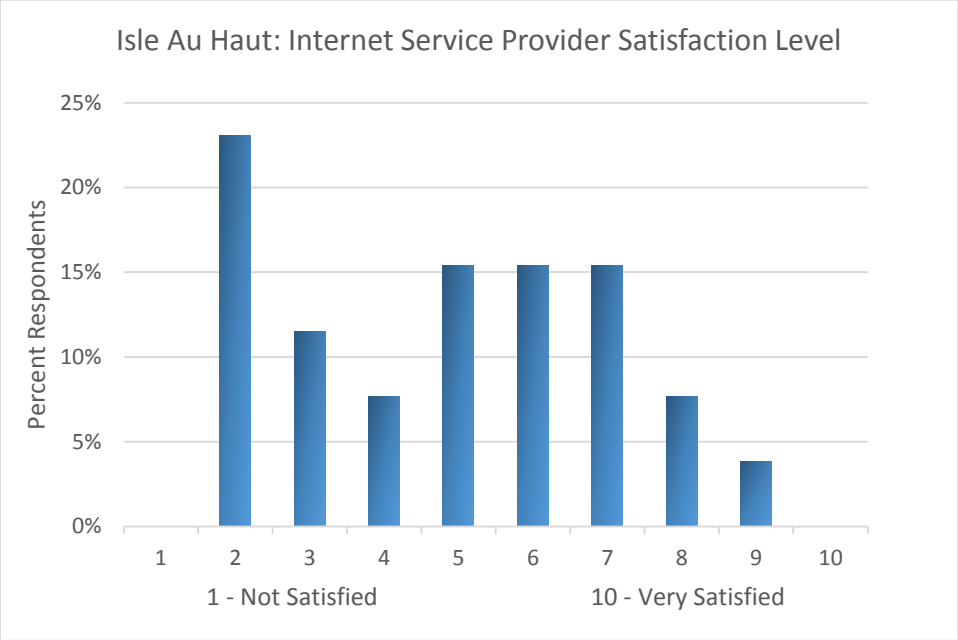


Of these respondents, 15 seasonal and all 10 year-round indicated that they currently had Internet service on the island, with all respondents indicating that TDS Telecom is their current ISP.

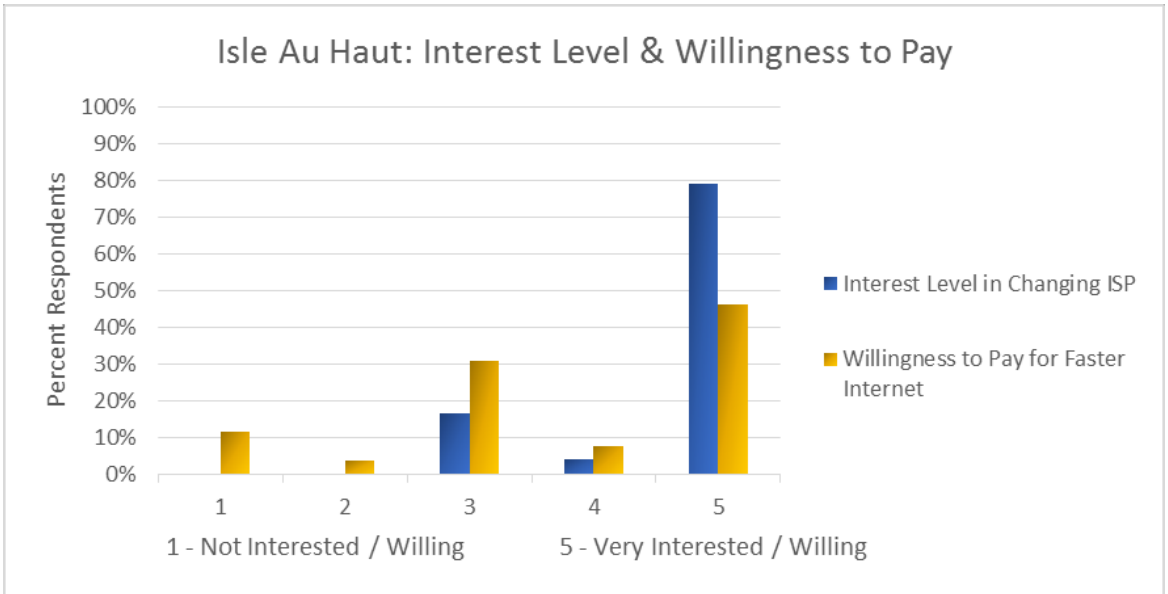
Nearly half (43%) of all respondents indicated that they were not satisfied with their current provider, as 11 respondents indicated a rating between 1 and 4 on a scale of 1 to 10. An equal number (11 respondents) provided a rating between 6 and 10, indicating that they were satisfied with current service. Four respondents (15%) rated their current service a 5, indicating that they are neither satisfied nor dissatisfied with their service.

According to the Institute for Customer Service, customers that rate a service provider at less than eight are often willing to switch if an alternate offering is available.[89] Eighty-eight percent (88%) of Isle Au Haut respondents were in this category, scoring their provider between 1 and 7.

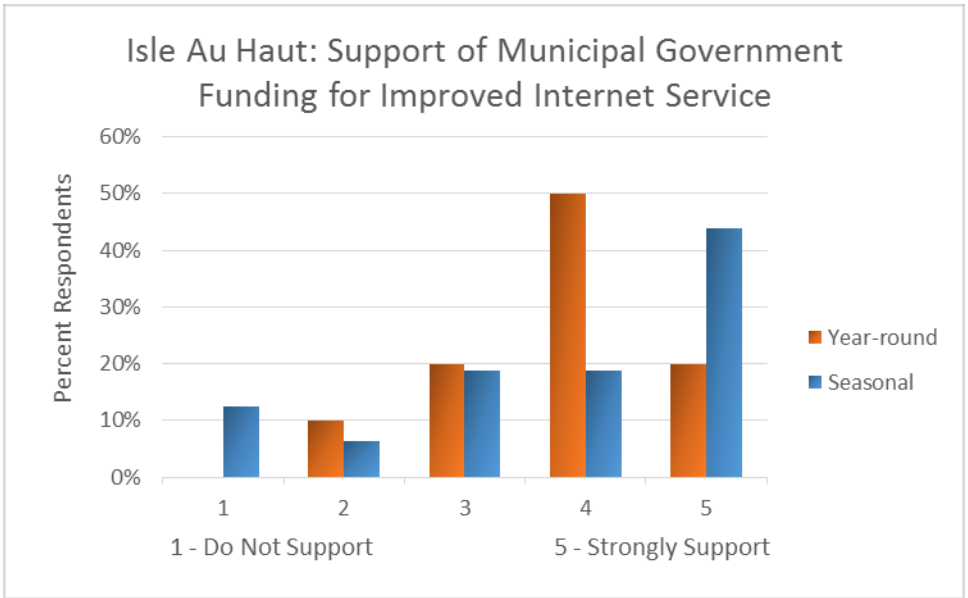
[89] Institute of Customer Service. *UK Customer Satisfaction Index.* July 2015.



The last few questions of the survey gave an indication of islanders' attitudes towards change. While 83% of respondents indicated that they would be interested in changing their current ISP if it meant better Internet service, only 54% of respondents indicated that they would be willing to pay more for faster service. While a relatively small percentage (16%) indicated that they would not be willing to pay for faster internet, a significant percentage (31%) neither indicated willingness to pay more nor unwillingness to pay more. The responses indicate that residents are willing to switch ISPs for faster service, but are value sensitive, and not as enthusiastic about paying more for the service. It should be noted that while the willingness to pay results emphasize the importance of a cost effective solution, the survey did not collect information regarding the current Internet costs being paid by respondents.

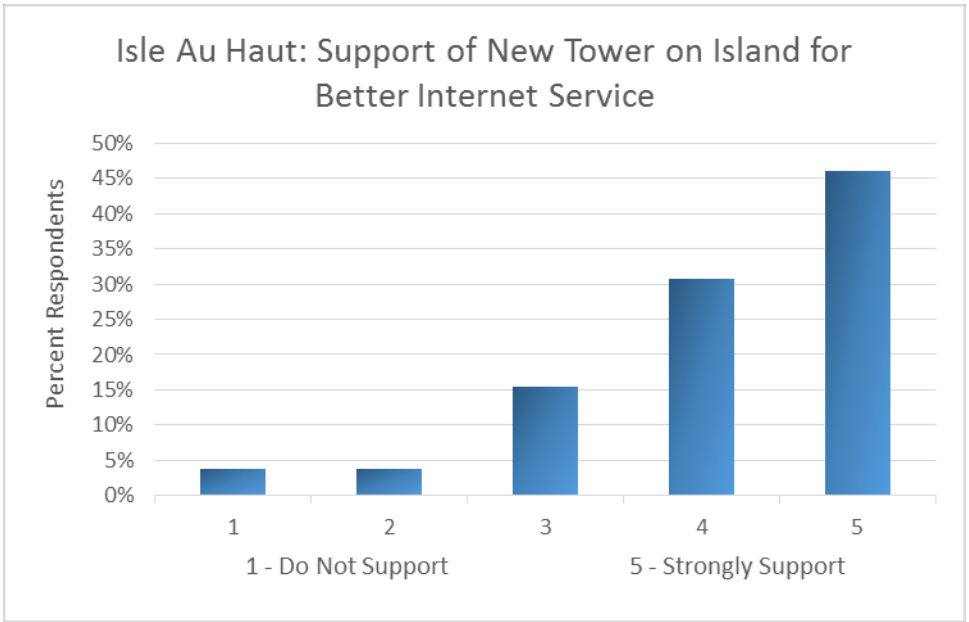


In terms of respondents' support for municipal government funding an improvement in Internet service, an average of 67% of respondents (seasonal and year-round taken together) indicated their support of municipal funding, whereas an average of 14% of respondents indicated that they are not in support of this. The remaining five Isle Au Haut respondents (19%) did not indicate either strong support or opposition.



As for the importance of everyone on the island having uniform Internet speeds and service, 20 out of 26 respondents (77%) viewed this as very important to them, with the remaining six (23%) not considering it important.

Finally, in terms of the support for new tower build on Isle Au Haut for better Internet service, 20 respondents (77%) indicated that they would support it, with two out of 26 respondents (8%) indicating that they would not support it, and the remaining four respondents (15%) indicating no strong preference in either direction.



Possible Solutions

Tilson examined three options for Isle Au Haut to consider: improving existing DSL service[90]; Redzone's wireless LTE service; and a fiber to the premise (FTTP) network. These options range in their ability to meet or exceed the island's needs. Taking no action to address the lack of broadband is also an option—however, it may prevent the community from achieving stated goals.

Fiber Network Design – Isle Au Haut

A fiber to the premise (FTTP) network is the gold standard in municipal network design: it is the most upgradeable, the least expensive to operate on a whole-island basis, the fastest, the most reliable, but also the most expensive to build. Because an FTTP network is so reliable, it requires less customer support and is less expensive to operate than DSL, hybrid fiber/coax, or wireless networks. The largest operating disadvantage to fiber is that if it is cut, it requires a technician skilled in fiber repair (and typically a bucket truck) to fix. Fiber networks can be configured to provide 1 Gigabit (Gbps) speed upload and download—100 times faster than the current ConnectME standard.

Tilson designed a FTTP solution that would pass and connect to all 136 premises on the island. Fiber counts were specified for each segment to optimize for current building distribution, and with future growth in mind. Tilson designed multi-port service terminals (MST's) throughout the network to enable easy and short interconnections with existing and future premises.

To complete the local access portion of this network, electronics are needed at the customer premise and at the traffic collection node, or end. In addition, an ISP would need to place its own electronics and

[90] This option may meet the needs of the community in the near term, but does not meet the ConnectME or FCC definition of broadband.

microwave backhaul to the mainland. There are various operating models whereby these network elements could be owned and operated either by the town, a network operator, or the ISP. [91]

Fiber Design – Isle Au Haut

Fiber Capital Cost Estimate

Tilson's detailed cost estimate included all the design, application, materials and labor costs associated with the fiber to the curb network.[92] For all of the islands, Tilson assumed that 90% of the route miles were aerial, and 10% were underground. The estimate also assumes that all of the fiber drops are built

[91] Tilson will describe municipal models that include ownership of a greater proportion of the infrastructure in the "Business Model Overview" section of this report.

[92] Tilson's detailed cost estimate is based on the known cost of the network components of its high level fiber design, plus estimates for labor costs, engineering and margin. A firm estimate is obtained when a project is put out to bid. Projects can be separated into engineering design and build, or put out to bid as a combined design/build.

at once, rather than on-demand. An island premium of 10% on materials, and 20% on labor was added onto all of Tilson's standard estimates, and is reflected in the numbers below.

Fiber Capital Cost Estimate – Isle Au Haut

Project Miles		10.4
Aerial Miles		9.4
Poles		300
Premise Count		136
Application and Make Ready	$	85,670
Materials	$	115,860
Labor	$	316,569
Engineering	$	21,105
Margin/Profit (20%)	$	109,115
Service Provider Tax (6% Labor and Engineering)	$	33,180
Sales Tax (5.5% Materials)		
Total	$	681,498
Per Premise Cost	$	5,011

The incremental capital cost of building out the network, which would be borne by either the ISP, the municipality, or a network operator - depending on the business model - are not included above.

To complete the local access portion of this network, electronics are required at the customer premise and the traffic collection node, or head end. These electronics cost about $570 per premise. In addition, an ISP would need to deploy network electronics, which are customarily paid for by the ISP, even though they may be housed in a municipal building.

The electronics described above need to be housed in a space with redundant power, heating and sufficient heat dissipation ("conditioned space"). That conditioned space can be provided by a stand-alone shelter for about $250,000, or a municipality can provide it in one of its buildings to deliver substantial cost savings.

If the network were to be connected to the mainland via microwave, the capital cost estimate for two microwave dishes and one new small tower on the island (this assumes the mainland microwave dish is mounted on an existing tower), is $45,000. While a microwave link will be necessary for every island without a subsea fiber cable, there are opportunities for islands to collaborate to either save money in operating the link and/or increase the redundancy and reliability of the links. These are highlighted in the "Opportunities for Regional Cost Savings" section near the end of this report.

Wireless LTE Design

Tilson engaged Redzone,[93] the only company offering fixed wireless LTE in Maine, to design a network that would provide universal access to all premises on the island. This means that all island users would

[93] Design work performed for Redzone by 4G Unwired, Indialantic, FL.

have access to the same speed offerings, which are fast enough to meet both the FCC and ConnectME definition of broadband.[94]

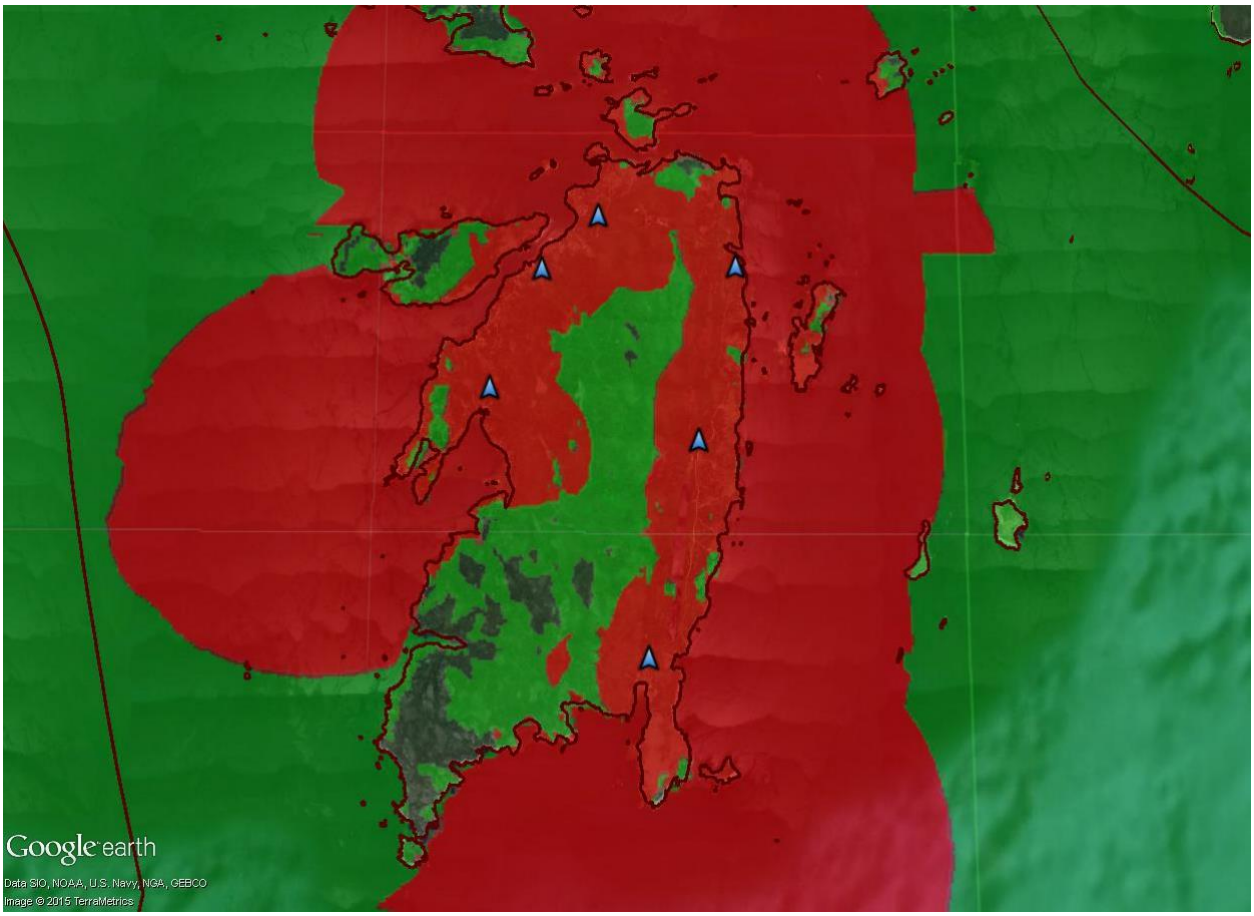
Redzone's design deployed 150' tall towers, placed in optimal locations to provide universal coverage with the fewest number of towers. The red on the map represents areas of indoor LTE coverage, meaning that an external antenna is not necessary to have access to all of Redzone's speed offerings. The green areas represent locations where an outdoor antenna is needed to access to Redzone's full service offerings. Across the islands for which Redzone designed a network, 91% of the households will have access via indoor router, and 98.7% will have access via outdoor router.

Redzone would likely backhaul its traffic to the mainland via microwave.

The following image shows the wireless LTE design for Isle Au Haut. [95] The red on the map represents indoor LTE coverage for households on the island. The green areas represent outdoor LTE coverage on the island. This design contemplates a six-tower build on the island.

[94] Current speed and pricing information are in the "Service Offering Overview" section near the end of this report.

LTE Wireless Design – Isle Au Haut



Legend – Wireless LTE Design

Indoor Router Coverage

Outdoor Router Coverage

Tower Location

Wireless LTE Cost Estimate

Redzone estimates that the capital cost of deploying equipment on a tower, plus microwave backhaul, is $125,000 per tower. Tilson estimates that the cost of building a 150' telecommunications tower on an island is an additional $200,000, although that can vary widely. Because Isle Au Haut does not have any

existing telecommunications towers, the Redzone solution would require 6 LTE sites, plus 6 towers for a total estimated cost of $1,950,000.

In this model, the town would fund and likely own the towers. New towers could potentially be used by other telecommunications carriers, like mobile providers. Redzone would retain ownership of its equipment and bill customers directly. In today's environment, it is unlikely that Redzone would deploy equipment on the island without an almost complete capital cost subsidy.

Redzone's business model and service offerings are further discussed in the "Service Offering Overview by Provider" section of this report.

ILEC Network Improvements

TDS Telecom is the incumbent DSL Internet and phone service provider on Isle Au Haut. Tilson has learned that TDS' Architectural Design team is undertaking a project to improve the microwave infrastructure on the island as part of a contract for FairPoint.[96] Fairpoint has contracted with TDS to upgrade the bandwidth to the Isle Au Haut school and library as part of its contract with the Maine Schools and Libraries Network (MSLN). When this is complete, FairPoint, via TDS, will provide has the school and library with 100 Mbps symmetrical speeds.

The backhaul capacity upgrade triggered by the MSLN service will enable TDS to offer faster DSL speeds to Isle Au Haut customers. Today, TDS Telecom offers DSL on Isle Au Haut with speeds up to 5 Mbps download and .512 Mbps upload. After the upgrade, these speeds will increase to a maximum of 15 Mbps download and .768 Mbps upload for customers within 10,000 route feet (1.9 miles) of the DSLAM, or DSL node.[97] Because Isle Au Haut has a large geographic area, and only one DSLAM, not all customers will be able to access the maximum speeds.

A practical solution for improving DSL service on Isle Au Haut would be to add an additional DSLAM in a strategic location that would minimize the distance between the greatest proportion of users that cannot access the highest available speeds due to distance from the single DSLAM in use today.

The TDS project is tentatively slated for completion at the end of the second quarter of 2016. Customers are expected to be able to take advantage of the improved speeds by the end of the third quarter of 2016.

[96] Per communication from Scott Brooks, Manager – State Government Affairs, TDS Telecommunications Corporation, 10/14/2015.

[97] More information on current and projected TDS speeds and pricing can be found in the "Service Offering Overview" section of this report.

Funding

The Town of Isle au Haut expressed some interest in partially or wholly funding a broadband network, but they have very limited resources currently, with a total town budget of less than $500,000. As such, the Town has a very strong preference for externally funded solutions but would consider a small municipal capital contribution if this were well matched with grants, loans or other subsidy.

Cliff Island

Background

Cliff Island is a small 302-acre island located in Casco Bay that is part of the City of Portland. The year-round population of Cliff is 71 residents as of the 2010 U.S. Census, with a summer population of 200. A recent survey conducted by the Island Institute placed the year round population estimate at 49.[98]

Current Service Offerings

The following table summarizes the various Internet, voice, video, and cellular service types, providers, and service notes related to resident experiences and prices. The school and library have broadband service that should meet the ConnectME standard of 10 Mbps download and 10 Mbps upload (these are speeds as provisioned, Tilson did not test the realized speeds), but the provisioned download speeds are short of the FCC standard of 25 Mbps download.

[98] Island Institute Informal Survey, Spring 2015.

Type	Provider	Service Notes
Internet	FairPoint DSL	• Variable speeds depending on island location. One resident gets 6.75/3.5 Mbps, another 3/.78 Mbps (and 35 ms ping) • Low reliability – service subject to rain, wind. • Residents cited poor call center service. Islanders feel dependent on field tech. for service, e.g. how to generate a ticket for help. • One telecommuter uses a remote desktop application, which makes DSL speeds workable. However, reliability is a serious issue.
Video	DirectTV, Dish	
Cellular	Verizon Wireless	• Works at ferry dock only. • Two attendees had a Sprint-provided femtocell that worked well with their DSL connection.

Public Internet Service – Cliff Island

Type	Provider, Service	Service Notes
Library	MSLN, 10 MBPS	bonded T1's, via FairPoint
School	MSLN, 10 MBPS	bonded T1's, via FairPoint
Public WiFi	Casco Bay lines	Only nearer to Portland; slow.

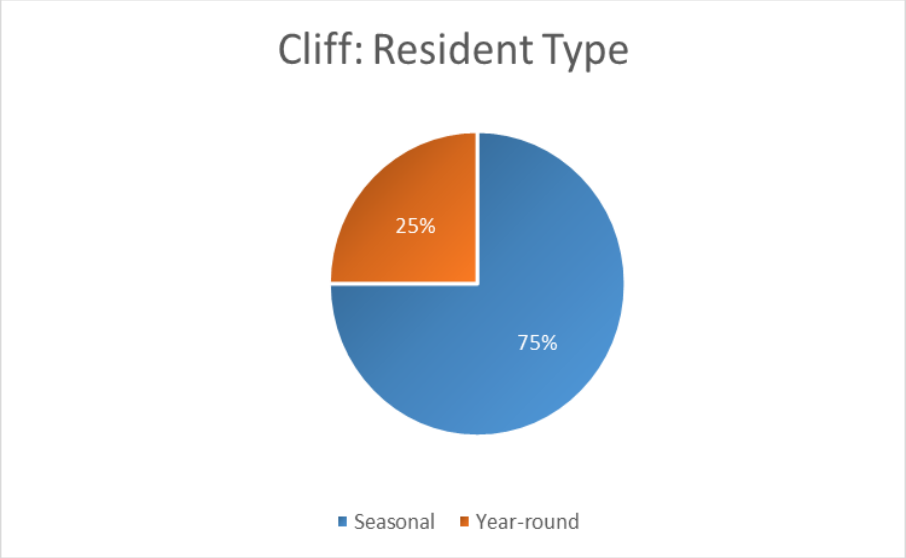
Stakeholders' Stated Community Goals

Cliff Island residents and stakeholders expressed goals relating to a number of different island concerns. Foremost among these were sustaining the year-round community, sustaining the schools, enabling telecommuting, access to government services, and facilitating telemedicine. Because the island does not have the public infrastructure (i.e. park facilities) to service day visitors to Cliff, a technological solution involving Wi-Fi is not currently a priority for this community's residents. Residents were interested in whether the MSLN project includes plans to extend fiber optic cable to service the school and library with 100/100 Mbps speeds, just as they plan to do in the fourth quarter of 2015 on

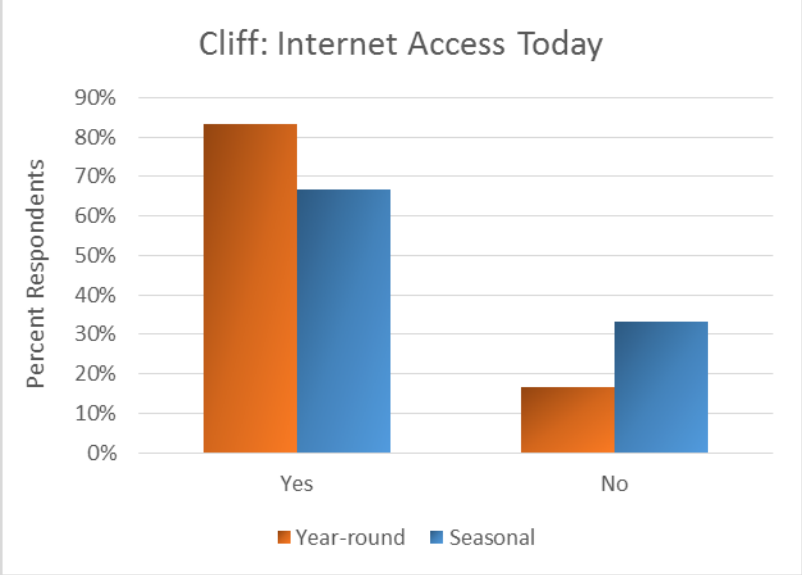
Chebeague. In terms of timing, islanders conveyed that they may be willing to wait to see what upgrades FairPoint does (e.g. extending fiber from Long Island) rather than pay for a private solution like Great Diamond Island did.

Survey Results

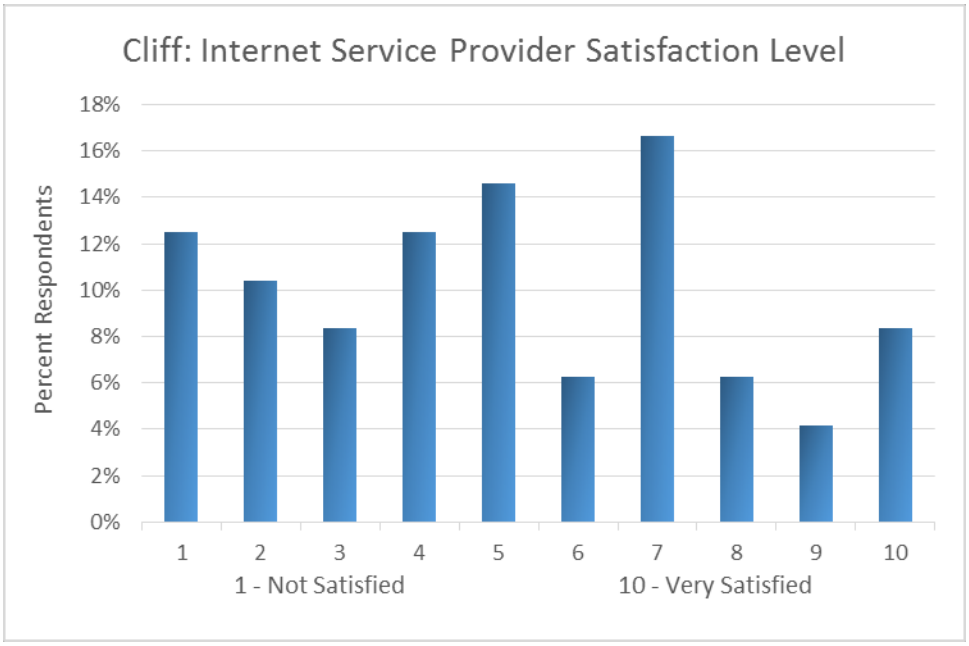
Tilson conducted an open source (i.e. not random), online survey of seasonal and year-round residents to determine their attitudes toward broadband and in particular, to gather information regarding current levels of Internet and cellular service, satisfaction, and interest in funding improvements to those levels. Forty-eight (48) residents responded to the online survey, with two-thirds of this number being seasonal residents and the other one-third being year-round residents.



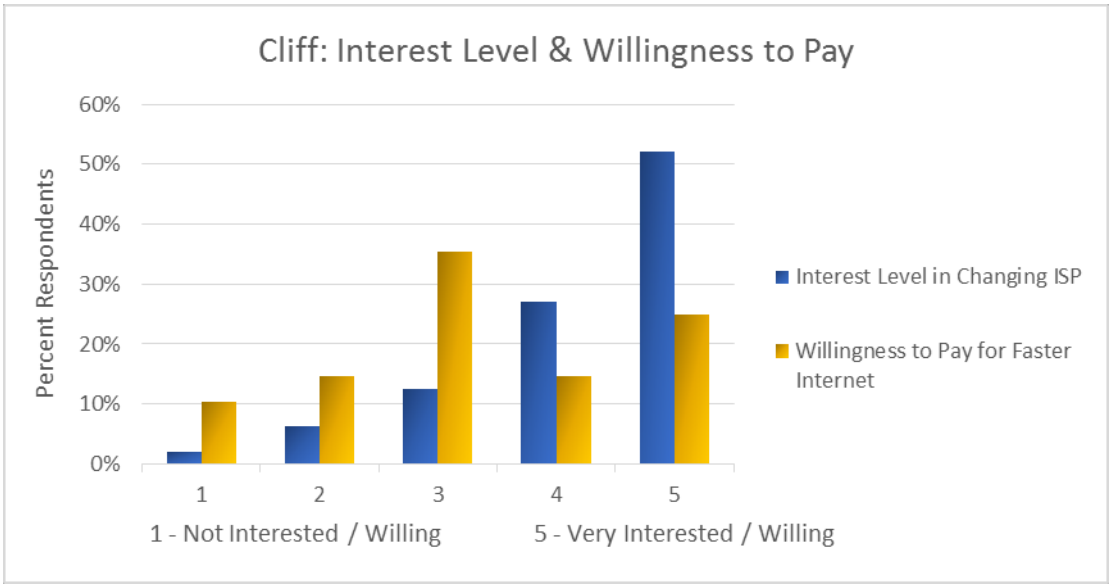
83% of year-round and 67% of seasonal respondents to the survey indicated that they currently had Internet service, as shown by the following chart.



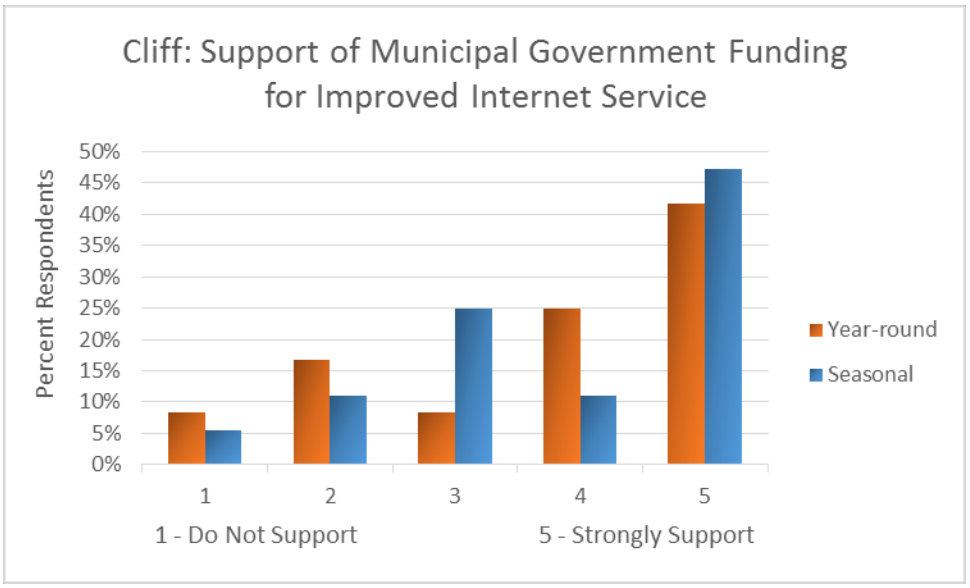
For this group of respondents, FairPoint was the primary ISP for 88% of seasonal and 100% of year-round residents on Cliff. In terms of satisfaction level towards the ISP, on a scale of 1 to 10, 20 respondents (41%) indicated satisfaction (a score between 6 and 10) with their ISP, with 21 respondents (44%) indicating that they were not satisfied with the current ISP. Fifteen percent (15%) of respondents indicated that they were neither satisfied nor dissatisfied.



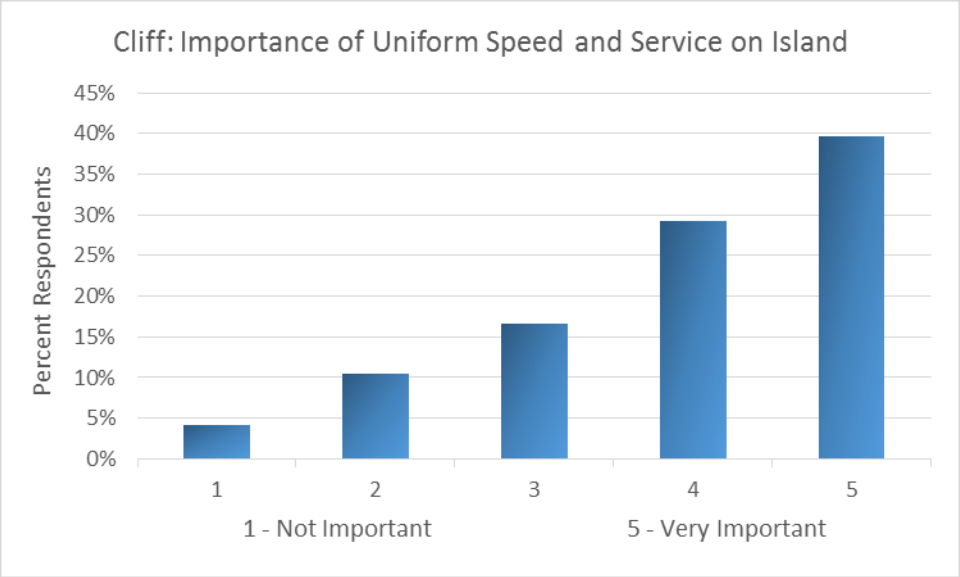
The survey also attempted to gauge islanders' attitudes toward change. 79% of Cliff survey respondents indicated that they would be willing to switch ISPs if it meant being able to have faster connectivity. Despite this clear interest, only 40% of this same group of respondents indicated that they would be willing to pay more money to obtain that service, with 25% being unwilling to do so, and 35% not sure one way or the other. These two attitudes—interest and willingness to pay—can be compared side-by-side in the following graph. It should be noted that while the willingness to pay results emphasize the importance of a cost effective solution, the survey did not collect information regarding the current Internet costs being paid by respondents.



In terms of Cliff respondents' support for municipal government funding an improvement of Internet service on the island, an average of about 63% of respondents would either support or strongly support their municipal government funding a connectivity solution, with an average of 21% (seasonal and year-round) respondents who would not support this.



As for uniformity of a connectivity solution and the importance of everyone on the island having access to the same level of Internet speed and service, most respondents agreed that this was very important.



Finally, Cliff Island residents were asked their opinion of how they would feel about a new telecommunications tower being built on the island so as to enable better Internet service. While a sizable contingent 17% would not support this at all, 58% of respondents indicated that they would.

Possible Solutions

Tilson outlined three options for Cliff Island to consider: improving existing DSL service;[99] wireless LTE, and a fiber to the premise (FTTP) network. These options range in their ability to meet and exceed the community's short term needs. Taking no action to address the lack of broadband is also an option: however, it may eventually prevent the island from achieving its stated goal of sustaining the year round community.

Fiber Cost Estimate

A fiber to the premise (FTTP) network is the gold standard in municipal network design: it is the most upgradeable, the least expensive to operate on a whole-island basis, the fastest, the most reliable, but also the most expensive to build. Because an FTTP network is so reliable, it requires less customer support and is less expensive to operate than DSL, hybrid fiber/coax, or wireless networks. The largest operating disadvantage to fiber however, is that if it is cut, it requires a technician skilled in fiber repair (and typically a bucket truck) to fix. Fiber networks can be configured to provide 1 Gigabit (Gbps) speed upload and download—100 times faster than the current ConnectME standard.

Tilson did not design a network for Cliff, but prepared a high level cost estimate for an FTTP solution to serve the 3.1 miles of roadway and all 142 premises on Cliff Island.

For Cliff, the total capital cost estimate of building an optical fiber network according to the assumptions above would be approximately $379,000. This translates to a total cost of about $2,700 per premise. It

[99] This option may meet the needs of the community in the near term, but does not meet the ConnectME or FCC definition of broadband.

should be noted that the design for this fiber network would not be a redundant ring. Costs were calculated assuming an island premium of 50% above normal costs so as to factor in transportation of materials to Cliff and housing costs for labor on the island. Additional assumptions in this cost estimate include the assumption that there would be an existing head end for space, power, and redundant power.

This capital cost estimate assumes that the network would be a dark fiber network, meaning that, while the estimate includes the cost of all aerial drops and underground fiber, the estimate does not include the cost of a central location for network electronics or the necessary backup generator.[100] Electronics costs would be assumed by the network operator or Internet service provider (ISP) as opposed to the City. In the event that the ISP did not provide its own electronics, the cost of these electronics would be approximately $570 per subscriber. In addition, an assumption in preparing the estimate was that all drops to the houses would be built at once, and the estimate includes a rough estimate of the cost for backhauling traffic to the mainland, including the construction of one 50-foot microwave tower.

The electronics described above need to be housed in a space with redundant power, heating and sufficient heat dissipation ("conditioned space"). That conditioned space can be provided by a stand-alone shelter for about $250,000, or a municipality can provide it in one of its buildings to deliver substantial cost savings.

If the network were to be connected to the mainland via microwave, the capital cost estimate for two microwave dishes and one new small tower on the island (this assumes the mainland microwave dish is mounted on an existing tower), is $45,000. While a microwave link will be necessary for every island without a subsea fiber cable, there are opportunities for islands to collaborate to either save money in operating the link and/or increasing the redundancy and reliability of the links. These are highlighted in the "Opportunities for Regional Cost Savings" section near the end of this report.

Wireless LTE Solution Capex

Due to the scope of this study, Tilson did not engage Redzone to do a wirless LTE network design for Cliff Island. However, it is an option. In fact, community members on Great Diamond Island, with the help of a ConnectME grant, subsidized Redzone's deployment of a cell site on an existing water tank (see the business models section for more information). Tilson believes that if the City were to pursue a wireless LTE broadband solution on Cliff, it would cost approximately $325,000 for a Redzone cell site and one new 150-foot tower. Redzone's offerings are fast enough to meet both the FCC and ConnectME definition of broadband.[101]

Incumbent Local Exchange Carrier (ILEC) Network Improvements

ILEC network improvements to the DSL infrastructure are the least expensive way to improve Internet service on the islands, but will not achieve speeds that meet the FCC or Connect ME definition of broadband. DSL improvements take two forms: existing DSL nodes can be upgraded to have faster

[100] Tilson estimates that 90% of fiber drops would be aerial drops, with the remaining 10% representing the potential for buried fiber on lengthy driveways.
[101] Current speed and pricing information in the "Service Offering Overview" section near the end of this report.

maximum speeds, and/or DSL nodes can be added. In Cliff Island's case, the DSL node serving it is capable of download speeds up to 15 Mbps, but is located on Long Island, and too far away for Cliff residents to access those speeds. (The Long Island DSLAM connects to Cliff via copper sub-sea cable.)

DSLAM on Long Island Serving Cliff Customers

If FairPoint located a DSLAM on Cliff, users closest to the nodes would have access to the DSLAM's highest speeds, likely 15 Mbps download and 1 Mbps upload with FairPoint's current equipment. Depending on the DSLAM's location, users farther away from the DSLAM might not have access to the fastest speed tiers.[102] In this scenario, Fairpoint's backhaul would need to be upgraded. Currently, FairPoint sends Cliff Island traffic to Long Island via sub-sea copper cable. Either this cable would need to be upgraded to fiber, or FairPoint would need to install microwave backhaul.

The costs for adding remote terminals vary widely, and are determined by the ILEC. The ILEC's cost are a function of whether additional microwave backhaul capacity is needed, how much fiber needs to be run to reach the remote terminal, and how much rewiring of copper cables is necessary. On the mainland, the costs for adding a remote terminal are typically less than $100,000. Tilson estimates that a private provider might charge $30,000 for upgrading an existing microwave link, $45,000 for installing a new microwave link and one tower. However, it is likely that an ILEC might spend (and charge) more money putting up a microwave link than an alternate provider would due to company technology and process specifications and labor restrictions.

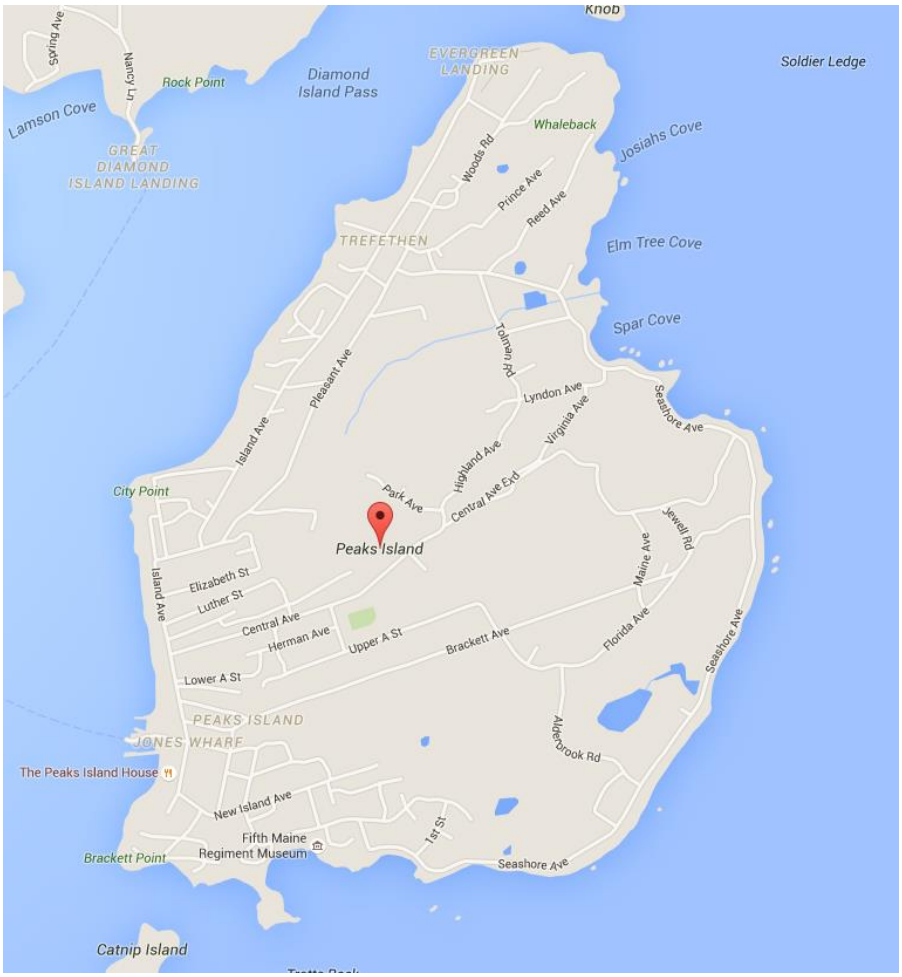
Funding

The FCC's Connect America Fund (CAF II) program is funded by the Federal Universal Service Charge on phone bills, and in Maine, that money is redistributed through the ILECs to broaden coverage of at least 10 Mbps download speeds. Eligible communities are outlined on the FCC's CAF II maps.[103] Not all

[102] See the "Service Offering Review by Provider" section at the end of this report for known speeds and pricing. Fairpoint would be able to determine copper cable route footage from potential DSLAM location.
[103] https://www.fcc.gov/maps/fcc-connect-america-fund-phase-ii-initial-eligible-areas-map

eligible communities will necessarily receive improved service through this program due to limited funding, and FairPoint is in the process of determining which municipalities will yield the greatest return on their CAF II subsidized investment. A portion of Cliff is eligible for CAF II subsidy according to the CAF II eligibility map.

Peaks Island



Background

Peaks Island is an island in Casco Bay that is approximately 750 acres in size, and is part of the City of Portland. As of the 2010 U.S. Census, it had a population of 864, and its summer population is estimated to be between 2,000 and 4,000 people given the high volume of day trip traffic for this island. A recent informal survey of Peaks residents placed the year-round population closer to 950 residents.[104]

Current Service Offerings

The following table summarizes the various Internet, voice, video, and cellular service types, providers, and service notes related to resident experiences and prices. Only the school and library are known to have broadband service that meets both the FCC and ConnectME standards. All of the homes on Peaks

[104] Island Institute Informal Survey, Spring 2015.

are believed to have access to Time Warner. If that is the case, they all have access to the FCC 25 Mbps download and 3 Mbps upload definition of broadband.

Type	Provider	Service Notes
Internet	FairPoint DSL TWC	• FairPoint has attractive seasonal rate
Video	DirectTV Dish TWC	
Cellular	Verizon AT&T	• Residents would like better coverage in general

Public Internet Service – Peaks Island

Type	Provider, Service	Service Notes
Library	MSLN, 100 MBPS	• Fiber via FairPoint
School	MSLN, 100 MBPS	• Fiber via FairPoint
Public WiFi	Casco Bay lines	• Service only nearer to Portland; slow speeds

Stakeholders' Stated Community Goals

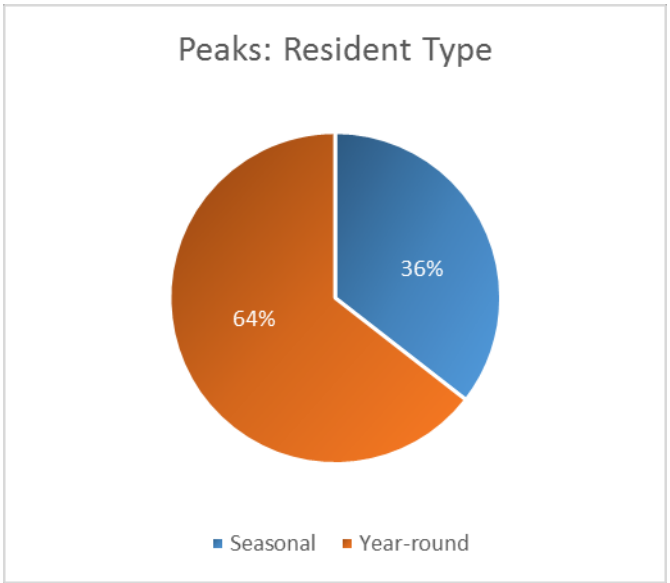
Tilson held a site visit with members of the Peaks Island community in July 2015 to better understand their goals for the island and for improved island connectivity, specifically. The meeting was poorly attended, with only two members present. Among the voiced objectives were the desire to attract new, young families to live on the island, and to empower existing small businesses so that they may be able to market more effectively while attracting new small business to the island. Residents said that they would like the ability to access educational opportunities online at home.

Attendees both wanted better reliability and improved customer service. An improvement in current service should also involve better cell phone coverage on the island as well as better Wi-Fi on the ferry.

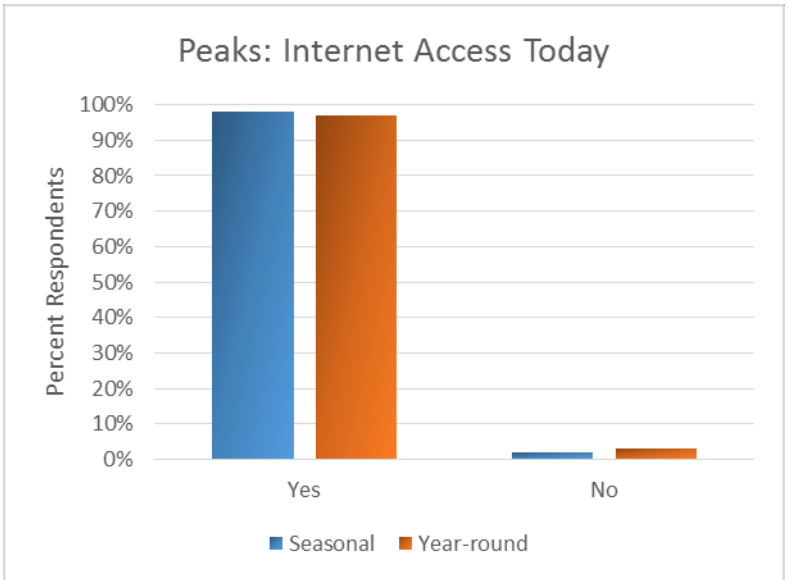
Other goals of island residents that could be facilitated by an improvement in Internet connectivity and service are attracting more and different visitors to the island and reducing residents' need to take trips to the mainland.

Survey Results

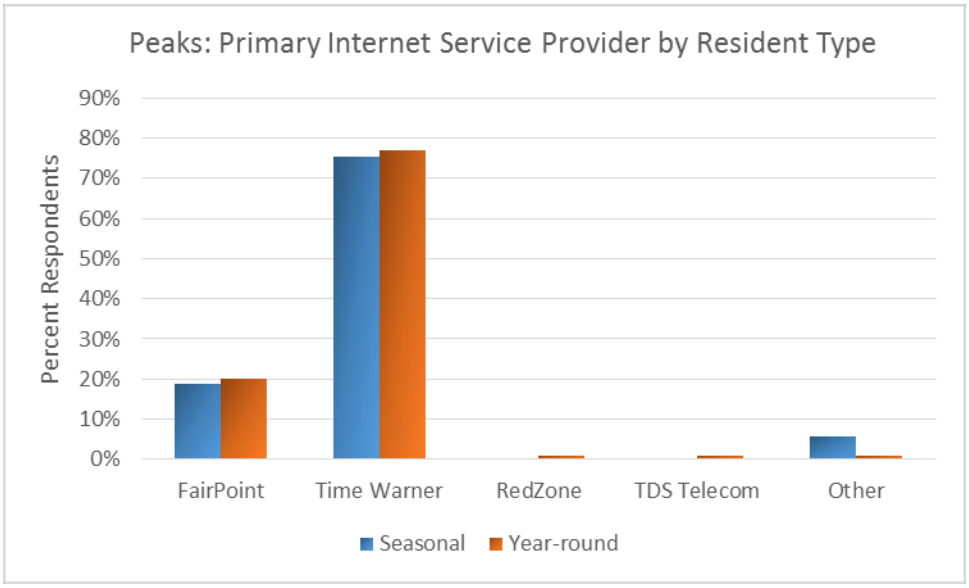
Tilson conducted an open source, online survey (i.e. not random) of seasonal and year-round Peaks residents to determine their attitudes toward broadband and in particular, to gather information regarding current levels of Internet and cellular service, satisfaction, and interest in funding improvements to those levels. 152 residents responded to the online survey, with nearly two-thirds of this number being year-round residents and the other one-third being seasonal residents.



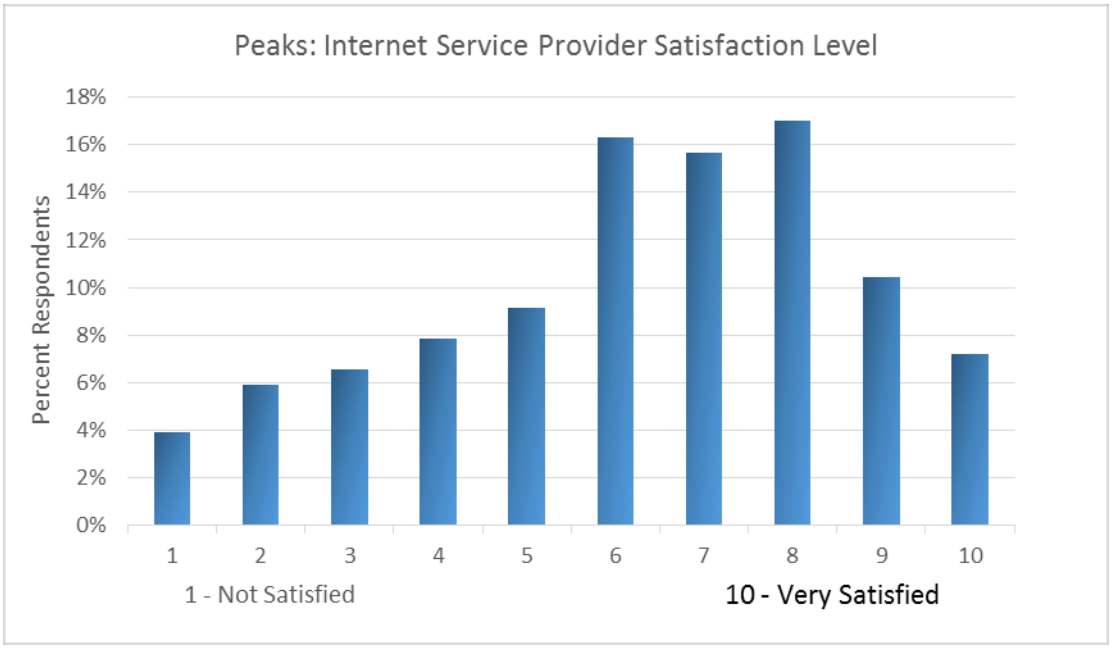
An overwhelming majority of residents on Peaks have internet access—97% of year-round and 98% of seasonal respondents, as shown by the following chart.



Time Warner is the primary ISP for most residents—75% of seasonal and 77% of year-round responders use Time Warner. Less than 20% indicated they used FairPoint.

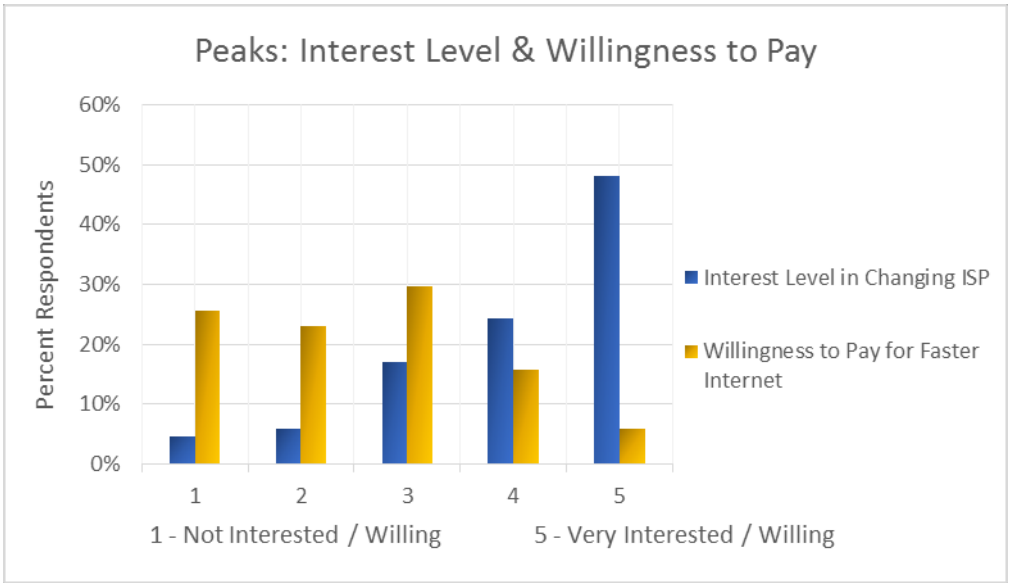


In terms of satisfaction level with their ISP, 102 respondents (66%) indicated satisfaction (a score between 6 and 10 on a 10 point scale) with their ISP, and 37 respondents (25%) indicated they were not satisfied (1-4).

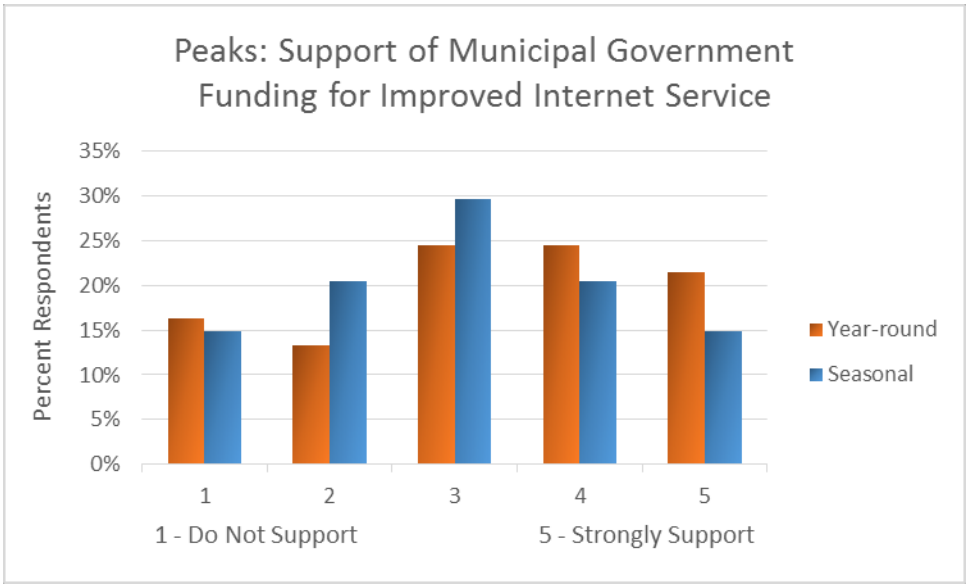


The survey also attempted to gauge islanders' attitudes toward change. 72% of Peaks survey respondents indicated that they would be willing to switch ISPs if it meant being able to have faster connectivity. Despite this clear interest, only 22% of respondents indicated that they would be willing to pay more money to obtain that service, with 49% being unwilling to do so, and 30% not sure one way or the other. These two metrics—interest and willingness to pay—can be compared side-by-side in the following graph. It should be noted that while the willingness to pay results emphasize the importance

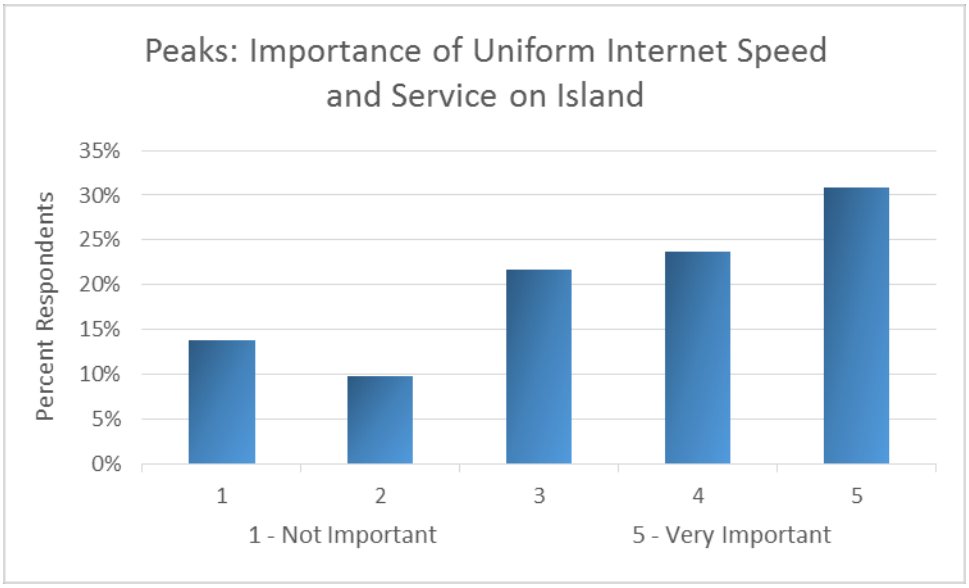
of a cost effective solution, the survey did not collect information regarding the current Internet costs being paid by respondents.



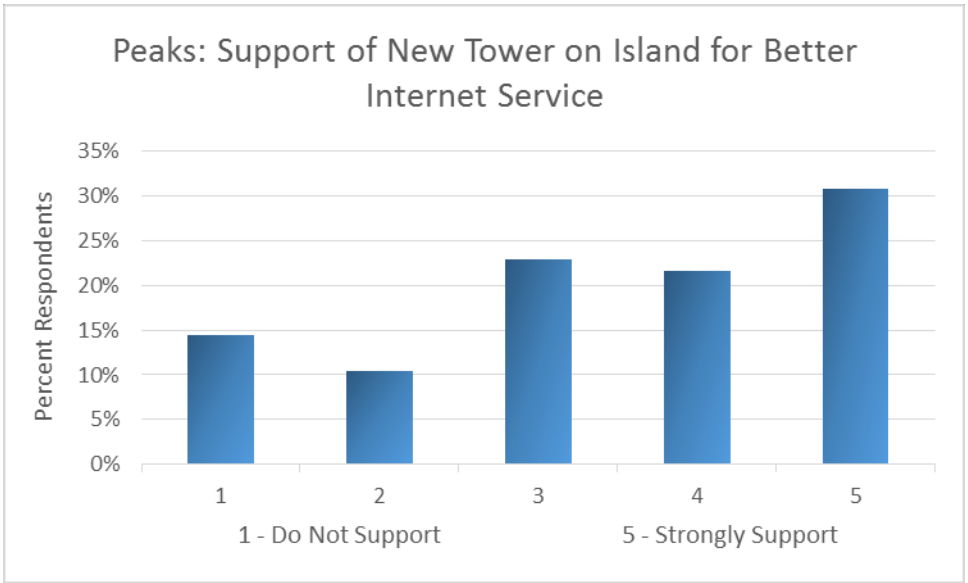
Year round respondents were more likely to strongly support municipal government funding for improvement of Internet service on the island. An average of about 40% of respondents would either support or strongly support their municipal government funding, with an average of 32% (seasonal and year-round) respondents who would not support this. Many respondents (27%) felt indifferent to municipal government funding an investment in improved connectivity on the island.



As for uniformity of a connectivity solution and the importance of everyone on the island having access to the same level of Internet speed and service, most respondents (55%) agreed that this was important to them, with 24% indicating that it was not important to them and 22% ambivalent on the question.



Finally, Peaks Island residents were asked their opinion of how they would feel about a new telecommunications tower being built on the island to enable better Internet service. While 48 respondents (24%) would not support this at all, and 80 respondents (53%) indicated that they would be in favor of a new tower build. Given that Peaks has Time Warner coverage that is at least as fast as a potential wireless solution, this question is likely not germane to broadband improvement. However, it is relevant to potential future improvements in cell phone coverage.



Possible Solutions

Tilson outlined only one option for Peaks Island to consider: a fiber to the premise (FTTP) network. Tilson did not address a Time Warner solution, since they are believed to cover 100% of the island with the FCC's definition of broadband. Tilson excluded an improved DSL option since the Time Warner service is faster than any likely FairPoint solution.

Fiber Cost Estimate

A fiber to the premise (FTTP) network is the gold standard in municipal network design: it is the most upgradeable, the least expensive to operate on a whole-island basis, the fastest, the most reliable, but also the most expensive to build. Because an FTTP network is so reliable, it requires less customer support and is less expensive to operate than DSL, hybrid fiber/coax, or wireless networks. The greatest operating disadvantage to fiber is that if it is cut, it requires a technician skilled in fiber repair (and typically a bucket truck) to fix. Fiber networks can be configured to provide 1 Gigabit (Gbps) speed upload and download—100 times faster than the current ConnectME standard.

Due to the scope of this study, Tilson did not design a network for Peaks, but rather prepared a high level dark Fiber-to the Premise (FTTP) design for a network to serve the 20 roadway miles and 997 premises on Peaks Island. For Peaks, the total capital cost estimate of building an optical fiber network according to these assumptions would be $2,083,200. This translates to a total cost of $2,089 per premise. Costs were calculated assuming an island premium of 20% above normal costs so as to factor in transportation of materials to Peaks and housing costs for labor on the island. Additional assumptions in this cost estimate include the assumption that there would be an existing head end for space, power, and redundant power. This capital estimate assumes that the network would be a dark fiber network, meaning that, while the estimate includes the cost of all aerial drops and underground fiber the estimate does not include the cost of a central location for network electronics or the necessary backup generator.[105] Electronics costs would be assumed by the network operator or Internet service provider (ISP) as opposed to the City. In the event that the ISP did not provide its own electronics, the cost of these electronics would be approximately $570 per subscriber.

The electronics described above need to be housed in a space with redundant power, heating and sufficient heat dissipation ("conditioned space"). That conditioned space can be provided by a stand-alone shelter for about $250,000, or a municipality can provide it in one of its buildings to deliver substantial cost savings.

If the network were to be connected to the mainland via microwave, the capital cost estimate for two microwave dishes and one new small tower on the island (this assumes the mainland microwave dish is mounted on an existing tower), is $45,000. While a microwave link will be necessary for every island without a subsea fiber cable, there are opportunities for islands collaborate to either save money in operating the link and/or increasing the redundancy and reliability of the links. These are highlighted in the "Opportunities for Regional Cost Savings" section near the end of this report.

[105] Tilson estimates that 90% of fiber drops would be aerial drops, with the remaining 10% representing the potential for buried fiber on lengthy driveways.

Island Cellular Service

Like wireline carriers, cellular carriers[106] invest in new network coverage and capacity where their customers have their greatest need. Each of the major carriers has recently completed a large, multi-year effort to improve their ***coverage***—their network footprint, and are not focused on ***capacity***—providing more voice and data within that existing footprint. This means that areas like rural island communities that do not currently have coverage (let alone capacity), are unlikely to see major investments from cellular carriers on a market basis in the near term. Generally, major cellular carriers are resistant to accepting public subsidy and prefer to operate on a market basis.

To build a cellular network specifically to serve residents of the Maine Island communities at this time is not wholly feasible due to costs to the carrier and a low potential return on their investment, but future technologies may allow for a cheaper implementations, and wholesale infrastructure providers may be enticed by subsidy to provide wholesale cellular networks in areas outside the usual focus of large carriers. Among the barriers to major carrier investment in rural areas are limits to current technology to serve multiple carriers at once, high costs for backhaul transport, expensive switching equipment, costly towers, and the cost and availability barriers of leasing or owning spectrum.

Current generation Long Term Evolution (LTE) technology allows for high data speeds and very efficient use of spectrum. It has the potential benefit of being a universal platform for all carriers, allowing universal roaming (one phone from any carrier, Verizon, AT&T, etc.) making calls and using data off of a single antenna and radio, whereas older technologies are shared by Sprint/Verizon and AT&T/T-Mobile respectively and only allow roaming between small groupings of carriers. Unfortunately the LTE that is available today does not allow voice calls, only data. While a phone is paired with an LTE system and the user makes a voice call, it falls back to a legacy system that can handle voice and these legacy systems are limited to the older technologies and would not allow universal roaming. To deploy an LTE system in a rural location to provide voice calls, a legacy system would also have to be deployed and fall-back switching would need to be implemented. The complexity of this system is matched by its high costs. Carriers are currently testing a new technology, called voice over LTE, or VoLTE, which will allow them to eliminate this dependence on carrier unique legacy technologies for voice. It will likely be another two to four years before this is ubiquitous in Maine's existing cellular coverage footprint.

[106] Cellular service means mobile voice and data carriers like AT&T, US Cellular, Verizon, Sprint and T-Mobile. This section does not discuss fixed wireless LTE service, like Redzone.

The rough costs to deploy a single site of modern VoLTE capable LTE is:

Item	Capital	Monthly Reoccurring
LTE Hardware	$ 70,000.00	
LTE Software	$ 35,000.00	
Legacy Hardware	$ 15,000.00	
Legacy Software	$ 5,000.00	
Installation	$ 45,000.00	
Backhaul		$ 1,250.00
Core Service		$ 7,500.00
Switch	$ 500,000.00	
E-911 Services		$ 125.00
Total	$ 670,000.00	$ 8,875.00

These costs do not include the costs of leasing space, permitting, engineering, or construction of a tower if no pre-existing structures exist, or the costs of purchasing or leasing spectrum. Even without these sometimes significant costs factored in it is clearly not feasible to deploy a single site network to cover a rural area without a large amount of subsidy, and a willing carrier partner to take such a subsidy. Though both the capital and the reoccurring costs per site drop dramatically when a larger number of sites are deployed, there is a reason why most of the Maine islands are underserved by cellular coverage as there simply are not enough customers to warrant a full site dedicated to their service.

Possible Future Solutions - Cellular

For truly better cellular coverage there are three future possibilities:

1.) US Cellular has used federal and state subsidies to provide cellular coverage to large numbers of rural areas in Maine and continues to build towers in underserved areas. They will continue to build out coverage along Maine's coast and might someday build towers to cover some of the underserved islands. Though their exact schedule is not available to the public as they are a privately held company, they do often offer the best service in very rural areas because of their subsidy-based model.

2.) Complaining of poor coverage to existing cellular provider is a reasonable option. Carriers take customer complaints very seriously as they are tied to a number of metrics that they compete with each other on. Enough complaints of poor coverage can sometimes lead to either optimization of existing antenna configurations to provide better coverage or even warrant a new tower. Sometimes customers who complain will receive a free Femto cell (typically $75-$300, and sometimes paid for by the carrier) to plug into their existing Internet to provide cellular coverage in their home.

3.) Cheaper switching and a better LTE platform. The future promises cloud-based switching and core services which will be far cheaper than existing technologies and that would work well for the relatively small number of customers that would be served by a cell site based on an island in Maine. Additionally, the LTE platform will eventually offer a true voice solution without the need for fall-back switching to legacy gear. These two factors will make it far more economical for a co-op, plantation or municipality to deploy their own equipment to provide cellular coverage. This is likely several years off from being mature enough and priced right for this application.

Possible Interim Solutions - Cellular

There are two interim solutions for better cellular coverage, but these solutions are only useful for small area coverage of a single point such as a home or store. The first solution is the installation of a more powerful antenna and repeater which would pick up cellular signals and rebroadcast them in their vicinity. This solution requires some ability to pick up a weak signal from a cellular site but would allow for calls and data to be used. The other option is the Femto cell, typically purchased or given away by a customer's current cellular carrier and hooked into the customer's broadband or Internet connection. This solution typically has the range of a wireless router and allows for use of a cell phone so long as you have an Internet connection, even if there is no wireless coverage from the customer's carrier nearby.

Service Offering Overview by Provider

Time Warner Cable

Time Warner Cable offers Internet service, cable TV and voice in North Haven and Vinalhaven as a franchised cable operator. In Maine, the franchises are granted by each municipality. Their advertised service uses DOCSIS 3 hybrid fiber/coaxial cable network on Vinalhaven, and FTTP on North Haven. Both islands have access to the same speed offerings, which range from 2/1 Mbps to 50/5 Mbps. Actual speeds on a cable network are determined by network configuration and data traffic congestion.

Time Warner aggressively markets a joint bundle with TV and phone. Time Warner offers an unpublished seasonal hold for about $10-$15/month."[107]

Federal law allows franchising authorities to charge a cable operator a fee of up to a five percent gross TV revenue for the right to operate in a franchise area. Tilson does not know whether the Vinalhaven and North Haven franchise agreements stipulate those fees.

Time Warner Residential Internet Access Pricing

Time Warner Cable Published Residential Pricing

Speeds (Mbps down/up)	Delivery Method	Monthly Price	Notes
2/1	FTTP or hybrid	$14.99	
6/1	FTTP or hybrid	$29.99	
15/1	FTTP or hybrid	$34.99	
20/2	FTTP or hybrid	$44.99	
30/5	FTTP or hybrid	$54.99	includes home wi-fi
50/5	FTTP or hybrid	$64.99	includes home wi-fi

Source: Time Warner web site

[107] Source: TWC customer support. However, the TWC customer representative would not commit to a rate or timeframe until after the service was ordered.

FairPoint

On Islesford, Great Cranberry, Vinalhaven, North Haven, Monhegan, and Long Island (and soon-to-be Chebeague), FairPoint provides copper-based DSL service to addresses within roughly four cable-route miles of its DSLAMs, or DSL nodes. Maximum speeds per island depend on the equipment deployed, and are discussed in the island-specific sections of this report. Provisioned and realized speeds are dependent on the copper route distance from FairPoint's DSLAM, the gauge of the wire, and the condition of the copper infrastructure.

Prices are not published, therefore Tilson obtained a sampling based on calls to FairPoint's customer service center, asking for prices at specific addresses. FairPoint offers a seasonal hold for any of their voice and Internet packages for $8.95/month for up to six months.

In addition to DSL, FairPoint will supply copper- or fiber-based Ethernet on some islands. Prices are not published, and it is likely that fiber-based services are priced and provisioned on a case-by-case basis. These services are typically used to provision 100 Mbps connections to the Maine School and Library Network (MSLN).

FairPoint Residential Internet Access Pricing

Fairpoint Residential Pricing Sample

Speeds (Mbps down/up)	Delivery Method	Monthly Price	Notes
0.768	DSL	$16.99	if bundled with phone
3/1	DSL	$37.98	
7/1	DSL	$42.99	
15/1	DSL	n/a	

TDS Telecom

On Swan's, Frenchboro, Matinicus and Isle Au Haut, TDS provides copper-based DSL service to addresses within roughly 3.4 miles of its DSLAMs, or DSL nodes. Maximum speeds per island depend on the equipment deployed, and are discussed in the island-specific sections of this report. After an upgrade of the microwave backhaul on the islands for the MSLN, maximum speeds on all the islands will be 15 Mbps. Provisioned and realized speeds are dependent on the copper route distance from TDS's DSLAM, the gauge of the wire, and the condition of the copper infrastructure on the island.

TDS does not offer seasonal pricing, although customers can disconnect and reconnect their service.

TDS Residential Internet Access Pricing

TDS DSL Residential Pricing

Speeds (Mbps down/up)	Delivery Method	Monthly Price*	Notes
Swans Isand			
5/.512	DSL	$29.95	"Express," max distance 16,000 ft, 2 yr promo
15/.768	DSL	$34.95	"Turbo," max distance 10,000 ft, 2 yr promo
25/.768	DSL	$59.25	*Available 3Q '16 after MSLN upgrade**
Frenchboro, Matincus, and Isle as Haut			
1/.512	DSL	$33.95	"Lite," max distance 18,000 ft
5/.512	DSL	$29.95	"Express," max distance 16,000 ft, 2 yr promo
15/.768	*DSL*	$34.95	*Available 3Q '16 after MSLN upgrade**
25/.768	DSL	$59.25	*Available 3Q '16 after MSLN upgrade**

* Current price in TDS territory. Prices may change by 3Q '16 when new service in place
Source: TDS

Redzone

While Redzone does not currently provide services to any of the islands covered in this study, their solution is outlined as a possibility for several of the islands. Below is their published pricing for the Camden and Rockport market. Pricing is equivalent for residential and business use. It is not known what prices users pay on Great Diamond Island, although Tilson believes the pricing to be similar if not equivalent.

Redzone Residential and Businesses Internet Access Pricing

RedZone Wireless LTE Camen/Rockland Offerings and Price

Speeds (Mbps down/up)	Delivery Method	Monthly Price	Notes
5/1	wireless LTE	$39.00	100 GB limit; no contract; includes wi-fi
10/1	wireless LTE	$25.00	pre-launch promotion; unlimited data; wi-fi
10/5	wireless LTE	$59.00	250 GB limit; no contract; includes wi-fi
25/10	wireless LTE	$89.00	unlimited data; no contract; includes wi-fi

Source: RedZone web site

Business Model Overview

Examples of Other Community Broadband Models

Tilson examined several municipalities' experiences in studying the various permutations of business models available for addressing the islands' service needs, both immediately, and moving forward. Among the examples surveyed, several threshold areas such as network funding, structures, ownership, operation, tax payment, risk, revenue, and fiber use were explored in an effort to learn about the successes and shortcomings of each structure and to recommend structures which align best with island goals.

The following summarizes the various permutations of business models, and the important structural differences between them:

Great Diamond Island, ME

Ownership/Operation. Redzone owns and operates a wireless LTE node on Great Diamond Island.

Funding. The capital cost was funded by the The Diamond Cove Homeowners Association (DCHA) and a ConnectME grant. ConnectME funded $44,000 of the grant, and the DCHA funded the balance. Redzone was able to use an existing water tank on the island and existing infrastructure on the mainland at One City Center in Portland, thus minimizing capital costs.

Operating Costs/Risk. The operating costs and operating risk of the network are assumed by Redzone.

Revenue. Redzone bills customers directly and receives the revenue for the service. The network is not limited to DCHA customers – it is open to all potential users able to receive the signal.

Access. This is a closed access system.

Chebeague Island, ME

Ownership/Operation. Chebeague.net owns the network, and relies heavily on three other providers: FairPoint for the last mile copper to premises; Cornerstone Communications for CLEC status that gives Chebeague.net access to FairPoint's infrastructure; and Axiom Communications for backhaul.

Funding. Funding was provided by a mix of residents and a ConnectME grant.

Operating Costs/Risk. The operating costs and risk of the network are assumed by Chebeague.net.

Revenue. Chebeague.net bills customers directly and receives the revenue for the service.

Access. Not applicable to date.

South Portland, ME

Ownership/Operation. The City of South Portland is working with the ISP GWI, and GWI will own and operate the fiber network.

Funding. GWI constructed this 1 Gbps fiber to the home (FTTH) network connected to the Maine Three Ring Binder.[108] The project construction cost was approximately $170,000, with $150,000 of this cost covered by a one-time, $150,000 lease payment to connect City-owned facilities to the network. The remaining $20,000 was invested by the ISP.[109] Customers would be signed up for the service during the construction phase with installation fees waived for early sign-ups. It should be noted that the South Portland fiber network only covers a handful of homes and businesses. This relatively limited scope in comparison to the island fiber designs outlined in this report is the primary reason the South Portland network costs are less than the various island solutions outlined here.

Operating Costs/Risk. The operating costs and operating risk of the network will be assumed by GWI as the network owner.

Revenue. The City's arrangement with the ISP will allow it to drop a $2,000/month lease cost which it had for its previous fiber network provider, and after installation, the City and the ISP will share in five percent of the revenue of business and residential customers who sign up for the network.[110]

Access. The ISP which owns this network is providing the fiber on an open-access basis, thus opening the door to competition from other service providers.[111]

Rockport, ME

Ownership/Operation. Owned by the Town of Rockport, GWI operates the network, contracting with customers for the actual service.[112] GWI offers Internet access and voice.

Funding. For the Town of Rockport, Maine's 1.6 mile fiber project, cost of installing the network was estimated at $60,000, half of which came from the University of Maine's Networkmaine program and private investment from local business, and half of which came from a Town of Rockport tax increment financing (TIF) tool.[113] Just as with the South Portland network, this portion of Rockport's fiber project was designed to serve a limited geographical area in Rockport as opposed to the island designs in this report, all of which have designs (regardless of the technology employed) contemplating universal, comprehensive broadband solutions for all residents.

---

[108] http://www.pressherald.com/2014/09/22/super-fast-internet-coming-to-parts-of-south-portland/
[109] Id.
[110] http://bangordailynews.com/2014/09/22/business/gwi-beats-out-maine-fiber-co-for-south-portland-municipal-fiber-contract/)
[111] Id.
[112] http://www.wcsh6.com/story/news/local/2014/08/11/rockport-builds-municipal-owned-internet/13922981/.

[113] http://www.muninetworks.org/content/rockport-builds-maine%E2%80%99s-first-municipal-network.

Operating Costs/Risk. Similar to the City of South Portland, Rockport's network is one in which the municipality only funds the capital investment for the fiber and does not fund the capital investment for the equipment. In addition, the Town does not have any significant operating expense or responsibility. Instead, ISP's are responsible for providing and operating the network's equipment.

Revenue. The revenue model employed in Rockport is the subscriber-based revenue model, with a percentage of monthly subscriber costs for the network going to the Town to pay off the original investment.

FastRoads, (Keene, NH)

Ownership/Operation. The FastRoads network in Keene, New Hampshire is owned and operated by a single-member LLC, FastRoads, LLC, in which the Monadnock Economic Development Corporation (MEDC), which is a private non-profit economic development entity, is the sole member.[114] MEDC works closely with the Town of Keene, and they are a quasi-public 501(c)(3) organization. In this example, MEDC was approached by the Town to oversee the construction of the network and to be the recipient of grant money used to fund construction of the network. When MEDC assumed this role, it hired the executive director and technical engineer for FastRoads and oversaw contracts.

Funding. The funding for FastRoads came primarily from a National Telecommunications and Information Administration (NTIA) Broadband Technology Opportunities Program (BTOP) grants (70%). The remainder was borrowed by FastRoads and guaranteed by the MEDC. In addition, some private investment money in the form of royalty financing was secured as well. The New Hampshire Business Finance Authority provided additional funding and an Economic Development Administration grant from another part of the state rounded out the funding totaling $2.4 Million.

Operating Costs. In terms of costs associated with the network, the City of Keene charges FastRoads, LLC to use the city's conduit (lease) and the city taxes FastRoads in addition to this lease charge.

Operating Risk. MEDC assumes the operational risk from managing the network as the sole shareholder in FastRoads LLC.

Revenue. Service providers pay a portion of their revenue to the network in exchange for use of the network. The amount or percentage of this revenue is based on the type of service, with lower percentages paid by service providers who use the network for limited hours (i.e. a computer backup service), and larger percentages paid by ISP's which use the network heavily during daytime hours. Revenue from the project goes to FastRoads, LLC and this revenue is currently applied against expenses. At present time, revenue is offsetting expenses at a breakeven level and in the event of any shortfall, these are made up by MEDC.

Access. The FastRoads fiber network is an open network, so anyone able to find an ISP connect agreement can use the network.

[114] Information for this section was gathered from phone interview with FastRoads personnel.

Note. Since its development, the FastRoads network has struggled to make its payments.

Leverett, MA

Ownership/Operation. In the case of Leverett, the Town owns this town-wide fiber-to-the-home (FTTH) network and the town-created Municipal Light Plant (MLP) entity (with a separate budget) is the custodian of the network. Crocker Communications is the ISP, and also provides voice service.

Funding. The Leverett, Massachusetts network is an example of a FTTH municipal network which was constructed with funding from tax-backed municipal bonds. While the Leverett network does rely on subscriber revenue, it is only to the extent necessary to pay for ongoing maintenance costs.[115]

Operating Costs. Users of the network pay a monthly network operations charge, to cover the fixed operating costs of the network. The more users on the network, the lower that portion of their bill.

Operating Risk. The town-created MLP, which has a separate budget both performs a number of network operations responsibilities and also assumes the financial risk of operations as well.

Revenue. As referenced above, the Leverett network relies on subscriber revenue, but only to offset ongoing maintenance costs.

Access. Leverett has reserved the right to limit access to the network to Leverett residents and businesses only. As such, it is not an open access network, in contrast to most municipally-owned networks. The reasoning behind the closed nature of the network is that it allows for one Internet Service Provider (ISP) chosen by the Town itself to provide services to subscribers.

Chattanooga, TN

Ownership/Operation. Chattanooga's FTTH broadband fiber network is a model of a successful municipally owned and operated fiber network, with the Chattanooga Electric Power Board (EPB) performing the range of network operations responsibilities and assuming the financial risk of operations as well.

Funding. The city of Chattanooga, Tennessee, undertook to improve broadband access for its citizens through its municipally-owned power utility, the Chattanooga Electric Power Board (EPB). One of the primary advantages of this structure for Chattanooga was that it significantly reduced the cost of constructing the network through lower make ready expenditures. Similar to the previous municipalities mentioned in this section, Chattanooga also used municipal bonds to provide funding for constructing its 170,000-service location, 8,000 mile network. The total project cost of the EPB network was

[115]There are a number of municipal networks for which construction of these networks was funded by revenue-backed bonds. Networks built by revenue bonds are susceptible to financial pressure if these municipalities fail to gain enough subscribers. Failure to make debt payments resulting from undersubscription is a leading cause of failure among municipally owned networks.

approximately $340 million, with $111 million funded through a federal American Recovery and Reinvestment Act (ARRA) grant from the Department of Energy. The remaining cost of the network was funded through the City's passing of a $229 million municipal bond to provide matching funds. The structure of the loan involved EPB's electric division lending EPB's cable/Internet division sufficient funds, with the loan being repaid using revenue generated from network subscriptions.[116]

Operating Costs. These are assumed by the EPB, as it serves as the network ISP.

Operating Risk. The operating risk for the network is also assumed by EPB as the network ISP.

Revenue. The revenue for the Chattanooga network comes from subscribers to the network.

Access. Only Chattanooga EPB operates over their network. Access is closed to other competition.

Burlington Telecom

Ownership/Operation. Burlington Telecom is a department of the City of Burlington, Vermont and is 100% municipally owned and operated.

Funding. Originally funded through a capital lease, this network was refinanced in an effort to expand the money available.

Operating Costs. While the original intent of the City was for network operations to be funded not by general revenue (taxpayer dollars) but instead by project revenue, Burlington Telecom ran out of money and used $17 million from the City Treasury department to support network operations.

Operating Risk. Burlington Telecom shouldered the operating risk associated with the network.

Revenue. Burlington Telecom then failed to repay the loan from the City Treasury. Burlington Telecom has settled a suit levied against it by its commercial lender, CitiLeasing. Burlington Telecom assumed additional debt to retire the settlement liability. The telco is still making payments against this loan.[117]

Access. The Burlington Telecom network is an open access network.

CityNet (Santa Monica, CA)

Ownership/Operation. CityNet is currently a 10 Gbps network in the city of Santa Monica, California, spawned by the City's need to reduce its data access costs.[118] After forming a task force evaluating several different approaches, Santa Monica decided to pursue an institutional fiber network in 1998. The first step in developing its fiber network was for Santa Monica to lease an institutional fiber network

[116] Information regarding EPB's network was obtained in a phone interview with Danna Bailey, EPB's Vice President of Corporate Communications (baileydk@epb.net).
[117] Information gathered from interview with Chris Campbell, former director of the Vermont Telecommunications Authority.
[118] http://www.bbpmag.com/MuniPortal/EditorsChoice/0511editorschoice.php

from the local cable TV operator. That network connected 43 city buildings as well as school and college facilities.

Funding. When it leased the institutional network, the City funded the network construction but shared the operations and maintenance costs with the local school district and college. The operational cost savings derived from this shared cost approach reduced the combined telecom costs by $500,000 per year shortly after the network went live in 2002. From here, the City utilized the savings to build its own 10 Gbps municipal fiber network, from which it began leasing its excess dark fiber to local businesses. Because of low monthly fees, these businesses were willing to fund the cost of building fiber from the backbone to their buildings. In this manner, Santa Monica's network was extended at no cost to the city. In 2009, the city made an additional investment in the network in an effort to provide lower cost bandwidth to small businesses in the area. It did this by leasing a fiber connection to a major colocation center in Los Angeles, 15 miles away and getting transport from a service provider.

Operating Costs/Risk. As noted above, initially the operations and maintenance costs were shared by Santa Monica with the local school district and college.

Revenue. City Net's revenue is $300,000 per year, which is adequate to fund network operations and maintenance while also supporting a network of 27 WiFi hot spots throughout Santa Monica. The city used its nearly $200,000 in remaining capital funds as a revolving capital improvement project account. This account funds construction for network expansion, which is repaid by customers as the network continues to expand to their premises.

Access. While the city provides Internet access directly, it also makes the network available to third-party providers on an open-access basis.

Note. CityNet's requirement that customers pay for their own connections slows the growth of the network, but short of receiving a stimulus grant, CityNet will continue a policy of expanding based on demand alone.

The table below shows some of the variations of business models by type of municipal broadband solutions:

Type	Electric Company	Municipally Owned	Public-Private Partnership
Example	Leverett, MA	Burlington Telecom	Great Diamond Island
Network Ownership	Town-Owned Utility	Municipality	Private Provider
Network Operation	Town-Owned Utility and Private Provider	Municipality	Private Provider
CapEx Funding	Municipal Bonds	Capital Lease funded by user fees	ConnectME and Home Owners Association
Operating Costs and Risk	Users bear the majority of the costs (see above); Town Owned Utility and ISP bear the risk	Municipality	Private Provider
Revenue	Subscriber Revenue	Subscriber Revenue	Subscriber Revenue
Provider Access	Closed retail; open wholesale	Closed	Closed

Possible Business Models for the Islands

With these previous municipal broadband business model structures as the backdrop, there are a number of business model options that could have application to the Maine offshore islands. Tilson has provided a general description of the models, and provided guidance as to which models apply to which island community in the matrix below.

Utility Owned and Privately Operated/Utility Owned and Operated Network

In this model, the municipally-owned utility leverages it assets – poles, bucket trucks, billing, etc., to provide some or almost all of a municipal broadband solution. A utility could provide just the physical assets and outsource the service to an ISP (Utility Owned and Privately Operated); or a utility could provide the assets and the retail service, while likely working with an ISP on a wholesale basis for backhaul (Utility Owned and Operated Network).

Chebeague.net, while not a utility, is an example of a small, municipal broadband network that operates its own network – it provides the billing, provisioning, customer service, local network configurations, and manages the backhaul via wholesale purchase. Chebeague.net also owns the network elements described in the FTTP solutions -- the network electronics at the customer's home, the head end electronics, and microwave backhaul. A utility-operated network would do the same. An island utility may decide to outsource the network functions to an ISP, or it may find that it has to insource many of those functions for practical reasons.

Funding for the network build could come from municipal tax revenues, Federal grants (e.g. National Telecommunications and Information Administration (NTIA), Broadband Technology Opportunity Program (BTOP), or Economic Development Administration (EDA)), state grants (ConnectME), and private donations.

The island communities of Monhegan, Isle au Haut, Swan's Island, Frenchboro, Matinicus, Vinalhaven, and North Haven would have this option available to them. The other islands are served by large investor owned utilities that are not currently providing retail service.

Work with Incumbent

Every island community has the opportunity to work its incumbent local exchange carrier to improve its existing service. As detailed in the corresponding island sections of the report, TDS has plans in place for its service territories (Matinicus, Frenchboro, Swan's and Isle Au Haut). A community should contact TDS to address questions and/or discuss further improvements.[119]

FairPoint has indicated to Tilson that it is willing to collaborate with municipalities to improve DSL service. If a town decides to engage FairPoint to explore a broadband solution, the first step is for town

[119] Scott A. Brooks -- Manager, State Government Affairs ME, NH, NY, VT, TDS Telecommunications Corporation 242 Main Street,New London, NH 03257. Scott.brooks@tdstelecom.com, Phone: 603-526-2211

leaders to contact FairPoint[120] to schedule a meeting to review and discuss the current network infrastructure and service offerings, practical solutions, likely upgrade paths, and possible funding sources (e.g. municipal contribution, ConnectME grants, and the FCC's CAF II program).[121] The timeframe for a joint municipal/FairPoint solution will depend on the scope of the project, the speed with which a municipality commits, and FairPoint's engineering backlog at the time. Island-specific practical solution types are detailed in the corresponding island sections of this report.

Municipally Owned and Privately Operated

Under this network option model, the town would own the network and contract with a private partner to operate the network. An example of this would be the 1.6 mile Rockport network, which is owned by the town and operated by GWI. Funding for the network build could come from municipal tax revenues, Federal grants (e.g. National Telecommunications and Information Administration (NTIA), Broadband Technology Opportunity Program (BTOP), or Economic Development Administration (EDA)), state grants (ConnectME), and private donations.

Private partners could operate under a variety of models regarding network ownership, including what percentage of the network they own as well as operate. For example, they could own none, some, or all of the network elements described in the FTTP solutions for each island – the network electronics at the customer's home, the head end electronics, and microwave backhaul. Partners and towns will have different views on the level of network ownership they'd like to maintain given their outlook on factors such as financials and risk. Private partners would likely be existing ISPs operating in Maine.

Privately Owned and Privately Operated

Under this network option model, the town would subsidize a private operator to build the network and the private operator run the network. An example of this would be Redzone's solution on Great Diamond Island. Redzone owns and operates the network. Funding for the network build could come from municipal tax revenues, state grants (ConnectME), and private donations. Municipalities could lower the capital cost requirements by using existing towers and tanks, or building a telecommunications tower that they would own and control, thereby leasing space to tenants when possible.

Municipally Owned/Municipally Operated

In this model, the municipality owns and operates the network. An example of this would be Burlington Telecom. Funding for the network build could come from municipal tax revenues, Federal grants (e.g. National Telecommunications and Information Administration (NTIA), Broadband Technology

---

[120] Jeffrey J. Nevins – Director, Regulatory & External Relations and Community Broadband Development FairPoint Communications | 1 Davis Farm Road, Portland, ME 04103 | jnevins@fairpoint.com
207.535.4170 main | 207.400.6897 cell | 207.797.1221 fax

[121] Because the cost to serve an island – for any carrier – is higher due to low spatial density and the necessity of transmitting data across water, a viable solution will almost certainly require a subsidy. There is state ConnectME grant money available to towns, and the federal CAF II program available to FairPoint. While an incumbent DSL solution will be the lowest cost, it may still require towns to help fund the capital costs.

Opportunity Program (BTOP), or Economic Development Administration (EDA), state grants (ConnectME), and private donations).

The municipality would operate the network by providing the billing, provisioning, customer service, and local network configurations. Under this model, a municipality would own the network elements described in the FTTP solutions -- the network electronics at the customer's home, the head end electronics, and microwave backhaul. A municipality operating its own network would likely purchase wholesale Internet access from a private partner.

Possible Paths Forward for the Islands

Below is a matrix that outlines which models potentially apply to which island community. Tilson is not making specific recommendations on which solution and business model for each island to pursue. The best model for an island depends on the extent of its unmet need, the willingness for a community to assume risk and control of a network, and the amount of money available to fund a network.

Offshore Islands Business Model Options

NETWORK STRUCTURE/ ISLAND	Utility Owned and Operated Network	Utility Owned and Privately Operated	Work with Incumbent	Municipally Owned and Privately Operated	Privately Owned and Privately Operated	Municipally Owned/Municipally Operated
Cranberry Isles			✓	✓	✓	✓
Monhegan	✓	✓	✓	✓	✓	✓
Frenchboro	✓	✓	✓	✓	✓	✓
Chebeague			✓	✓	✓	✓
Long Island			✓	✓	✓	✓
Isle au Haut	✓	✓	✓	✓	✓	✓
Swan's	✓	✓	✓	✓	✓	✓
Matinicus	✓	✓	✓	✓	✓	✓
Vinalhaven	✓	✓	✓	✓	✓	✓
North Haven	✓	✓	✓	✓	✓	✓

Cost Savings Strategies

Regional Cost Savings Opportunities

There is opportunity for the islands to save costs by working together on a broadband solution. Cost savings can be placed into two categories: capital expenses and operating expenses. For the ILEC and wireless LTE solution, it is unlikely that TDS, FairPoint or Redzone would realize significant cost savings by deploying their infrastructure across multiple islands. Thus, for practical purposes, this section speaks to FTTP solutions.[122]

Capital expense. These expenses, as outlined in the island-specific sections of the report, include the cost of building out a fiber network, deploying microwave links, building wireless LTE towers and installing necessary electronics, and the cost of deploying additional DSL nodes. With the exception of sharing microwave links, the amount of infrastructure that would need to be deployed on each island, for any of these solutions, is unchanged by whether one or more islands deploy the same solution at once. In other words, there is little opportunity to share infrastructure.

The one opportunity to share infrastructure between neighboring islands is to deploy a mesh infrastructure with microwave backhaul. Instead of each island deploying one microwave link to the mainland, proximate islands could create a mesh network in a ring configuration that would provide an alternate path for data in the event that one link goes down. This redundant design is more expensive than a non-redundant design. The more islands that are in a mesh, the lower the premium to create the redundancy. In addition to being an economical way to create redundancy, a mesh network provides an opportunity for operational cost savings, which is explored in the next section.[123]

High Level Capital Costs for Independent vs Shared Microwave Backhaul, 2 Islands

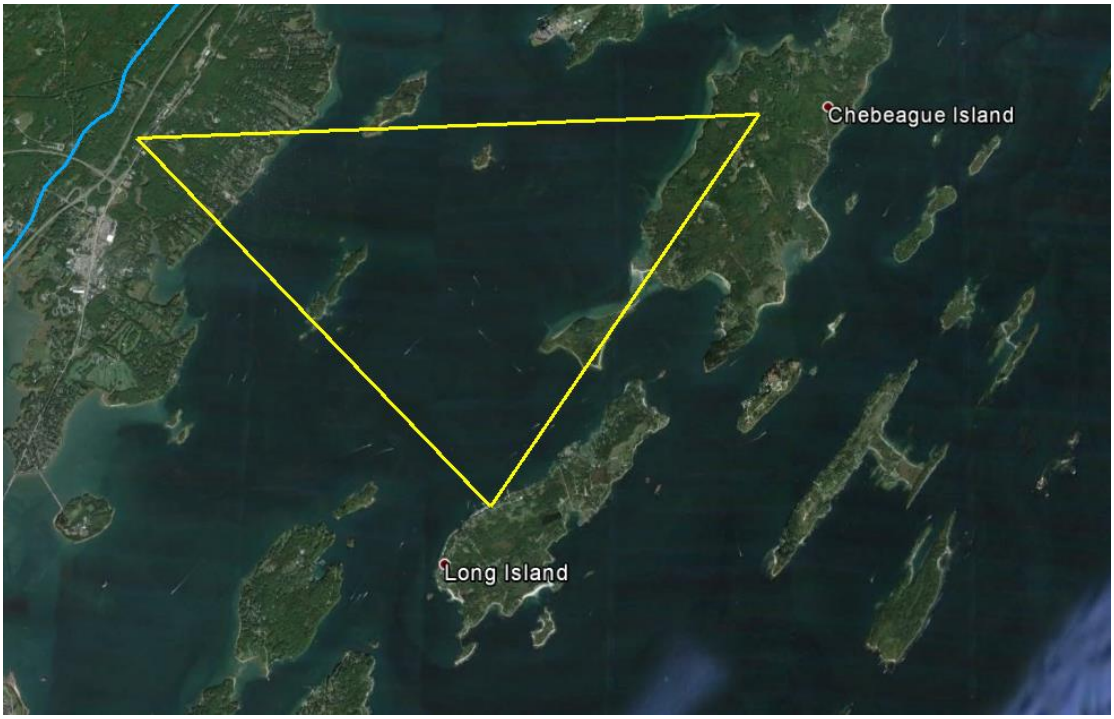
Network Element	Independent Non-Redundant	Independent Redundant	Shared Mesh Redundant
Microwave Dishes (Pair)	1 @ $30,000	2 @ $30,000 = $60,000	3 @ $30,000 = $90,000
Microwave Tower On Island (assumed use of existing tower on mainland)	1 @ $15,000	$15,000	2 @ $15,000 = $30,000
Total Per Island	**$45,000**	**$75,000**	$120,000 / 2 = **$60,000**

[122] Although RedZone currently deploys combined microwave backhaul wherever possible, they currently do not pass those savings on to customers in their current pricing model.

[123] Islands could "daisy chain" their microwave backhaul, to create operational savings. However, this would not generate capital savings.

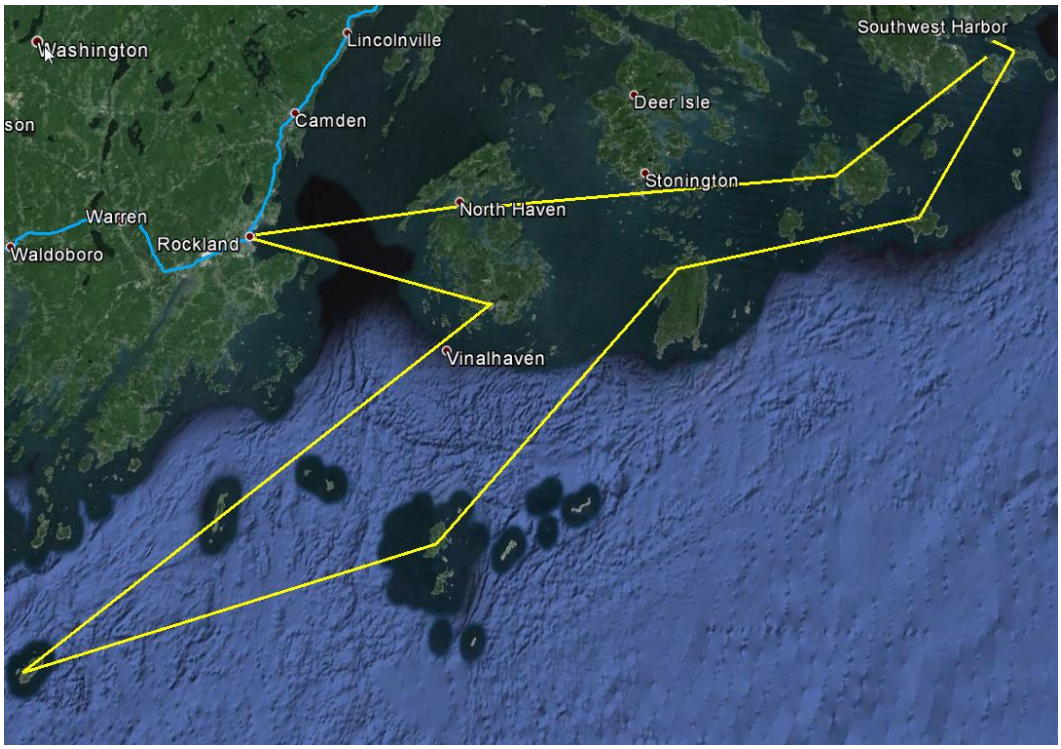
The following images are sample mesh network topologies for possible groupings of islands in the study. The sample topologies are for illustrative purposes only. Tilson has not engineered a design for these islands.[124]

Mesh Network Example – Chebeague and Long Island



[124] There are multiple considerations in siting microwaves, including ensuring an unbroken line of sight between dishes, having fiber at both ends of the link, and the ability to use an existing tower. While Tilson did not site specific end points, Tilson did ensure that the longest link in these drawings, 30 miles between Vinalhaven and Monhegan, is well within the range of microwave technology.

Mesh Network Example – Monhegan, Matinicus, Vinalhaven, North Haven, Frenchboro, Swan's, Isle Au Haut, Cranberries



Operational expense. Operational expenses can be grouped into fixed and variable operating expenses, or costs. Fixed operating costs are independent of the number of users on a network, and include rent (for utility poles, space to house electronics and towers to house microwave dishes), certain equipment maintenance—like the upkeep of a bucket truck—and some administrative costs. Variable costs are a function of the number of users on a network, and include billing, customer support, and wholesale Internet access on the mainland.

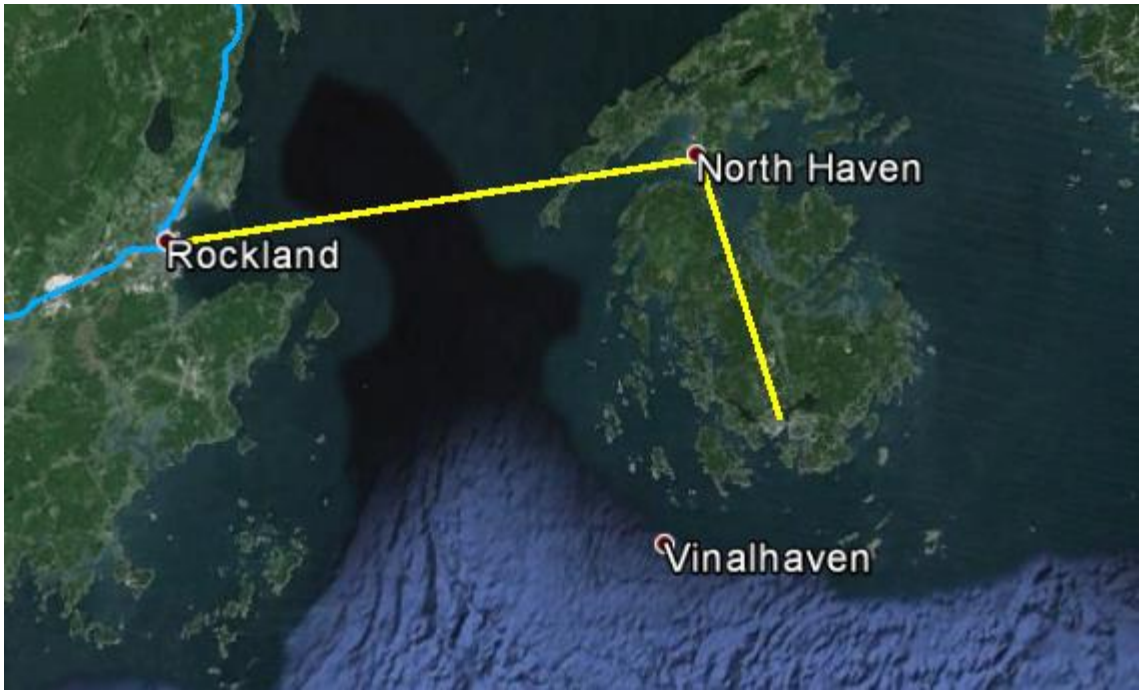
By implementing a regional solution, islands could save money on the rent for the towers on the mainland required to mount microwave dishes, shared administration (although the cost savings could potentially be off-set by increased complexity in governance), and bulk purchasing of billing, customer support, backhaul and wholesale Internet access.

The largest opportunity for cost savings is likely in shared backhaul and wholesale Internet access. This could be done by having multiple islands terminate their traffic to one or two microwave antennas on the same tower on the mainland. The operational savings of doing this come in two forms: saved rent on a tower or a building housing the antenna ($400-$1,000/mo per antenna); and the bulk purchase of wholesale Internet access that carries the island traffic to the backbone of the Internet. The bulk purchase of wholesale Internet access generates savings in two ways – by buying in volume, and by pooling supply. Pooling supply creates savings by lowering the average amount of headroom, or excess

capacity that needs to be supplied on a per-user basis to ensure that there is not a traffic bottleneck on the mainland.

Either a mesh or daisy chain design supports shared microwave backhaul and wholesale Internet access. Below is an example of a daisy chain microwave network, which would be employed to save operating costs, although the capital cost would be unchanged.[125]

Daisy Chain Network Example – Vinalhaven and North Haven



Other Cost Savings Strategies for FTTP Networks

High Utilization Will Lower Cost per User. For an FTTP network, the fixed operating costs, meaning the expenses that are independent of the number of users on it – pole attachment fees paid to the utility pole owners, maintenance and repair, mostly borne by the network owner – will be a strong driver of the network's economics. Fixed operating costs are typically a greater percentage of the operating costs than variable operating costs (per-user fees of operating, like sending out a bill, which are typically borne by the network operator). While each island's fixed operating costs will vary widely based on several factors, the principal remains the same for all islands: the more users on the network, the lower the average cost per user on the network.

Major factors driving each island's fixed operating costs include the total aerial network route miles and whether there is a town-owned electric utility in place. As an example, annual fixed operating costs per mile for pole attachment fees are about $700/mile/year, and maintenance and repair on the mainland is

[125] The ILECs frequently employ a daisy chain microwave topology. It offers the lowest operating cost, and is relatively easy to add proximate islands to a given mainland node.

$2000/mile/year.[126] For municipalities without a town-owned utility, Tilson has typically seen adoption rates of 65%-75% in order to create a cash-flow business case that will both repay the debt needed to build the network, and cover operating expenses.[127]

Electric Utility Owned Networks Can Expect Lower Operating Costs. The small electric utilities on the islands (Fox Islands Electric Cooperative, Swan's Island Electric Cooperative, Isle Au Haut Electric Cooperative, Matinicus Plantation Electric Company and Monhegan Plantation Power District) have the billing, customer support and maintenance infrastructure in place. As such, Tilson expects that utility-owned networks and/or more premises per mile will have lower fixed operating costs per island premise, and therefore will require lower adoption rates and/or pricing in order to be cash flow positive. The islands served by small electric utilities are called out in the "Business Models" section below.

Use Existing Assets Where Possible. Fiber to the Premise networks require some network elements that can be provided by the municipality or some other owner of infrastructure. For example, a municipality could donate space in a municipal building for the head end electronics of a network. If that municipal building has a redundant power source, it can be used to power the network during an electrical outage. Another area of savings is a tower or building on which to mount a microwave antenna, or dish. The picture below shows the antenna for Chebeague.net's backhaul to the mainland that is mounted on the side of a private citizen's house.[128]

Chebeague.net's Microwave Backhaul

[126] Mainland costs. If a municipal utility owned the poles and the network, attachment fee would be zero. Island cost depends on whether the island would need to buy its own bucket-truck or the price at which it can find a vendor to use its own truck and fix the network within a mutually agreed upon service interval.

[127] These scenarios assumed zero seasonality (meaning all users subscribed year round), municipal *non-utility* ownership and private operator, and a fee from the private operator to the municipality of $20/month per network subscriber. The ultimate price per end user and speed offering would be negotiated between the town and the municipality.

[128] Any shared infrastructure would require that appropriate easements be in place.

Economic Impact of Broadband on Maine's Offshore Islands

Research has shown that investments in broadband infrastructure can dramatically improve economic development in rural communities. Broadband enhances productivity, makes firms more efficient, facilitates commerce, attracts jobs, increases consumer options, and saves residents money.

By transferring values from peer-reviewed economic valuations of the impact of broadband on communities, Tilson has developed estimates of the impact of major broadband investments in terms of improved economic output (i.e. GDP), job creation, wage growth, and state and local tax revenue for each of the offshore islands.

It is impossible to characterize the economic trajectory of Maine's offshore islands with one broad brushstroke. The Casco Bay islands have largely benefited from the economic growth of Cumberland and York Counties. The Downeast islands and the offshore islands, by contrast, have contracted. In that regard, Maine's offshore islands are a microcosm of the economic dynamics of the state as a whole. In aggregate, Maine's GDP has grown at a modest pace over the past five years. While it is difficult to determine precisely how the islands' GDP has changed over this period, it likely has not deviated from the general trend of the state. Tilson believes developing universally-available broadband infrastructure on the islands has the potential to increase GDP growth on the island from 1.0 percent to at least 2.0 percent in five years.

This estimate represents $90 million in additional goods and services sold on the islands over ten years. This figure is open to debate. However, a large increase in broadband penetration usually results in a significant increase in output. In a study of 22 Organization for Economic Cooperation and Development (OECD) member countries, Koutroumpis et al. (2009) found that an increase in broadband penetration of 10 percent added 0.25 percent to GDP growth on average.[129] In a similar study, Czernich et al. (2009) found that an increase in broadband penetration of 10 percent added 0.73 percent to GDP growth on average.[130]

A pertinent case study in the U.S. is Lake County, Florida, a rural area north of Orlando, which saw its economic output double relative to its neighboring counties within five years of a major broadband build out to the county's community anchor institutions (Ford and Koutsky, 2005).[131] Therefore, Tilson believes its estimates for the islands may be conservative. The table below indicates the island by island economic impact of a major broadband investment. The benefit is proportional to premise count. More premises subscribing to the service generates greater economic growth. Therefore, the islands with the

[129] Koutroumpis, P. 2009. The economic impact of broadband on growth: A simultaneous approach. *Telecommunications Policy*. Vol:33, Pages: 471-485.

[130] Czernich, N., Falck, O., Kretschmer, T. & Woessman, L. 2009. Broadband Infrastructure and Economic Growth. *The Economic Journal.* Vol: 121, Pages: 505-532.

[131] Ford, G. and Koutsky, T. 2005. Broadband and Economic Development: A Municipal Case Study from Florida. *Review of Urban & Regional Development Studies. Vol: 17, Pages: 219-229.*

most premises saw the highest improvement. Premise counts were obtained from the 2010 census count of "housing units" on each island.

Potential Island Impact of Major Broadband Investment

Island Community	Premise Share	Ten Year GDP
Vinalhaven	31%	28.09
Chebeague	13%	11.39
North Haven	12%	11.17
Swan's Island	12%	10.48
Long Island	9%	8.27
Cranberries	9%	8.14
Monhegan	4%	3.56
Matinicus	4%	3.19
Isle au Haut	4%	3.73
Frenchboro	2%	1.65
Total		89.66

In addition to increasing local GDP, broadband development also creates jobs. Unlike economic output, which typically takes at least two years for communities to begin reaping the full effects of an investment, job creation occurs immediately. Broadband investments affect employment in three ways:

- Direct Jobs (telecommunications technicians, construction workers, and manufacturers of telecom equipment)
- Indirect Jobs (upstream suppliers and sellers of raw materials)
- Induced Jobs (from the household spending resulting from the new direct and indirect jobs)

These jobs tend to be higher paying, technology-oriented jobs, some of which are temporary but many are stable and more or less permanent improvements to the region's economy. A study of broadband development in rural Kentucky found that every 1 percent increase in broadband adoption yielded a 0.14 percent increase in employment (Shideler et al. 2007).[132] This factor suggests that 170 new jobs will be created in coastal Maine (not all on the offshore islands) by 2028 as a result of a major broadband investment. Assuming these jobs pay the median wage of the Mid Coast region, Tilson estimates

[132] Shideler, D., Badasyan, N. & Taylor, L. 2007.The Economic Impact of Broadband Deployment in Kentucky. *Regional Economic Development*. Vol: *3*, Pages: 88-118.

approximately $84 million in new wages will be generated over the next ten years. Of this $84 million, $9 million will be paid in state and local taxes.

The table below shows the forecasted job creation by island community. Job creation is proportional to year round population. Therefore, Vinalhaven generates approximately half of all new jobs. Population estimates were taken from the Island Institute's "Island Indicators" report for 2015. This study used the more recent 2014 population estimates instead of the 2010 census population. This is to account for the significant swings in island population on some of the islands over that time.

Forecasted Island Job Creation

Island Community	Population Share	New Jobs	Wage Growth	Tax Increase
Vinalhaven	48.5%	83	40,707,783	4,274,317
Chebeague	12.7%	22	10,620,591	1,115,162
North Haven	12.0%	20	10,082,839	1,058,698
Swan's Island	11.2%	19	9,410,650	988,118
Long Island	6.4%	11	5,377,514	564,639
Cranberries	3.5%	6	2,957,633	310,551
Monhegan	1.6%	3	1,344,379	141,160
Matinicus	1.3%	2	1,075,503	112,928
Isle au Haut	1.4%	2	1,209,941	127,044
Frenchboro	1.3%	2	1,075,503	112,928
Total		**170**	**83,862,336**	**8,805,545**

Overall, Tilson believes that investment in broadband is a strong contributor to island economic development and offers a range of public benefits. Improving broadband access would supplement traditional economic activities, while also supporting conditions needed to encourage small business, telework, and telecommuting. Due to these added public benefits, Tilson recommends that investment in broadband infrastructure is considered not only through a lens of the network's profitability, but also through a long-term investment in the sustainability of the community and economic development on the islands.