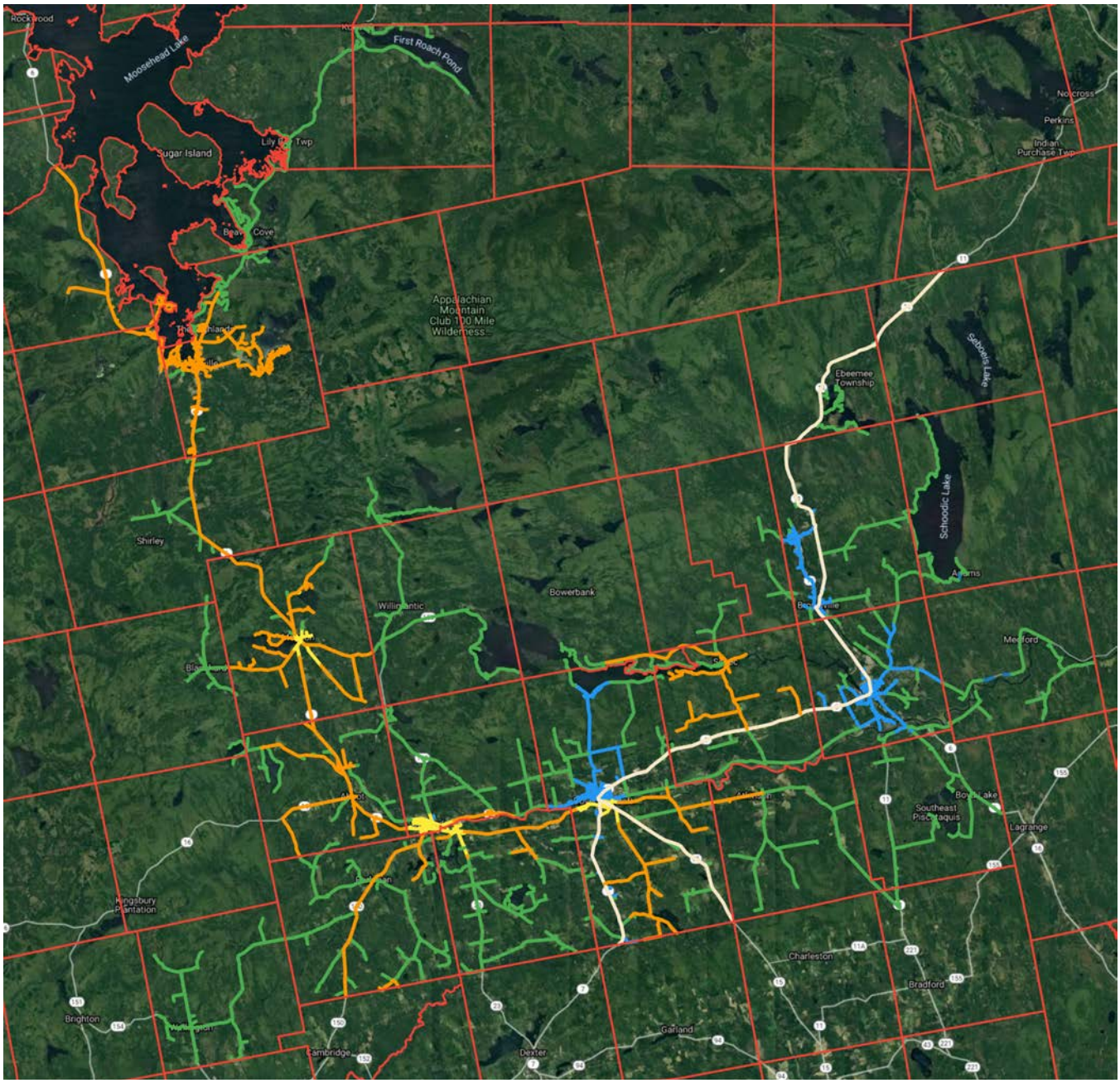
Casco Bay Advisors, LLC
Broadband/Telecom Consulting

Piscataquis County
Broadband Planning Report



Casco Bay Advisors, LLC
December 2021

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Cover Image

Map Key	
Orange	Fiber-to-the-Home (FTTH)
Yellow	Fiber-to-the-Home (FTTH) & Cable TV (CATV)
Blue	Cable TV (CATV)
Green	Uncabled *(DSL service only)*
White	3-Ring-Binder Network

Disclaimer

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

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

All service providers, except for Premium Choice Broadband declined to provide mapping or data to illustrate the location of their assets. In the absence of service provider data, we performed a detailed field audit during the third quarter of 2021 to visually capture and note the location of existing phone company fiber optic cables, remote terminals, and central offices. At the same time, we visually captured and noted the location of the hybrid fiber/coax infrastructure of the cable TV companies, and verified the data supplied by Premium Choice Broadband. We believe the process used to visually capture the presence of infrastructure is 98% accurate.

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

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1 Executive Summary

Casco Bay Advisors, LLC (Casco Bay) is pleased to present this Broadband Planning Report (Report) to the Piscataquis County Economic Development Council (PCEDC) for 33 Towns/Townships in Piscataquis County. The purpose of this Report was to identify the location of existing high-speed broadband infrastructure, the gaps in that infrastructure and the estimated costs and potential strategies to extend service to all potential subscriber locations across those 33 Towns/Twps.

How did we select the 33 Towns/Twps? – The project includes all areas where a local telephone company was identified as providing local telephone service in the County as reported by the Maine Public Utilities Commission.

How did we inventory the existing infrastructure? – We drove along every roadway *(public & private)* and every long driveway where we had access and manually noted the presence of cable TV (CATV) infrastructure and fiber optic cables used for either transmission purposes or Fiber-to-the-Home (FTTH) service delivery.

How did we document the findings from the field audit? – The maps manually notated in the field were entered into the VETRO Fibermap GIS system, identifying the type of infrastructure along each road segment. In addition, we utilized 911 addresses and manually examined aerial imagery to identify potential subscriber locations without 911 addresses assigned and incorporated that data in the VETRO system. Each potential subscriber location was then associated with the infrastructure type to determine the quantity of locations for each type of infrastructure and whether the location meets the State of Maine definition of served or unserved.

How did we determine the estimated costs? – The data created in VETRO was exported in tabular form to determine mileage by infrastructure type and quantity of potential subscriber locations per infrastructure type, and as either served or unserved. Using unit costs observed in past projects we were then able to determine estimated costs to deploy FTTH service in each Town/Twp.

How and why did we assign each Towns/Twp to one of three regional groups? – Developing independent solutions for each of the 33 Towns/Twps is not realistic from a funding and implementation perspective and would not achieve the synergies available with a regional approach. As such, we assigned each Town/Twp to one of three (3) groups based on natural networking considerations. We also determined that three (3) of the 33 Towns/Twps had too few subscribers or lacked commercial power distribution sufficient to feasibly provide landline-based service. These 3 Towns/Twps were then excluded from the Report. This type of grouping and associated scale will also help to facilitate discussions with potential service providers and streamline the issuance of RFPs should an RFP process be employed.

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How can we develop Public-Private Partnerships to fill the gaps? - From the start, we have approached this analysis to support the development of Public-Private Partnerships to fill the gaps in coverage. With the completion of this Report, we intend to share the Report and underlying data with all service providers currently operating in the state of Maine and facilitate discussions with those service providers to negotiate deployment and funding strategies, with a requirement to provide ubiquitous coverage in each Town/Twp.

How much will it cost to expand the availability of high-speed Internet? – We have estimated the cost to extend FTTH service in those areas of the County not currently served with FTTH or Cable TV infrastructure to be approximately $22,000,000. Our model suggests local and county funding of $3,225,000 with the balance provided by state and federal grants and private service provider investment.

How can this project be funded? – The private sector has determined there is not a viable economic business case to deploy network into the unserved areas. As a result, public funding must be secured to turn these uneconomic business cases into economic business cases to assure the long-term viability of the networks. The State of Maine strategy calls for the private sector, federal, state, and local government each contributing 25% of the costs on average. The hypothetical funding strategy provided in Section 7 of this Report analyzes the use of local and county American Recovery Plan Act (ARPA) funding, combined with state and federal funding administered by the ConnectMaine Authority (CMA) and the newly formed Maine Connectivity Authority (MCA) to equitably distribute the funding burden. As mentioned in the title of this Section 7, this analysis is hypothetical, but the model forms the foundation for a reasonable approach that can be modified as necessary.

What are the next steps? – Build community, funding, and service provider support:

- Share the report with the Piscataquis County Commissioners, with the leadership of each Town, with elected officials, with the CMA and MCA staff and board members, and with the service providers.
- Facilitate a Piscataquis County Broadband Advisory Committee consisting of municipal leaders, community stakeholders, and business leaders to assist with building community support and funding development.
- Quickly reserve all available ARPA funding.
- Negotiate Public-Private Partnerships with service providers.

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2 How to read this report

Section 3 – Incumbent Telephone Company Service Areas identifies the areas service by Consolidated Communications, TDS and Otelco.

Section 4 – Cable Television Service Areas identifies the Towns where Charter (Spectrum) provide CATV infrastructure broadband service.

Section 5 - Regional Groups organizes each of the Towns/Twps into three (3) geographical areas. The introduction to this section includes a table to identify which Towns/Twps are assigned to which Regional Group. The following subsections provides a breakdown of the quantity and types of existing infrastructure and provides an estimate of the costs to deploy FTTH infrastructure.

Section 6 – Public-Private Partnership Strategies discusses various approaches to utilize the data produced in this Report to facilitate discussions with potential service provider partners.

Section 7 – Hypothetical Funding Strategy breaks down the potential sources of funding by Town/Twp and by Regional Group.

Section 8 – Next Step Recommendations reviews the recommended steps to quickly move into discussions with potential service provider partners and efforts to secure funding.

Sections 9 & 10 – provides various definitions and overviews of the differing technologies used to provide broadband Internet service.

Section 11 – Maps Appendix – provides a map of each Town/Twp is more granular detail than the group maps provided in Section 5.

For those who chose to read only the first 8 sections of this Report (only 41 pages), there are three (3) definitions you should be familiar with.

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

- **CATV** - Cable modem Internet access is provided over a hybrid fiber coaxial (HFC) broadband network. It has been employed globally by cable television operators since the early 1990s and is the network architecture utilized by Spectrum. In an HFC cable system, service is provided

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over a fiber optic cable to a node where the signal is converted from light pulses to an electrical signal. The electrical signal is then transmitted to the subscriber over a coaxial cable. Currently, the maximum download speed of this type of architecture is 940Mbps in the downstream directly and 35Mbps in the upstream direction. A new cable industry standard – DOCSIS 4.0, is under development and reportedly will be capable of providing symmetrical gigabit speeds.

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

Additional discussion of these and other technologies are included in Section 10 – Internet Access Technology Overview.

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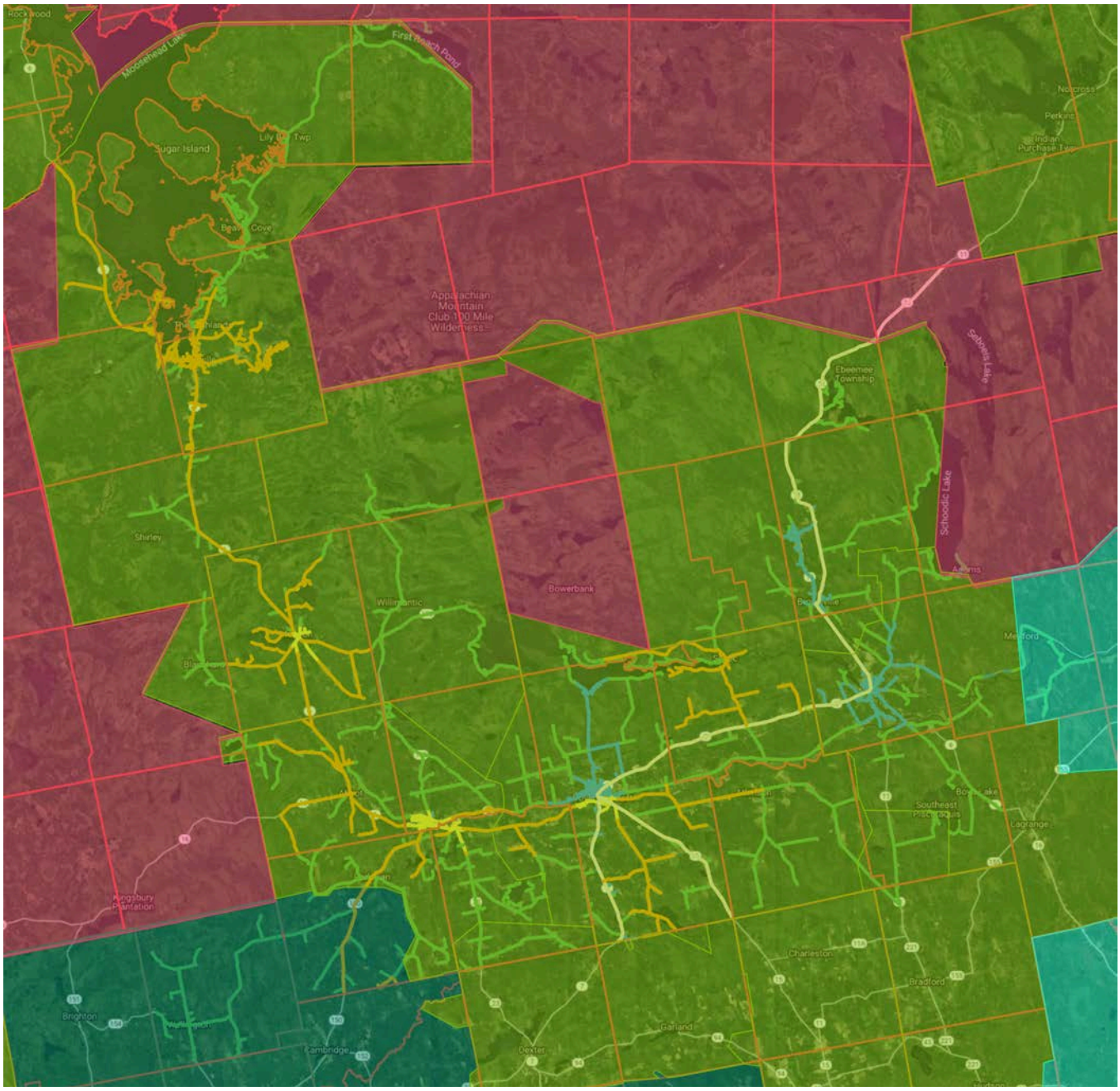
3 Incumbent Telephone Company Service Areas



Incumbent Telephone Company Service Areas	
	Otelco
	TDS
	Consolidated Communications
	No Telephone Service

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4 Cable Television Service Areas

- Greenville – Moosehead Cable – *conversion to Premium Choice Broadband FTTH in progress*
- Monsoon – Moosehead Cable - *conversion to Premium Choice Broadband FTTH in progress*
- Guildford – Moosehead Cable - *conversion to Premium Choice Broadband FTTH in progress*
- Sangerville – Moosehead Cable - *conversion to Premium Choice Broadband FTTH in progress*
- Dover-Foxcroft – Charter (Spectrum)
- Milo – Charter (Spectrum)
- Brownville – Charter (Spectrum)

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5 Regional Groups

Town/Township Groups		
North	**West/Central**	**East**
Beaver Cove	Abbot	Brownville
Big Moose Twp	Atkinson	Ebeemee Twp
Blanchard Twp	Barnard Twp	Katahdin Iron Works Twp
Elliottsville Twp	Bowerbank	Lake View Plt
Frenchtown Twp	Dover-Foxcroft	Medford
Greenville	Guildford	Milo
Harfords Pt	Kingsbury Plt	Orneville Twp
Lily Bay Twp	Parkman	T4 R9 NWP
Monson	Sangerville	T7 R9 NWP
Moosehead Jct	Sebec	Williamsburg
Shirley	Wellington	
Willimantic		

Each of the 33 Towns/Twps has been assigned to a group based on logical networking factors that we believe will help to facilitate discussions with potential service providers and streamline the issuance of RFPs should an RFP process be employed. Finally, finding solutions for 33 individual Towns/Twps on an individual case basis will be far too burdensome and will likely leave some Towns/Twps unserved in the long term.

In the following subsections, we provide:

- A map of each Group illustrating existing service and gaps in service
- Itemization of potential subscriber locations and road mileage for each type of infrastructure
- Estimated costs to either extend the CATV infrastructure or deploy FTTH infrastructure
- Detailed mapping of each Town is provided in the Appendix

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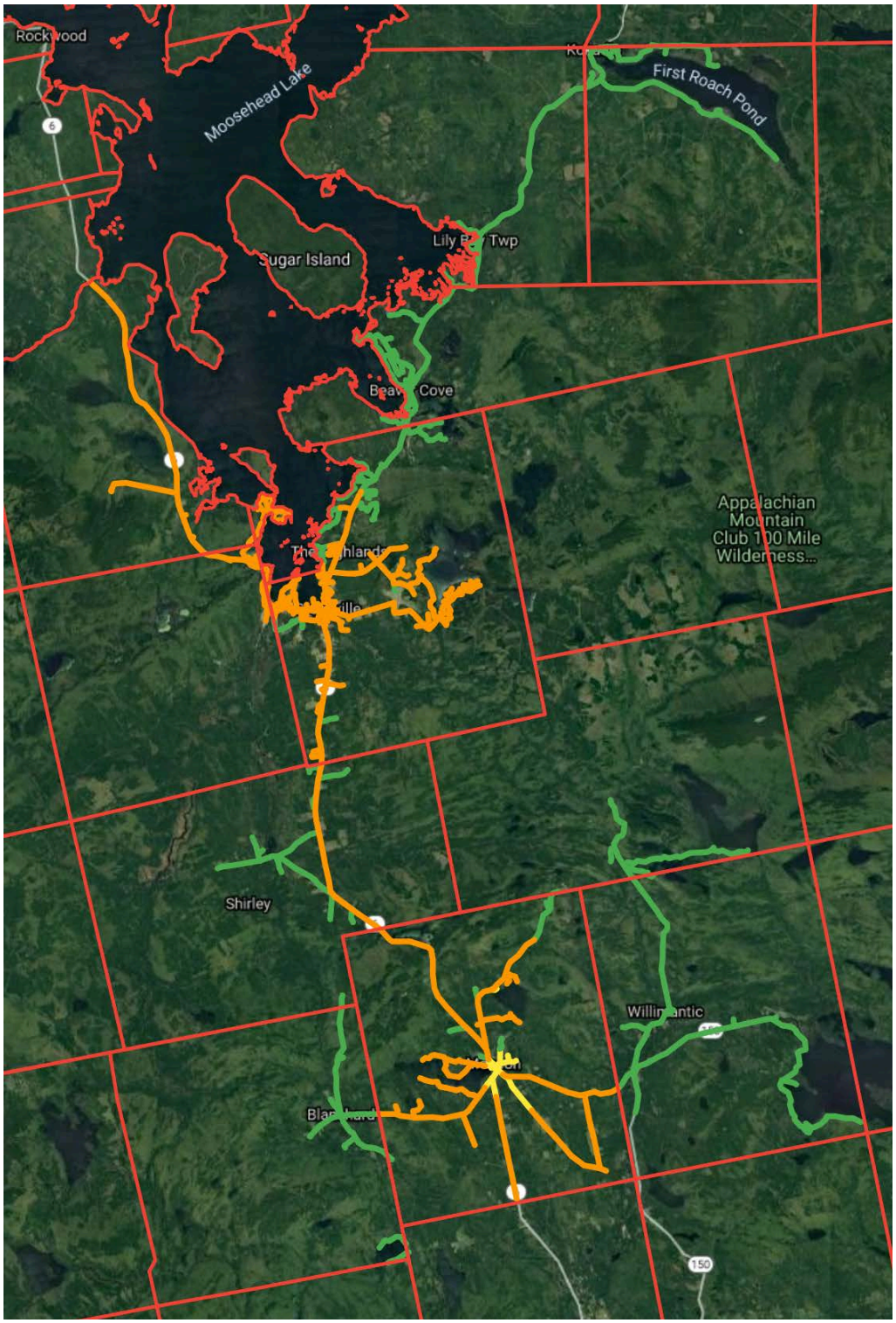
5.1 North Group Map



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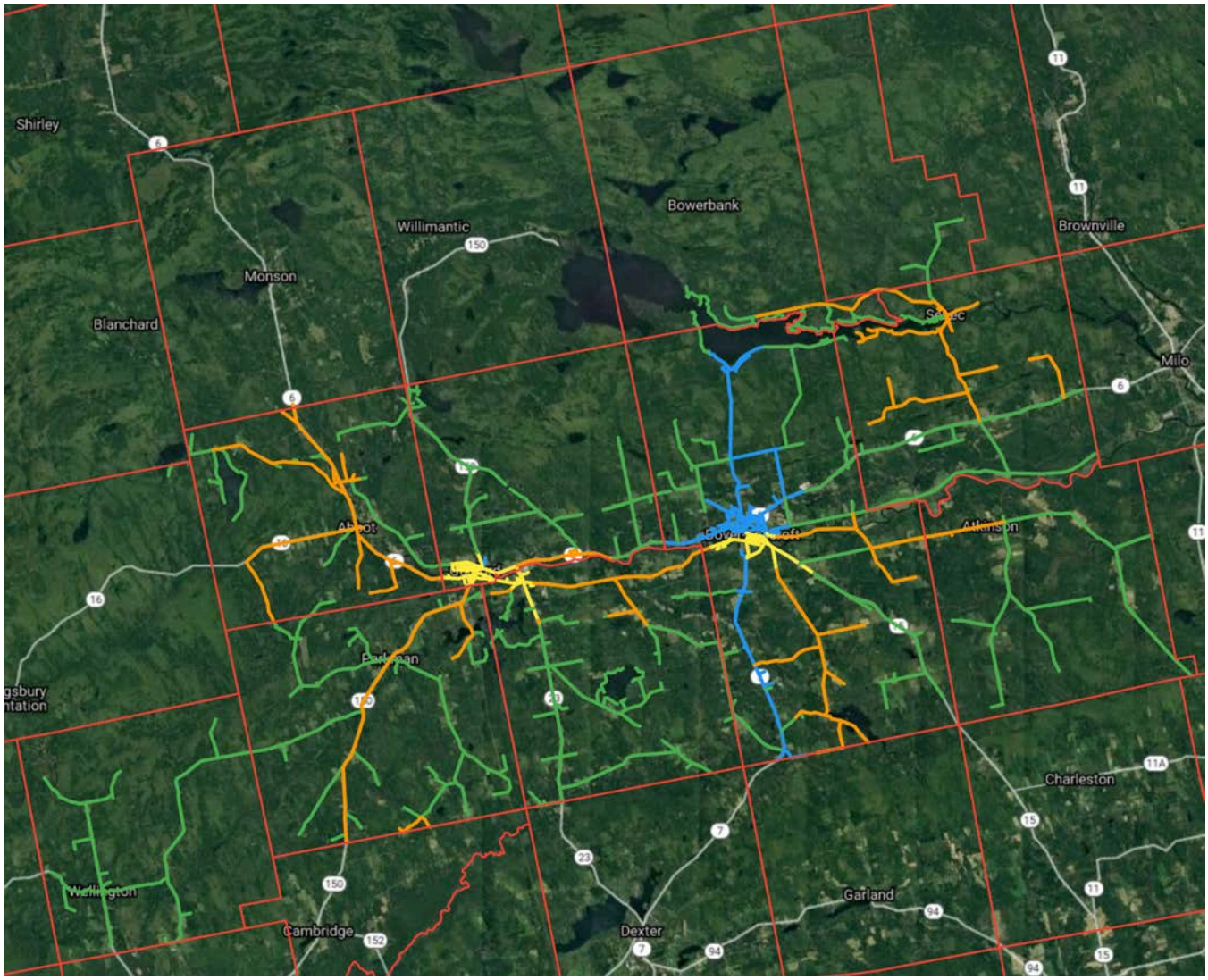
5.2 West/Central Group Map



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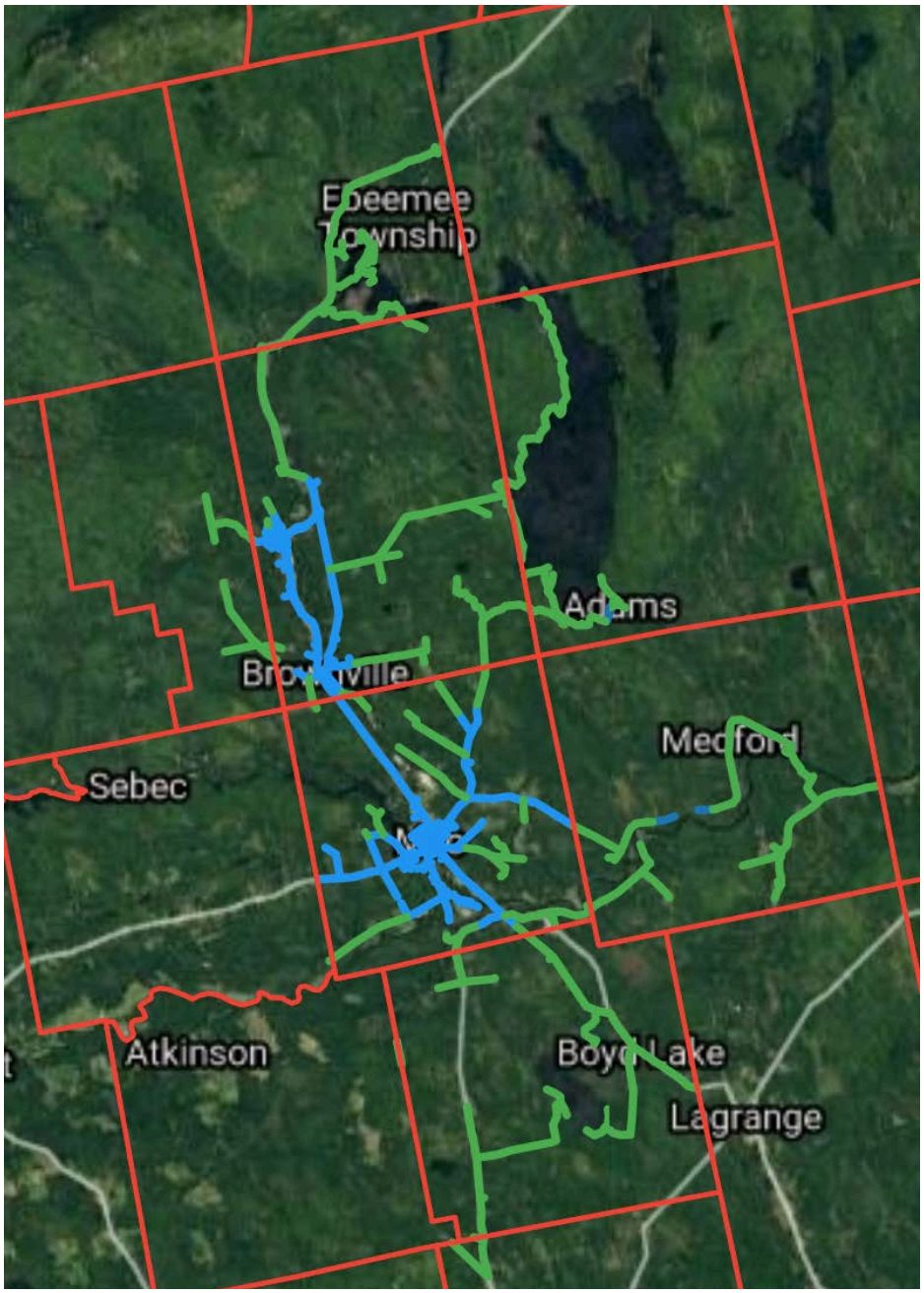
5.3 East Group Map



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5.4 Group Metrics - Mileage

		Mileage							Other Infrastructure	
Group	Town/Twp	Unserved <50/10	Served (Cabled)	Served FTTH & Uncabled	Served FTTH & Cabled	Under Ground or New Poles	Total		Phone Company non-FTTH Fiber	Maine Fiber Company 3RB
East	Brownville	17.4	17.2				**34.6**		20.6	8.5
East	Ebeemee Twp	13.4				0.2	**13.6**		6.6	6.6
East	Katahdin Iron Works Twp	*All potential subscriber locations off-grid or too remote*								
East	Lake View Plt	12.9				0.3	**13.3**		3.7	
East	Medford	16.1				1.5	**17.6**			
East	Milo	15.2	32.1				**47.3**		12.5	6.5
East	Orneville Twp	21.4					**21.4**		5.2	
East	T4 R9 NWP	*All potential subscriber locations off-grid or too remote*							4.3	4.3
East	T7 R9 NWP	*All potential subscriber locations off-grid or too remote*								
East	Williamsburg	5.1					**5.1**			
	Totals	**101.5**	**49.2**	**0.0**	**0.0**	**2.1**	**152.8**		**52.9**	**25.9**
North	Beaver Cove	14.6				1.1	**15.7**		6.2	
North	Big Moose Twp			10.5			**10.5**		8.0	
North	Blanchard Twp	9.3					**9.3**		1.0	
North	Elliottsville Twp	7.9					**7.9**			
North	Frenchtown Twp	12.4					**12.4**		2.6	
North	Greenville	14.5		40.7			**55.2**		19.2	
North	Harfords Pt			8.5			**8.5**			
North	Lily Bay Twp	9.1					**9.1**		6.6	
North	Monson	2.6		30.7	4.9		**38.3**		15.7	
North	Moosehead Jct			5.2			**5.2**		3.2	
North	Shirley	8.9		5.0			**14.0**		5.0	
North	Willimantic	19.6					**19.6**		5.5	
	Totals	**99.0**	**0.0**	**100.7**	**4.9**	**1.1**	**205.7**		**73.2**	
West/Central	Abbot	17.9		22.1			**40.0**		10.3	
West/Central	Atkinson	20.6		2.3		0.4	**23.3**		7.8	
West/Central	Barnard Twp	3.2					**3.2**			
West/Central	Bowerbank	11.3		4.3			**15.7**		4.0	
West/Central	Dover-Foxcroft	37.7	36.9	19.2	8.2		**102.0**		40.4	18.9
West/Central	Guildford	21.8	0.2	3.0	8.8		**33.9**		17.8	
West/Central	Kingsbury Plt	0.3					**0.3**			
West/Central	Parkman	30.4		11.7		0.3	**42.5**		14.3	
West/Central	Sangerville	36.5		7.9	3.9		**48.2**		11.7	
West/Central	Sebec	19.6		16.4			**36.1**		14.8	6.7
West/Central	Wellington	22.1				2.3	**24.4**		3.8	
	Totals	**221.5**	**37.2**	**87.0**	**20.9**	**3.0**	**369.6**		**125.0**	**25.6**
	Grand Totals	**422.0**	**86.4**	**187.7**	**25.8**	**6.2**	**728.1**		**251.2**	**51.5**

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The table on the previous page breaks down the estimated backbone mileage required to pass all potential subscribers in each Town/Twp with the exception of those locations believed to be off-the-grid or too remote to serve economically.

In addition, we have also captured "other infrastructure" that may be leveraged to expand FTTH or CATV services.

- **Phone Company non-FTTH Fiber** - Itemizes the amount of fiber optic cabling in each Town/Twp owned by the incumbent local telephone company (LEC) that is not designed for use as FTTH infrastructure. This fiber is typically utilized to provide a connection between central offices, service to cell towers, large businesses, schools, and libraries. It is also utilized to provide a high-capacity connection between the central office and remote terminals used to provision DSL-based Internet service.

- **Maine Fiber Company 3RB** – Itemized the amount of and location of the Maine Fiber Company 3-Ring-Binder Network (now owned by FirstLight) that can be used as backhaul to the remainder of the State of Maine and outside of the State.

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5.5 Group Metrics – Potential Subscriber Locations

Group	Town/Twp	Potential Subscriber Locations						Per Mile Averages		
		Unserved <50/10	Served (Cabled)	Served FTTH & Uncabled	Served FTTH & Cabled	Off Grid or Too Remote	Total	Average Locations per Unserved Mile	Average Locations per Served Mile	Average Locations per Mile per Town
East	Brownville	164	603			25	792	9.4	35.1	22.2
East	Ebeemee Twp	172				21	193	12.8		12.6
East	Katahdin Iron Works Twp					11	11			
East	Lake View Plt	433				13	446	33.4		32.6
East	Medford	131				15	146	8.2		7.4
East	Milo	129	1,039			7	1,175	8.5	32.4	24.7
East	Orneville Twp	241				26	267	11.2		11.2
East	T4 R9 NWP					24	24			
East	T7 R9 NWP						0			
East	Williamsburg	48				2	50	9.5		9.5
	Totals	1,318	1,642	0	0	144	3,104	13.0	33.4	19.4
		42%	53%	0%	0%	5%				
North	Beaver Cove	227				14	241	15.5		14.4
North	Big Moose Twp			15		16	31		1.4	1.4
North	Blanchard Twp	146					146	15.7		15.7
North	Elliottsville Twp	106				37	143	13.4		13.4
North	Frenchtown Twp	155				8	163	12.5		12.5
North	Greenville	245		1,177		78	1,500	16.9	28.9	25.8
North	Harfords Pt			176			176		20.6	20.6
North	Lily Bay Twp	102				9	111	11.2		11.2
North	Monson	22		386	212	18	638	8.4	16.8	16.2
North	Moosehead Jct			64			64		12.3	12.3
North	Shirley	150		49		9	208	16.8	9.7	14.3
North	Willimantic	232				20	252	11.9		11.9
	Totals	1,385	0	1,867	212	209	3,673	14.0	89.7	16.8
		38%	0%	51%	6%	6%				
West/Central	Abbot	253		257		12	522	14.1	11.6	12.8
West/Central	Atkinson	169		43		5	217	8.2	18.5	9.1
West/Central	Barnard Twp	35		1		1	37	11.0		11.3
West/Central	Bowerbank	282		18		13	313	24.9	4.2	19.2
West/Central	Dover-Foxcroft	519	1,228	228	404	74	2,453	13.8	28.9	23.3
West/Central	Guildford	252	4	48	454	8	766	11.5	41.9	22.4
West/Central	Kingsbury Plt	5				132	137	15.1		15.1
West/Central	Parkman	307		142		7	456	10.1	12.1	10.6
West/Central	Sangerville	473		77	227	1	778	13.0	25.8	16.1
West/Central	Sebec	205		226			431	10.4	13.7	11.9
West/Central	Wellington	201				61	262	9.1		8.3
	Totals	2,701	1,232	1,040	1,085	314	6,372	12.2	23.1	16.4
		42%	19%	16%	17%	5%				
	Grand Totals	5,404	2,874	2,907	1,297	667	13,149	12.8	146.2	17.1
		41%	22%	22%	10%	5%				

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The table on the previous page itemizes the quantity of potential subscriber locations for each Town/Twp. The first column is the quantity of locations determined by this Report to have service of less than 50Mbps/10Mbps, which is the new "unserved" standard established in June 2021. This is the quantity of locations that are not served by CATV or FTTH infrastructure and does not include those locations determined to be off-the-grid or too remote to serve economically.

We also calculate the per mile averages, which is the average quantity of potential subscriber locations for each Town/Twp for those locations that are unserved, those that are served, and the combined average.

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5.6 Cost Estimates – *excluding existing FTTH areas*

Group	Town/Twp	Town/Twp-wide FTTH Construction Cost *(excluded existing FTTH areas)*										
		Total Estimated Poles	Estimated Pole Make-ready Cost	Estimated Fiber Construction	Unserved Market Share after 3 years	Served CATV Area Market Share after 3 years	Total Subscribers after 3 years	Estimated Central Office / FDH Costs	Estimated Optical Electronics / Drop Cost	Project Manageent / Contingency Cost	Estimated Total Construction Cost	Average Cost per Location Passed
		33	**$400**	**$25,000**	**50%**	**30%**		**$100**	**$1,200**	**10%**		
East	Brownville	1,140	$456,107	$863,838	82	181	263	$26,290	$315,480	$166,171	**$1,827,886**	$2,383
East	Ebeemee Twp	449	$179,523	$340,007	86	0	86	$8,600	$103,200	$63,133	**$694,463**	$4,038
East	Katahdin Iron Works Twp	*All potential subscriber locations off-grid or too remote*										
East	Lake View Plt	438	$175,312	$332,030	217	0	217	$21,650	$259,800	$78,879	**$867,670**	$2,004
East	Medford	581	$232,409	$440,169	66	0	66	$6,550	$78,600	$75,773	**$833,502**	$6,363
East	Milo	1,560	$624,021	$1,181,857	65	312	376	$37,620	$451,440	$229,494	**$2,524,432**	$2,161
East	Orneville Twp	707	$282,787	$535,581	121	0	121	$12,050	$144,600	$97,502	**$1,072,520**	$4,450
East	T4 R9 NWP	*All potential subscriber locations off-grid or too remote*										
East	T7 R9 NWP	*All potential subscriber locations off-grid or too remote*										
East	Williamsburg	167	$66,961	$126,820	24	0	24	$2,400	$28,800	$22,498	**$247,480**	$5,156
	Totals	**5,043**	**$2,017,120**	**$3,820,302**	**659**	**493**	**1,152**	**$115,160**	**$1,381,920**	**$733,450**	**$8,067,952**	**$2,726**
					57%	**43%**						
North	Beaver Cove	519	$207,413	$392,827	114	0	114	$11,350	$136,200	$74,779	**$822,569**	$3,624
North	Big Moose Twp	*Already served or under construction with FTTH*										
North	Blanchard Twp	308	$123,072	$233,092	73	0	73	$7,300	$87,600	$45,106	**$496,171**	$3,398
North	Elliottsville Twp	262	$104,763	$198,414	53	0	53	$5,300	$63,600	$37,208	**$409,284**	$3,861
North	Frenchtown Twp	411	$164,282	$311,141	78	0	78	$7,750	$93,000	$57,617	**$633,790**	$4,089
North	Greenville	478	$191,255	$362,226	123	0	123	$12,250	$147,000	$71,273	**$784,005**	$3,200
North	Harfords Pt	*Already served or under construction with FTTH*										
North	Lily Bay Twp	300	$119,829	$226,948	51	0	51	$5,100	$61,200	$41,308	**$454,385**	$4,455
North	Monson	86	$34,584	$65,500	11	0	11	$1,100	$13,200	$11,438	**$125,822**	$5,719
North	Moosehead Jct	*Already served or under construction with FTTH*										
North	Shirley	294	$117,650	$222,823	75	0	75	$7,500	$90,000	$43,797	**$481,770**	$3,212
North	Willimantic	645	$258,084	$488,796	116	0	116	$11,600	$139,200	$89,768	**$987,448**	$4,256
	Totals	**3,302**	**$1,320,933**	**$2,501,767**	**693**	**0**	**693**	**$69,250**	**$831,000**	**$472,295**	**$5,195,245**	**$3,751**
					100%	**0%**						
West/Central	Abbot	591	$236,515	$447,946	127	0	127	$12,650	$151,800	$84,891	**$933,802**	$3,691
West/Central	Atkinson	693	$277,001	$524,623	85	0	85	$8,450	$101,400	$91,147	**$1,002,622**	$5,933
West/Central	Barnard Twp	105	$41,908	$79,370	18	0	18	$1,750	$21,000	$14,403	**$158,431**	$4,527
West/Central	Bowerbank	374	$149,464	$283,076	141	0	141	$14,100	$169,200	$61,584	**$677,424**	$2,402
West/Central	Dover-Foxcroft	2,463	$985,050	$1,865,625	260	368	628	$62,790	$753,480	$366,694	**$4,033,639**	$2,309
West/Central	Guildford	728	$291,361	$551,820	126	1	127	$12,720	$152,640	$100,854	**$1,109,396**	$4,334
West/Central	Kingsbury Plt	11	$4,374	$8,284	3	0	3	$250	$3,000	$1,591	**$17,499**	$3,500
West/Central	Parkman	1,016	$406,356	$769,613	154	0	154	$15,350	$184,200	$137,552	**$1,513,070**	$4,929
West/Central	Sangerville	1,204	$481,455	$911,846	237	0	237	$23,650	$283,800	$170,075	**$1,870,825**	$3,955
West/Central	Sebec	648	$259,332	$491,158	103	0	103	$10,250	$123,000	$88,374	**$972,114**	$4,742
West/Central	Wellington	804	$321,561	$609,016	101	0	101	$10,050	$120,600	$106,123	**$1,167,349**	$5,808
	Totals	**8,636**	**$3,454,375**	**$6,542,377**	**1,351**	**370**	**1,720**	**$172,010**	**$2,064,120**	**$1,223,288**	**$13,456,170**	**$3,421**
					79%	**21%**						
	Grand Totals	**16,981**	**$6,792,428**	**$12,864,446**	**2,702**	**862**	**3,564**	**$356,420**	**$4,277,040**	**$2,429,033**	**$26,719,368**	**$3,228**

- **Total Estimated Poles** – We assume there are an average of 33 utility poles per mile based on records from similar past projects. The actual quantity of poles cannot be known for certainty until additional detailed field audits are performed to determine the GPS coordinates and pole IDs for each required pole. This is the first step performed after a solution is identified and funding is secured.

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- **Estimated Pole Make-ready Cost** – We assume the average make-ready cost per pole is $400, which includes the field audit effort referenced above, submission of the pole applications and processing of those applications to determine the actual costs for make-ready, as well as the costs the pole owners will charge to make the poles ready for a new attachment or replacement of poles without sufficient space.

- **Estimated Fiber Construction** – We assume an average cost of $25,000 per mile to install the fiber optic backbone. This cost can vary depending upon the quantity of down guys and anchors required to be installed, the position of the attachment on the poles, any traffic control requirements for a particular area, and the density of potential subscribers along the route.

- **Unserved Market Share after 3 years** – For areas that are currently unserved, we are conservatively assuming 50% of the potential subscriber locations will subscribe to service within three (3) years. This is a conservative estimate and most of the projects previously observed attain 65% - 80% after three (3) years.

- **Served Market Share after 3 years** – For those areas where there is existing CATV infrastructure, or a viable competitive alternative, we assume 30% of the potential subscriber locations will subscribe to service within three (3) years. Again, this is a conservative estimate, and we routinely see market share in these over-built areas achieve 35% – 45% market share.

- **Estimated Central Office / FDH Costs** – We have assumed $100 per subscriber contracted after three (3) years to cover the costs for the central office and fiber distribution hubs to provide service.

- **Estimated Optical-Electronics / Drop Costs** – We have assumed an average of $1,200 per subscriber for the fiber optic drop cable from the backbone network to the subscriber location and for the optical-electronics in the central office and subscriber location for the total subscribers contracted after three (3) years.

- **Project Management / Contingency –** For planning purposes, we have included an additional 10% for project management of the construction project and as a contingency for unexpected costs or material/labor cost increases. This contingency amount may be reduced or modified once actual quotes from the pole owners for make-ready are received and bids are secured for construction.

The **Estimated Total Construction Cost** is the sum of the individual costs described above and represents the capital cost of building a new publicly owned FTTH network for this regional group. Creating a public-private partnership with the incumbent provider or an alternative provider, where the private provider shares in the overall cost will reduce this amount significantly.

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5.7 Cost Estimates – *excluding existing FTTH and CATV areas*

Group	Town/Twp	Town/Twp-wide FTTH Construction Cost (excluded existing FTTH & CATV areas)								
		Total Estimated Poles	Estimated Pole Make-ready Cost	Estimated Fiber Construction	Unserved Market Share after 3 years	Estimated Central Office / FDH Costs	Estimated Optical Electronics / Drop Cost	Project Manageent / Contingency Cost	Estimated Total Construction Cost	Average Cost per Location Passed
East	Brownville	574	$229,656	$434,955	82	$8,200	$98,400	$77,121	**$848,332**	$5,173
East	Ebeemee Twp	449	$179,523	$340,007	86	$8,600	$103,200	$63,133	**$694,463**	$4,038
East	Katahdin Iron Works Twp	*All potential subscriber locations off-grid or too remote*								
East	Lake View Plt	438	$175,312	$332,030	217	$21,650	$259,800	$78,879	**$867,670**	$2,004
East	Medford	581	$232,409	$440,169	66	$6,550	$78,600	$75,773	**$833,502**	$6,363
East	Milo	501	$200,600	$379,924	65	$6,450	$77,400	$66,437	**$730,811**	$5,665
East	Orneville Twp	707	$282,787	$535,581	121	$12,050	$144,600	$97,502	**$1,072,520**	$4,450
East	T4 R9 NWP	*All potential subscriber locations off-grid or too remote*								
East	T7 R9 NWP	*All potential subscriber locations off-grid or too remote*								
East	Williamsburg	167	$66,961	$126,820	24	$2,400	$28,800	$22,498	**$247,480**	$5,156
	Totals	**3,418**	**$1,367,249**	**$2,589,486**	**659**	**$65,900**	**$790,800**	**$481,343**	**$5,294,778**	**$4,017**
North	Beaver Cove	519	$207,413	$392,827	114	$11,350	$136,200	$74,779	**$822,569**	$3,624
North	Big Moose Twp	*Already served or under construction with FTTH*								
North	Blanchard Twp	308	$123,072	$233,092	73	$7,300	$87,600	$45,106	**$496,171**	$3,398
North	Elliottsville Twp	262	$104,763	$198,414	53	$5,300	$63,600	$37,208	**$409,284**	$3,861
North	Frenchtown Twp	411	$164,282	$311,141	78	$7,750	$93,000	$57,617	**$633,790**	$4,089
North	Greenville	478	$191,255	$362,226	123	$12,250	$147,000	$71,273	**$784,005**	$3,200
North	Harfords Pt	*Already served or under construction with FTTH*								
North	Lily Bay Twp	300	$119,829	$226,948	51	$5,100	$61,200	$41,308	**$454,385**	$4,455
North	Monson	86	$34,584	$65,500	11	$1,100	$13,200	$11,438	**$125,822**	$5,719
North	Moosehead Jct	*Already served or under construction with FTTH*								
North	Shirley	294	$117,650	$222,823	75	$7,500	$90,000	$43,797	**$481,770**	$3,212
North	Willimantic	645	$258,084	$488,796	116	$11,600	$139,200	$89,768	**$987,448**	$4,256
	Totals	**3,302**	**$1,320,933**	**$2,501,767**	**693**	**$69,250**	**$831,000**	**$472,295**	**$5,195,245**	**$3,751**
West/Central	Abbot	591	$236,515	$447,946	127	$12,650	$151,800	$84,891	**$933,802**	$3,691
West/Central	Atkinson	693	$277,001	$524,623	85	$8,450	$101,400	$91,147	**$1,002,622**	$5,933
West/Central	Barnard Twp	105	$41,908	$79,370	18	$1,750	$21,000	$14,403	**$158,431**	$4,527
West/Central	Bowerbank	374	$149,464	$283,076	141	$14,100	$169,200	$61,584	**$677,424**	$2,402
West/Central	Dover-Foxcroft	1,244	$497,720	$942,651	260	$25,950	$311,400	$177,772	**$1,955,492**	$3,768
West/Central	Guildford	720	$288,147	$545,733	126	$12,600	$151,200	$99,768	**$1,097,448**	$4,355
West/Central	Kingsbury Plt	11	$4,374	$8,284	3	$250	$3,000	$1,591	**$17,499**	$3,500
West/Central	Parkman	1,016	$406,356	$769,613	154	$15,350	$184,200	$137,552	**$1,513,070**	$4,929
West/Central	Sangerville	1,204	$481,455	$911,846	237	$23,650	$283,800	$170,075	**$1,870,825**	$3,955
West/Central	Sebec	648	$259,332	$491,158	103	$10,250	$123,000	$88,374	**$972,114**	$4,742
West/Central	Wellington	804	$321,561	$609,016	101	$10,050	$120,600	$106,123	**$1,167,349**	$5,808
	Totals	**7,410**	**$2,963,831**	**$5,613,316**	**1,351**	**$135,050**	**$1,620,600**	**$1,033,280**	**$11,366,076**	**$4,208**
	Grand Totals	**14,130**	**$5,652,012**	**$10,704,569**	**2,702**	**$270,200**	**$3,242,400**	**$1,986,918**	**$21,856,099**	**$4,044**

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This table is identical to the previous table with the difference that this table excludes areas currently serviced by CATV *and* FTTH infrastructure, reducing the overall cost by approximately $5,000,000.

6 Public-private partnership strategies

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

6.1 Incumbent Telephone & Cable Providers

The local telephone company and cable providers are the lowest cost options to upgrade service to FTTH or to extend the cable infrastructure, by virtue of their existing attachments to all or most of the utility poles. Sharing this report with each of these providers will generate interest and discussions which should be pursued.

6.2 Alternative service providers

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

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7 Hypothetical Funding Strategy

Group	Town/Twp	Hypothetical Funding Strategy (excluding existing FTTH & CATV areas)						
		Unserved Potential Subscriber Locations	FTTH Estimated Total Construction Cost	Total Cost per Unserved Location	Local ARPA Funds Received	Pro rata share of 50% of County ARPA Funds	State / Federal Funding	Private Service Provider Funding
						$1,627,500		37%
East	Brownville	164	$848,332	$5,173	$118,000	$49,391	$367,058	$313,883
East	Ebeemee Twp	172	$694,463	$4,038		$51,801	$385,711	$256,951
East	Katahdin Iron Works Twp	*All potential subscriber locations off-grid or too remote*						
East	Lake View Plt	433	$867,670	$2,004	$8,000	$130,405	$408,227	$321,038
East	Medford	131	$833,502	$6,363	$24,000	$39,453	$461,653	$308,396
East	Milo	129	$730,811	$5,665	$228,000	$38,850	$193,561	$270,400
East	Orneville Twp	241	$1,072,520	$4,450		$72,581	$603,106	$396,832
East	T4 R9 NWP	*All potential subscriber locations off-grid or too remote*						
East	T7 R9 NWP	*All potential subscriber locations off-grid or too remote*						
East	Williamsburg	48	$247,480	$5,156		$14,456	$141,456	$91,567
	Totals	**1,318**	**$5,294,778**	**$32,848**	**$378,000**	**$396,937**	**$2,560,774**	**$1,959,068**
					7%	**7%**	**48%**	**37%**
			Investment per Unserved Location		***$301***	***$1,943***	***$1,486***	
								40%
North	Beaver Cove	227	$822,569	$3,624	$12,000	$68,365	$413,177	$329,028
North	Big Moose Twp	*Already served or under construction with FTTH*						
North	Blanchard Twp	146	$496,171	$3,398		$43,970	$253,732	$198,468
North	Elliottsville Twp	106	$409,284	$3,861		$31,924	$213,647	$163,714
North	Frenchtown Twp	155	$633,790	$4,089		$46,681	$333,594	$253,516
North	Greenville	245	$784,005	$3,200	$160,000	$73,786	$236,617	$313,602
North	Harfords Pt	*Already served or under construction with FTTH*						
North	Lily Bay Twp	102	$454,385	$4,455		$30,719	$241,912	$181,754
North	Monson	22	$125,822	$5,719	$65,000	$6,626	$3,868	$50,329
North	Moosehead Jct	*Already served or under construction with FTTH*						
North	Shirley	150	$481,770	$3,212	$22,000	$45,175	$221,887	$192,708
North	Willimantic	232	$987,448	$4,256	$14,000	$69,870	$508,599	$394,979
	Totals	**1,385**	**$5,195,245**	**$35,814**	**$273,000**	**$417,115**	**$2,427,032**	**$2,078,098**
					5%	**8%**	**47%**	**40%**
			Investment per Unserved Location		***$301***	***$1,752***	***$1,500***	
								35%
West/Central	Abbot	253	$933,802	$3,691	$67,000	$76,195	$463,776	$326,831
West/Central	Atkinson	169	$1,002,622	$5,933	$31,000	$50,897	$569,807	$350,918
West/Central	Barnard Twp	35	$158,431	$4,527		$10,541	$92,439	$55,451
West/Central	Bowerbank	282	$677,424	$2,402	$11,000	$84,929	$344,397	$237,098
West/Central	Dover-Foxcroft	519	$1,955,492	$3,768	$402,000	$156,305	$712,765	$684,422
West/Central	Guildford	252	$1,097,448	$4,355	$144,000	$75,894	$493,448	$384,107
West/Central	Kingsbury Plt	5	$17,499	$3,500	$3,000	$1,506	$6,868	$6,125
West/Central	Parkman	307	$1,513,070	$4,929	$79,000	$92,458	$812,038	$529,575
West/Central	Sangerville	473	$1,870,825	$3,955	$127,000	$142,451	$946,585	$654,789
West/Central	Sebec	205	$972,114	$4,742	$59,000	$61,739	$511,135	$340,240
West/Central	Wellington	201	$1,167,349	$5,808	$24,000	$60,534	$674,243	$408,572
	Totals	**2,701**	**$11,366,076**	**$47,608**	**$947,000**	**$813,449**	**$5,627,501**	**$3,978,127**
					8%	**7%**	**50%**	**35%**
			Investment per Unserved Location		***$301***	***$2,083***	***$1,473***	
	Grand Totals	**5,404**	**$21,856,099**	**$116,271**	**$1,598,000**	**$1,627,500**	**$10,615,307**	**$8,015,293**
					7%	**7%**	**49%**	**37%**
			Investment per Unserved Location		***$301***	***$1,964***	***$1,483***	

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- **The table above is a hypothetical view of the source of funds assuming the following:**
    - Targeting a $1,500 investment per unserved potential subscriber location, the private provider contributes from 35% - 40% of the funding depending upon the overall cost and subscriber density for each group.
    - The $1,627,500, or 50% of County ARPA funds are allocated to broadband.
    - The entire amount of Local ARPA funds are allocated to broadband.
    - The balance of the funding is sought from state/federal funds. *The current State of Maine strategy is for state and federal to each fund 25% of broadband expansion. This hypothetical model assumes 49% of overall funding to be provided from State and federal sources which aligns with the current strategy. Depending on yet to be announced grant criteria, additional local and/or county funding may be required.*

8 Next step recommendations

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

8.1 Revisit and confirm goals and vision

Now that the costs and options for various solutions have been identified in this Report, the County and Towns should revisit their goals and vision. This effort should be completed at the earliest opportunity to inform the next steps.

8.2 Public-private partnership negotiations

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

8.3 Secure funding to support negotiations

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

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9 Internet Access and Broadband Definition

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

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

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

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

In January 2015, the Federal Communications Commission (FCC) voted to define broadband as Internet service with at least 25 Mbps (megabits per second) download and 3 Mbps upload. Their definition affects policy decisions and the FCC's annual assessment of whether broadband is being deployed to all Americans quickly enough. In Maine, the ConnectMaine Authority Board[1] currently defines effective broadband network capacity as speeds equal to or greater than 50Mbps/10Mbps, and anything less as “unserved.”

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

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10 Internet Access Technology Overview

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

10.1 DSL

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

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

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

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

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

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

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

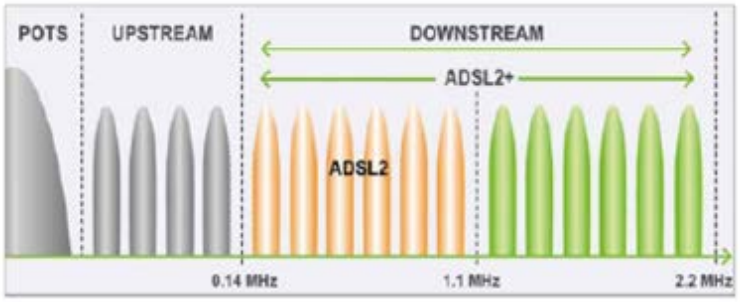

Figure 1: ADSL2+ Frequency Utilization

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

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

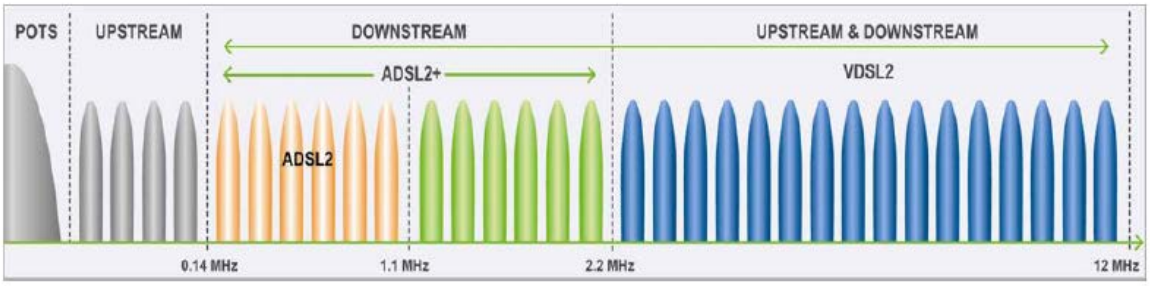

Figure 2: VDSL2+ Frequency Utilization

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10.2 Cable Modem

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

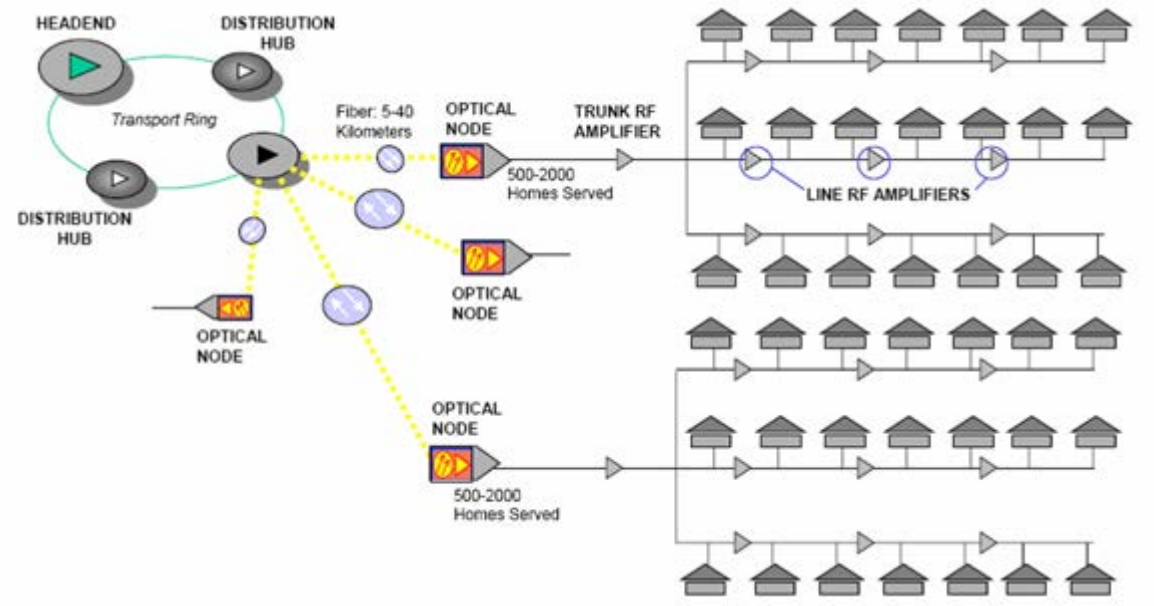

Figure 3: Hybrid Fiber/Coax Network Architecture Diagram

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

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

Data Over Cable Service Interface Specification (DOCSIS) is an international telecommunications standard that permits the addition of high-bandwidth data transfer to an existing cable TV (CATV) system. DOCSIS 3.1 has been deployed by Spectrum to provide Internet access over their existing HFC

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infrastructure. The DOCSIS 3.1 standard is capable of supporting Internet speeds of up to 10 Gbps *(gigabits per second),* but most providers are currently offering speeds of 1 Gbps or less service for residential users.

10.3 Fixed Wireless

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

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

10.4 4G/LTE Advanced Broadband

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

Mobile LTE wireless service uses MIMO technology to combine multiple antennas on both the transmitter and the receiver. A 2×2 MIMO configuration has two antennas on the transmitter and two on the receiver, but the technology is not limited to 2x2. More antennas could theoretically operate at faster speeds as the data streams can travel more efficiently. The signal is then combined with “carrier aggregation,” which allows a device to receive multiple 4G signals at once. The received signals don’t have to be on the same frequency; one could receive an 1800 MHz and an 800 MHz signal at the same

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time, which is not possible with standard 4G. Up to five different 20 MHz signals can be combined to create a data pipe of up to 100 MHz of bandwidth.

10.5 5G Wireless[2]

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

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

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

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

Previous generations of wireless technology have used lower-frequency bands of spectrum. To offset millimeter wave challenges relating to distance and interference, the wireless industry is also considering the use of lower-frequency spectrum for 5G networks so network operators could use

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

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

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spectrum they already own to build out their new networks. Lower-frequency spectrum reaches greater distances but has lower speed and capacity than millimeter wave.

10.6 Satellite

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

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

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

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

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

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10.7 Fiber-to-the-Home (FTTH)

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

FTTH networks can be configured and operated in several different ways. These include:

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

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

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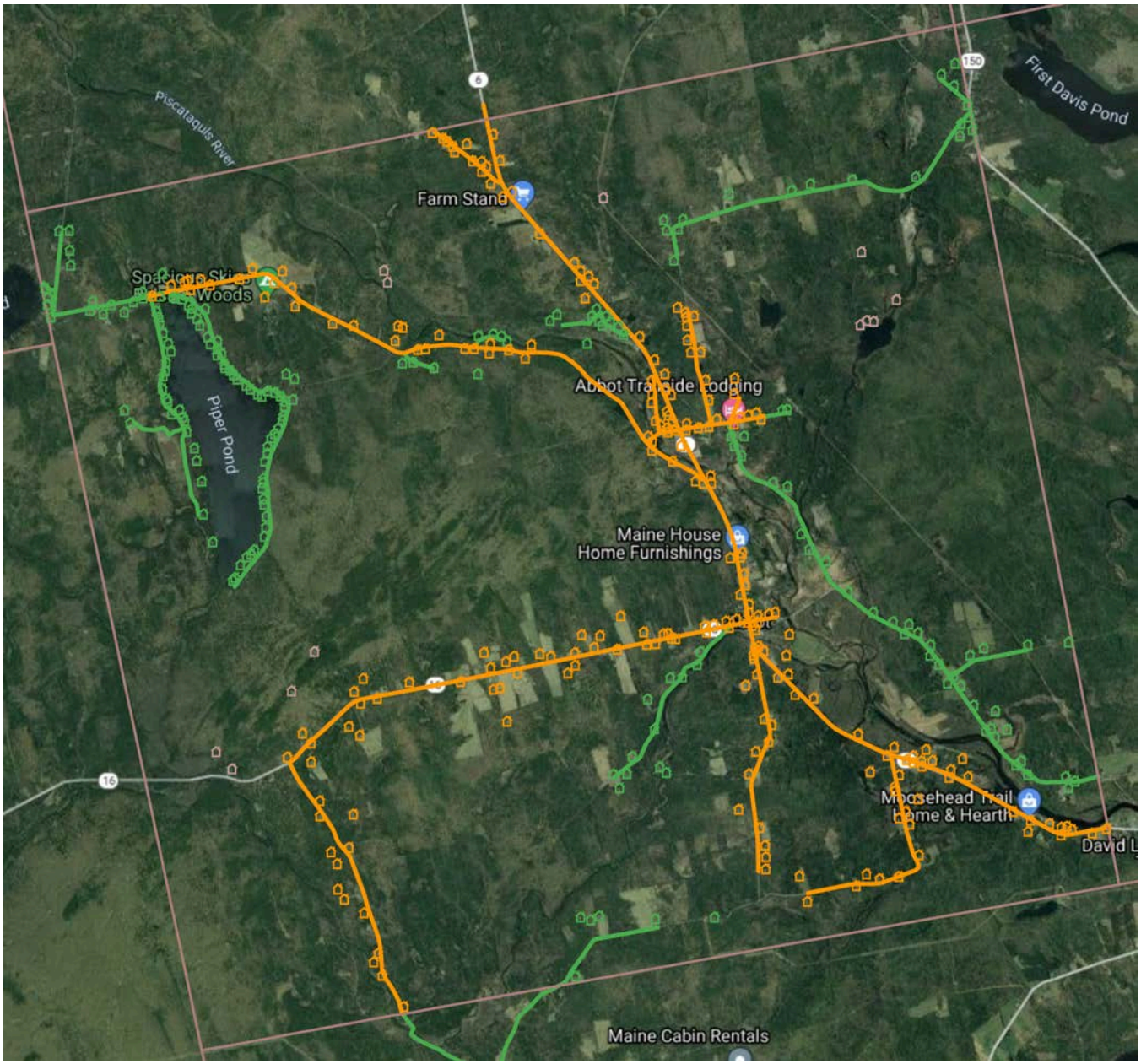
11 Maps Appendix

The following pages contain maps of the 33 Towns/Twps in alphabetical order.

Map Key	
Orange	Fiber-to-the-Home (FTTH)
Yellow	Fiber-to-the-Home (FTTH) & Cable Tvo (CATV)
Blue	Cable TV (CATV)
Green	Uncabled *(DSL service only)*
Pink	Off-Grid or Too Remote

Abbot



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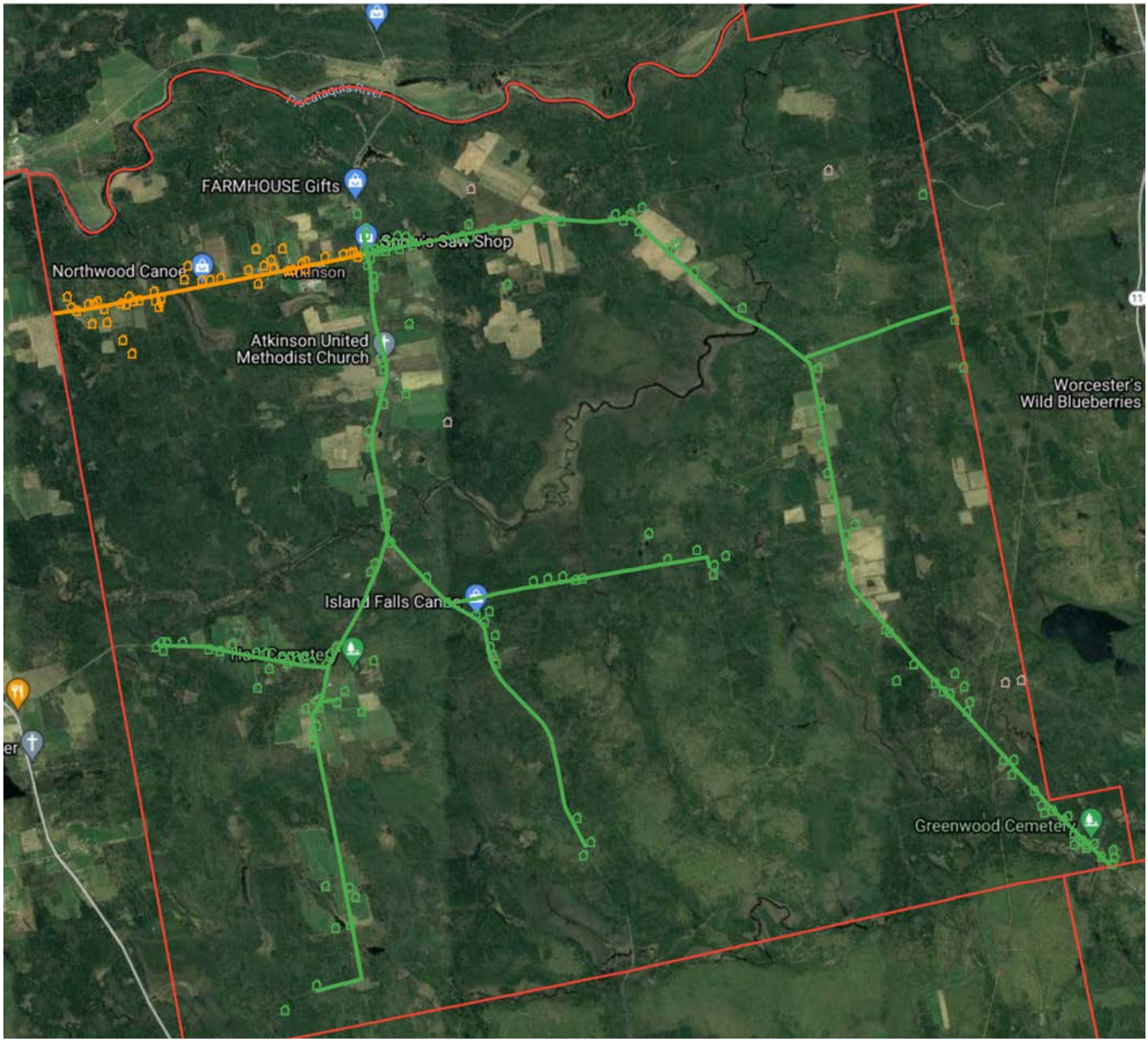
Atkinson



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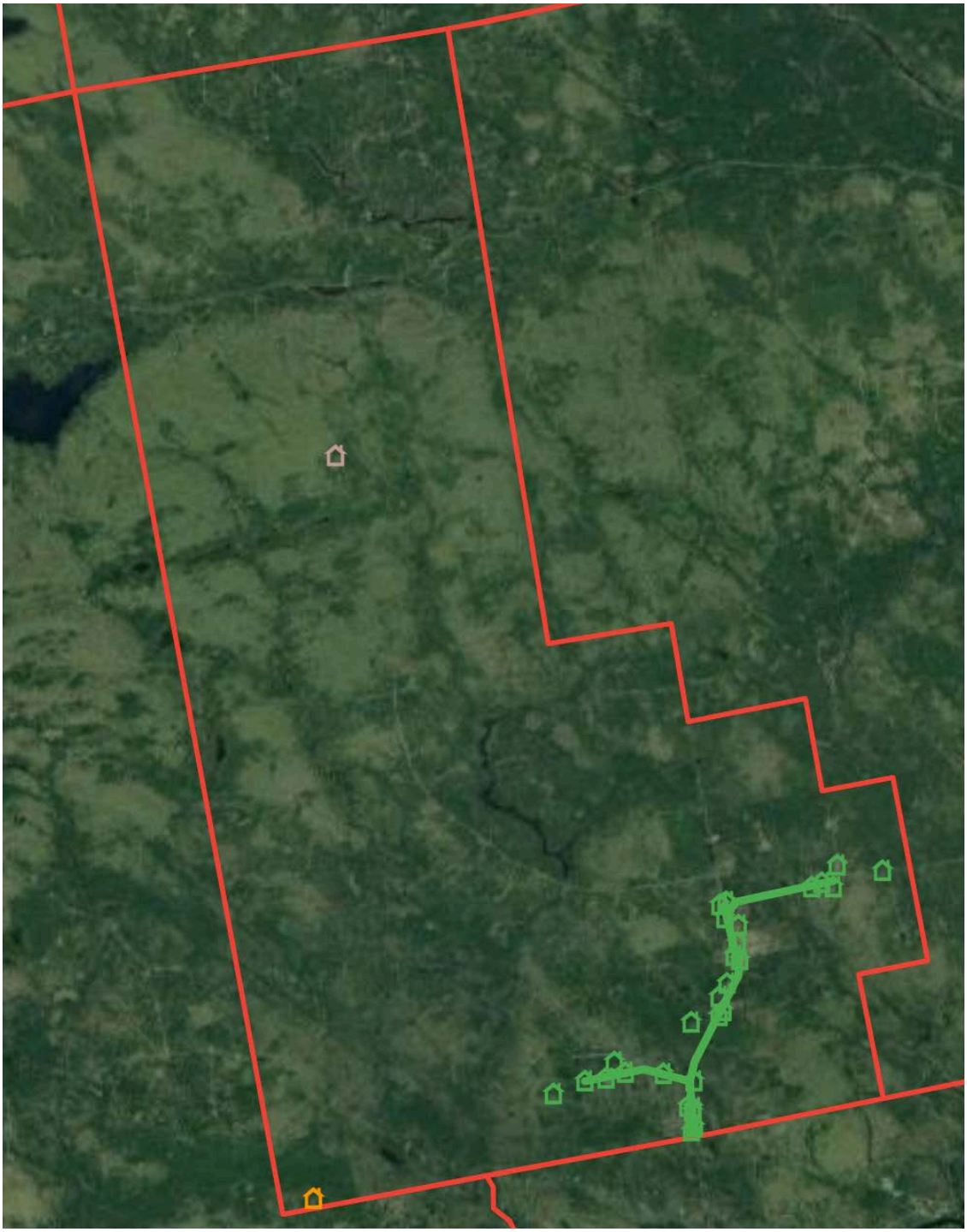
Barnard Township



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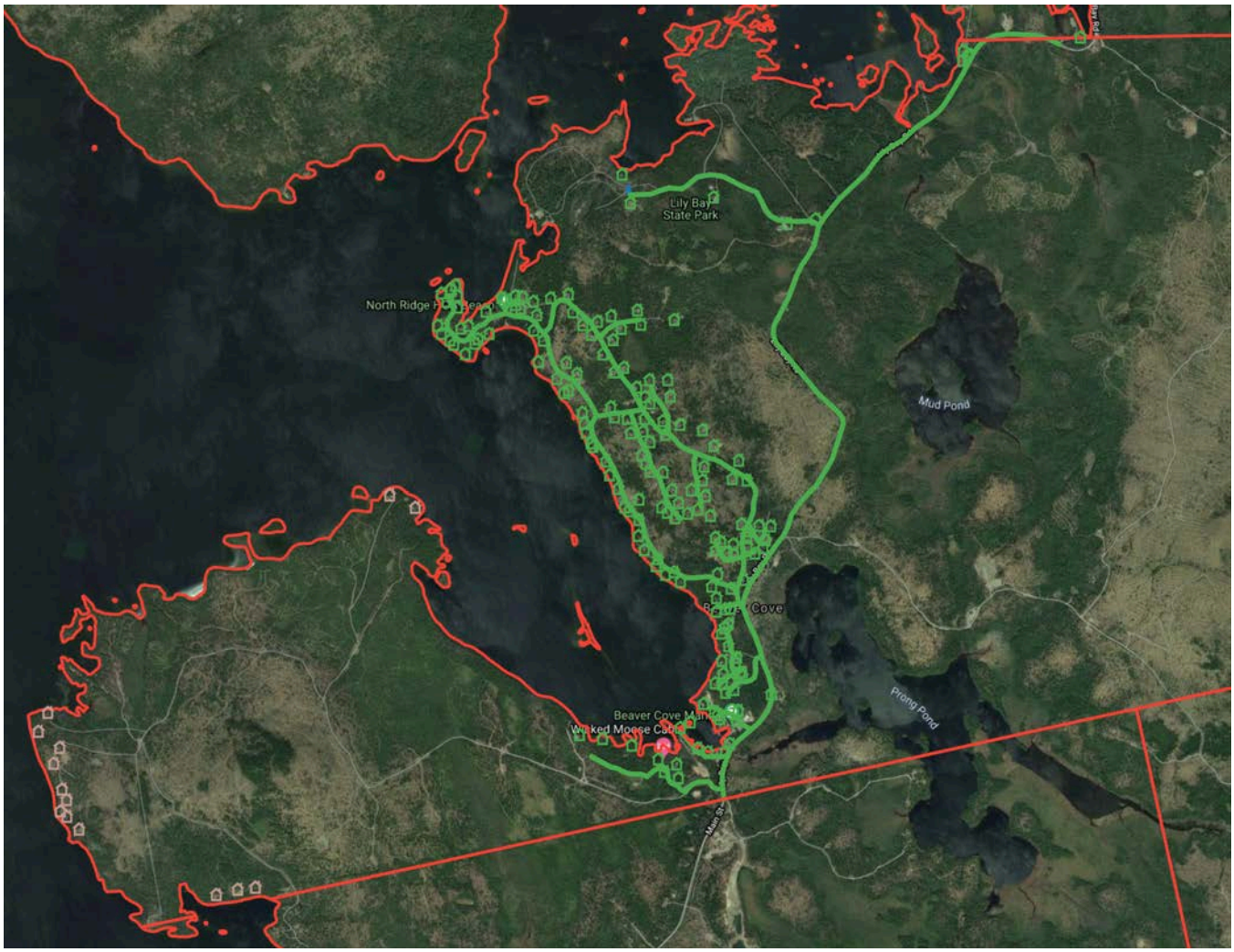
Beaver Cove



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Big Moose Township

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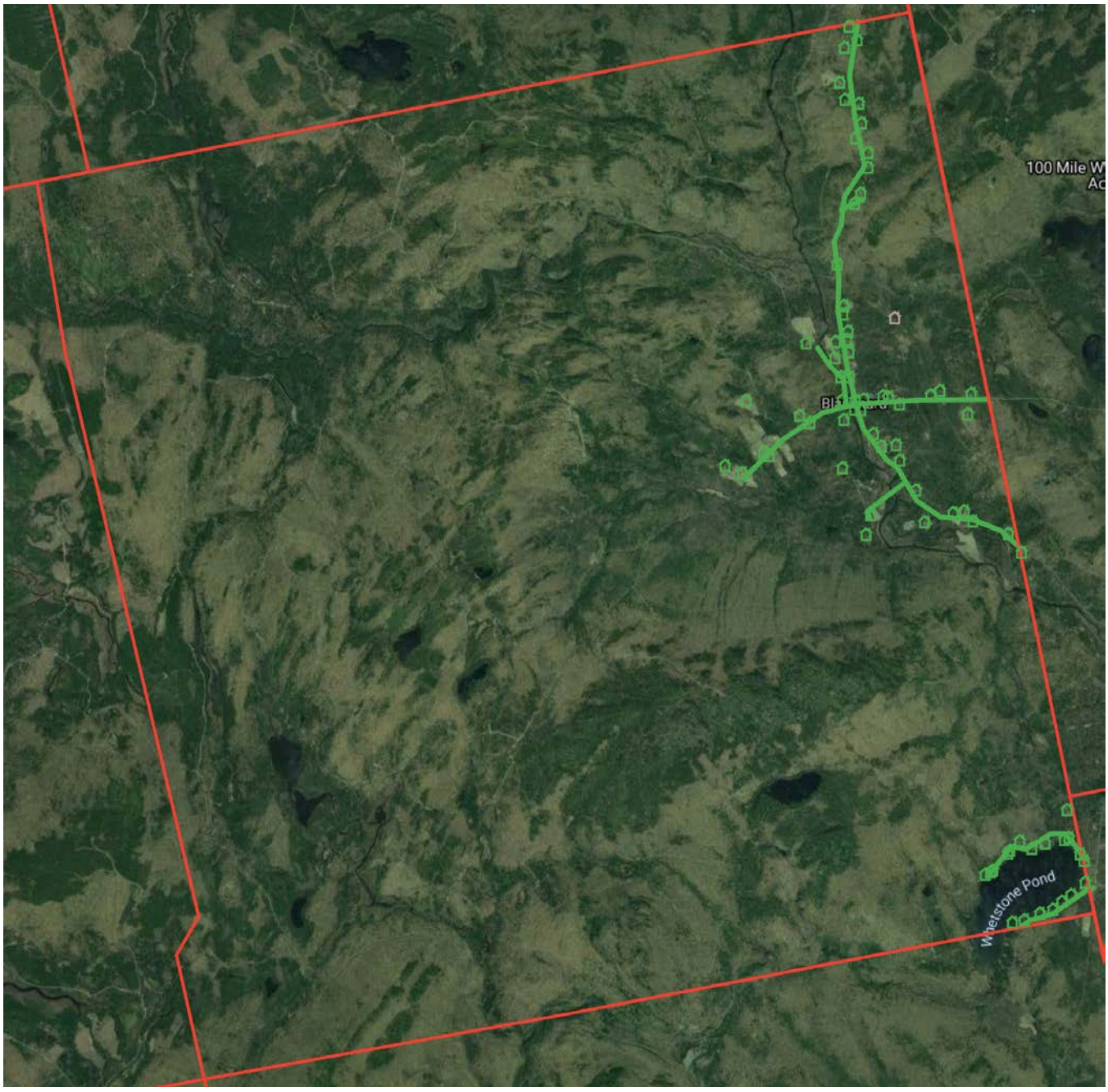
Blanchard Township



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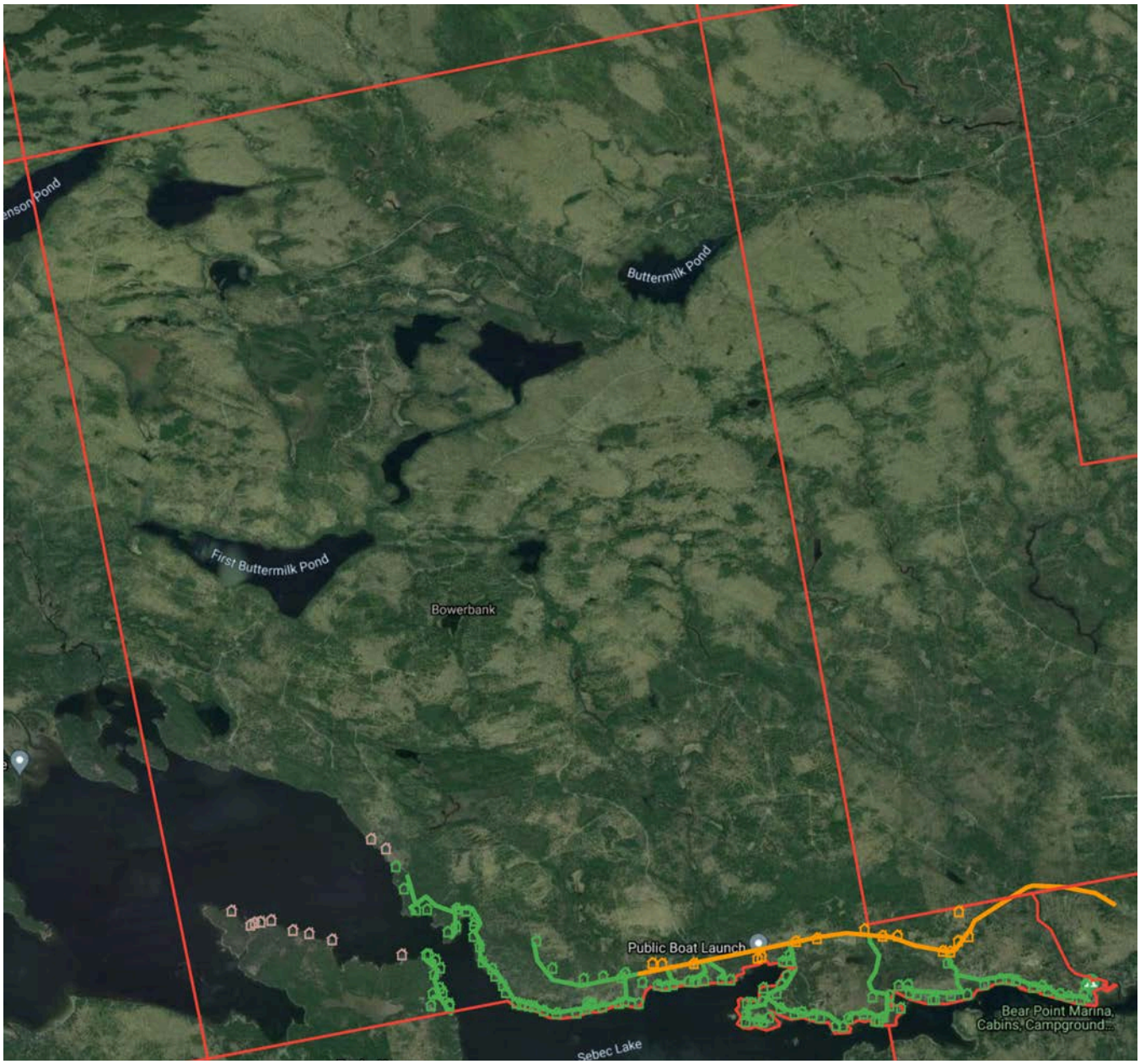
Bowerbank



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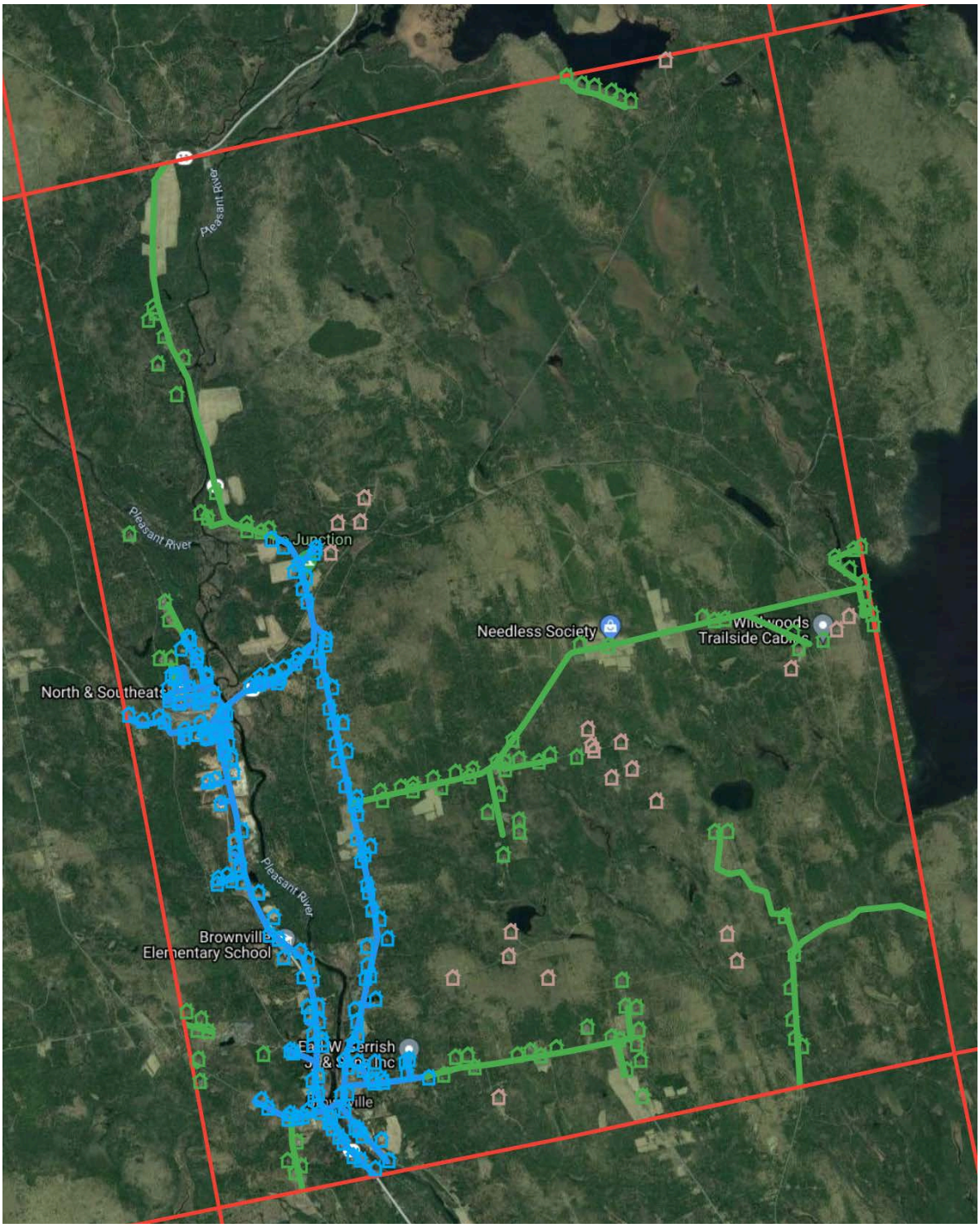
Brownville



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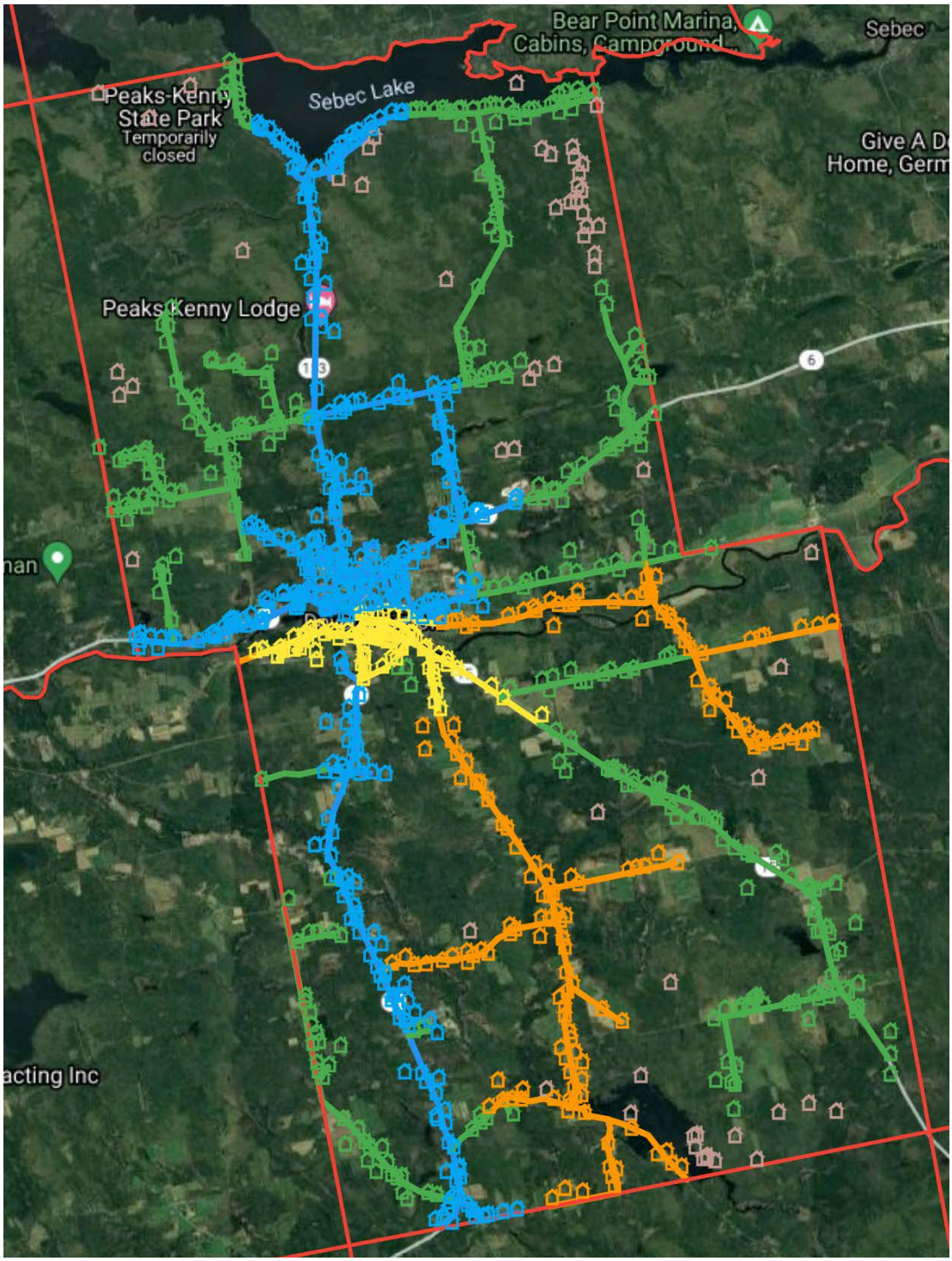
Dover-Foxcroft



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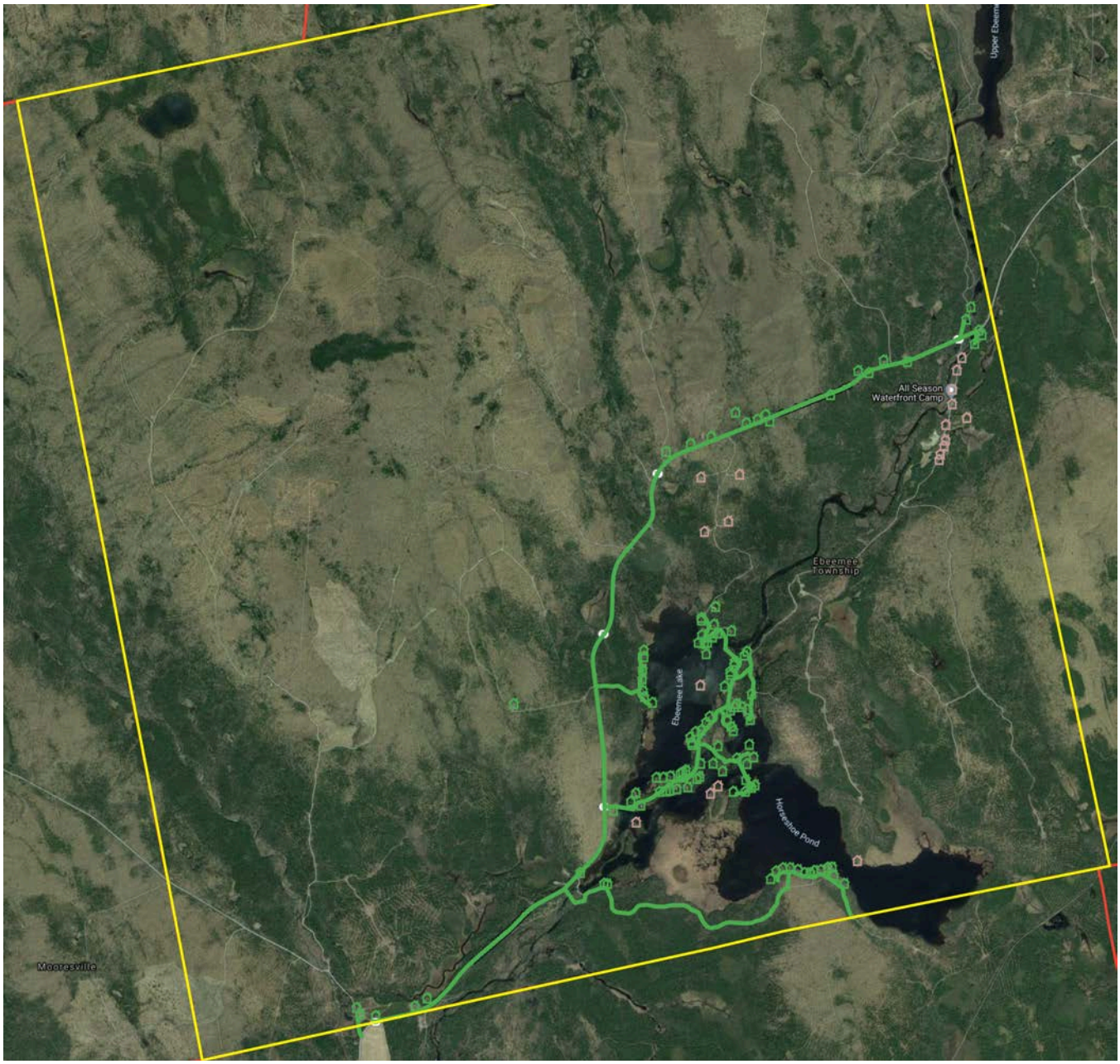
Ebeemee Township



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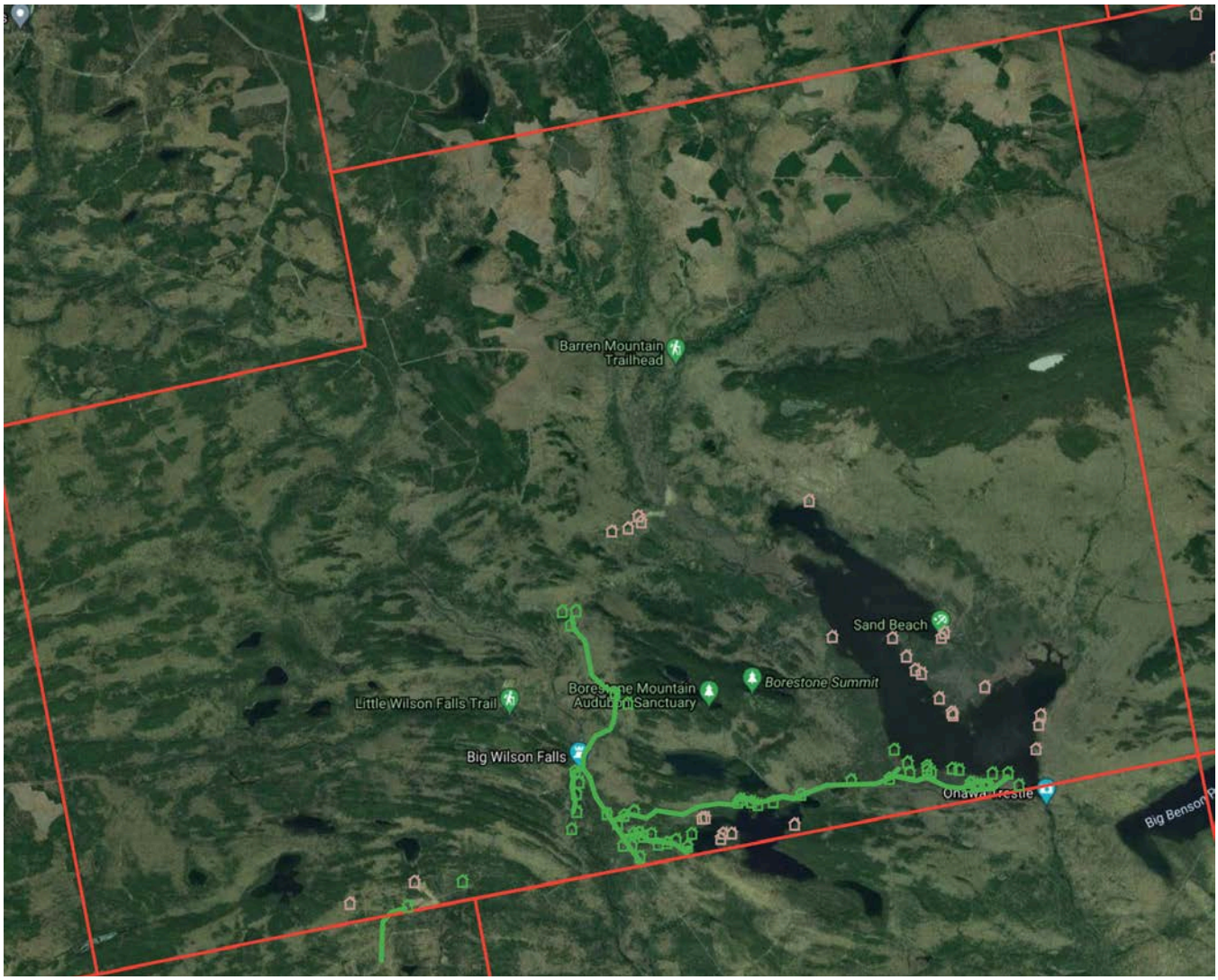
Elliottsville Township



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Frenchtown Township

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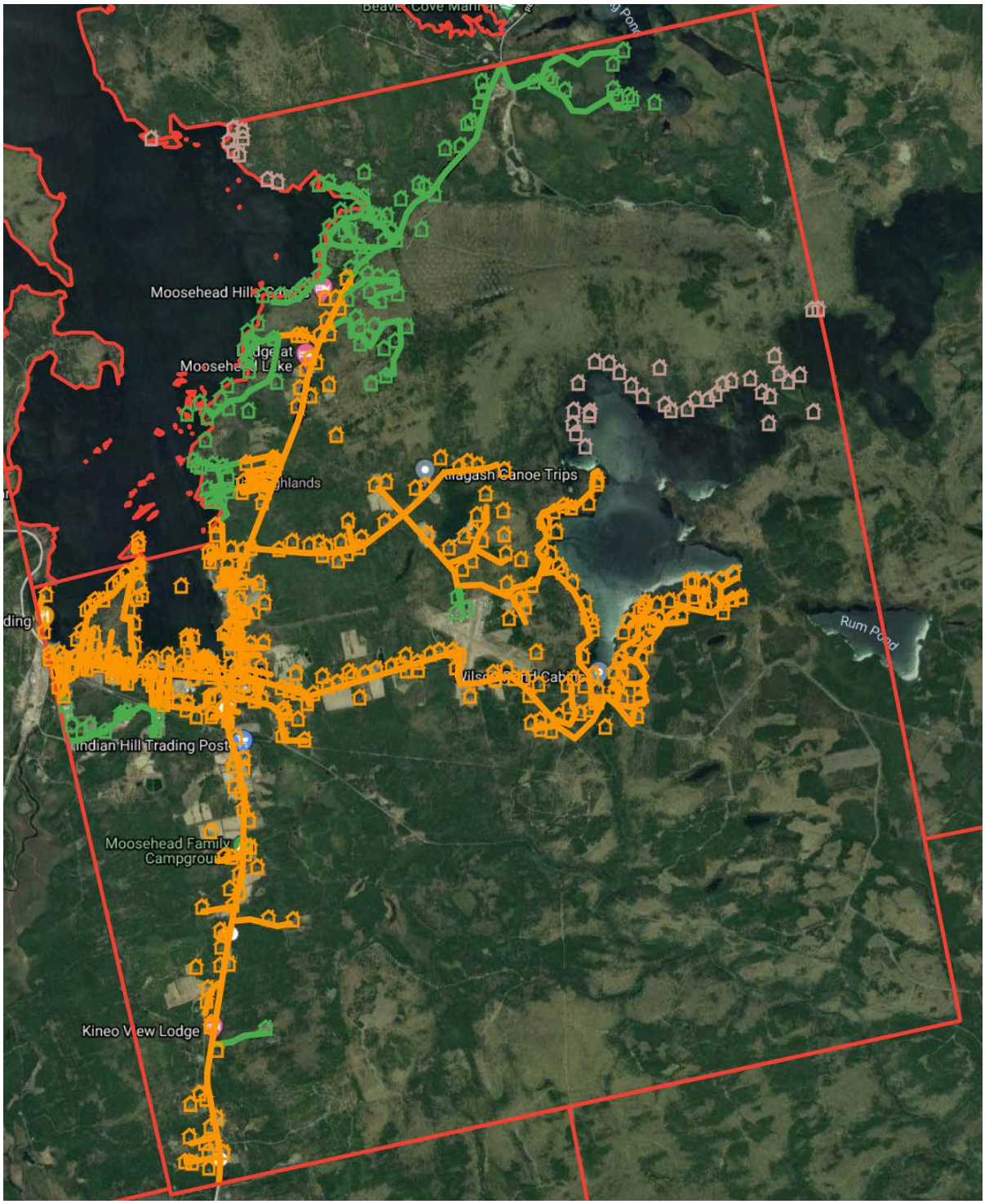
Greenville



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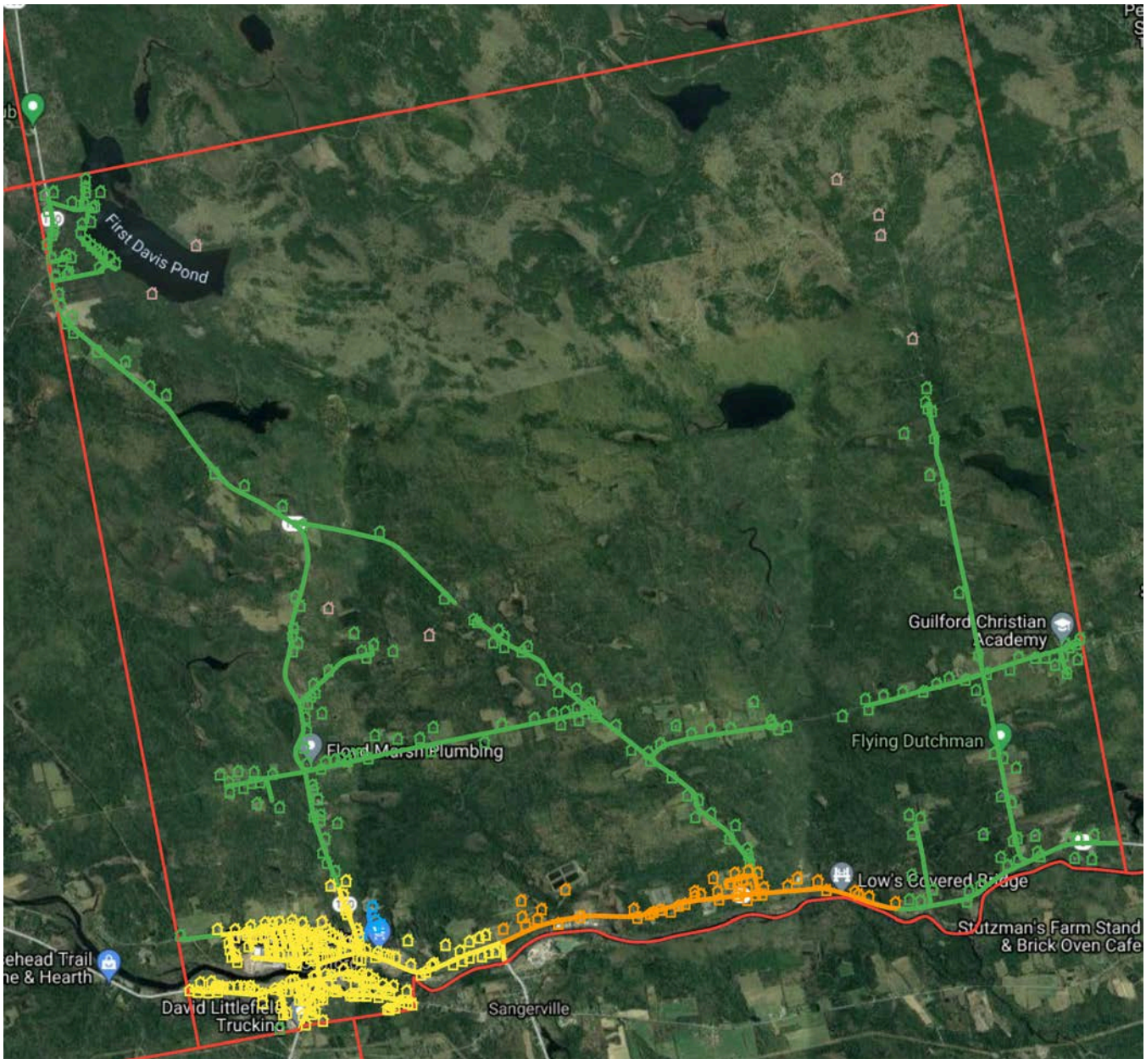
Guilford



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Harfords Point

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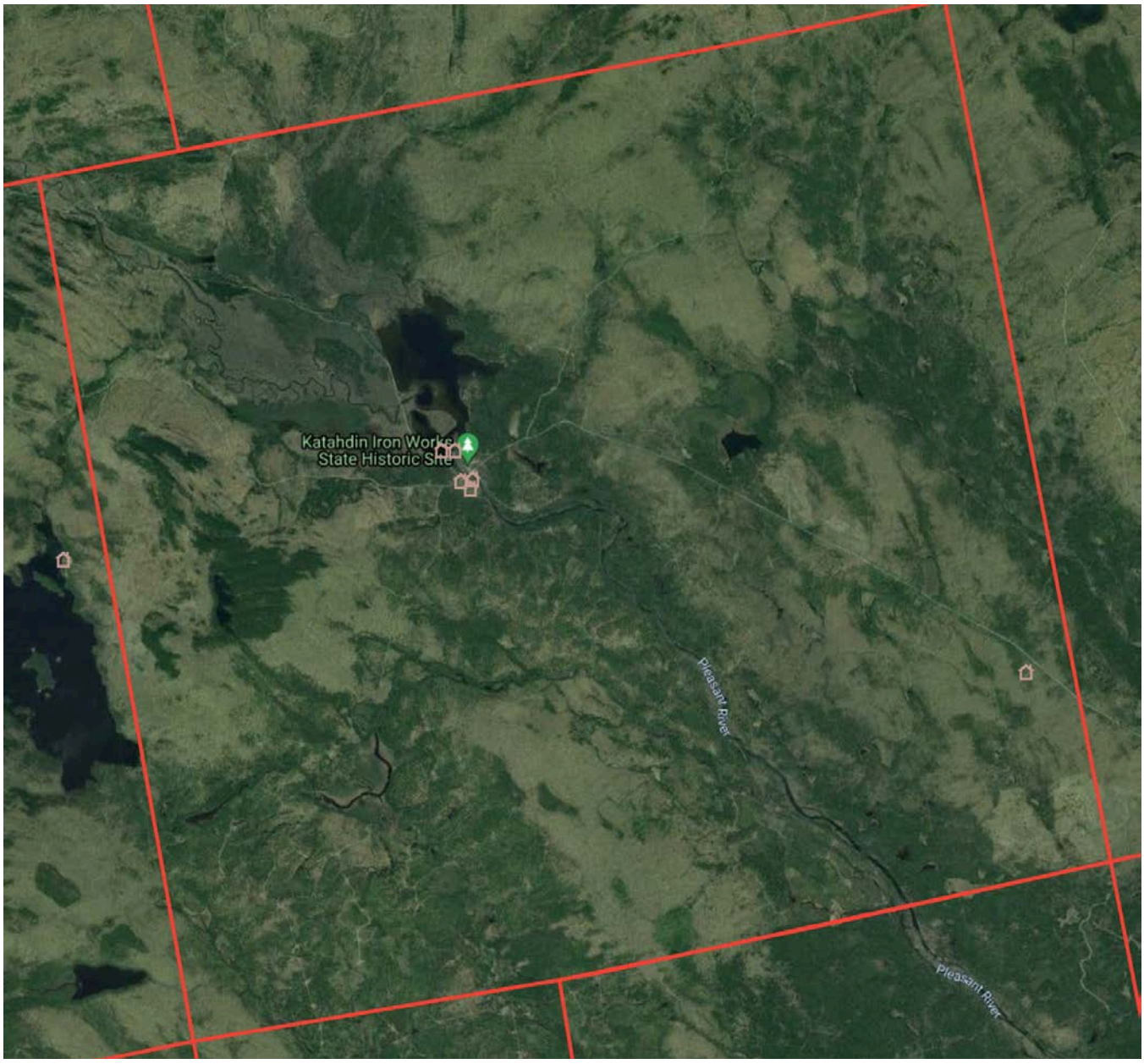
Katahdin Iron Works Township



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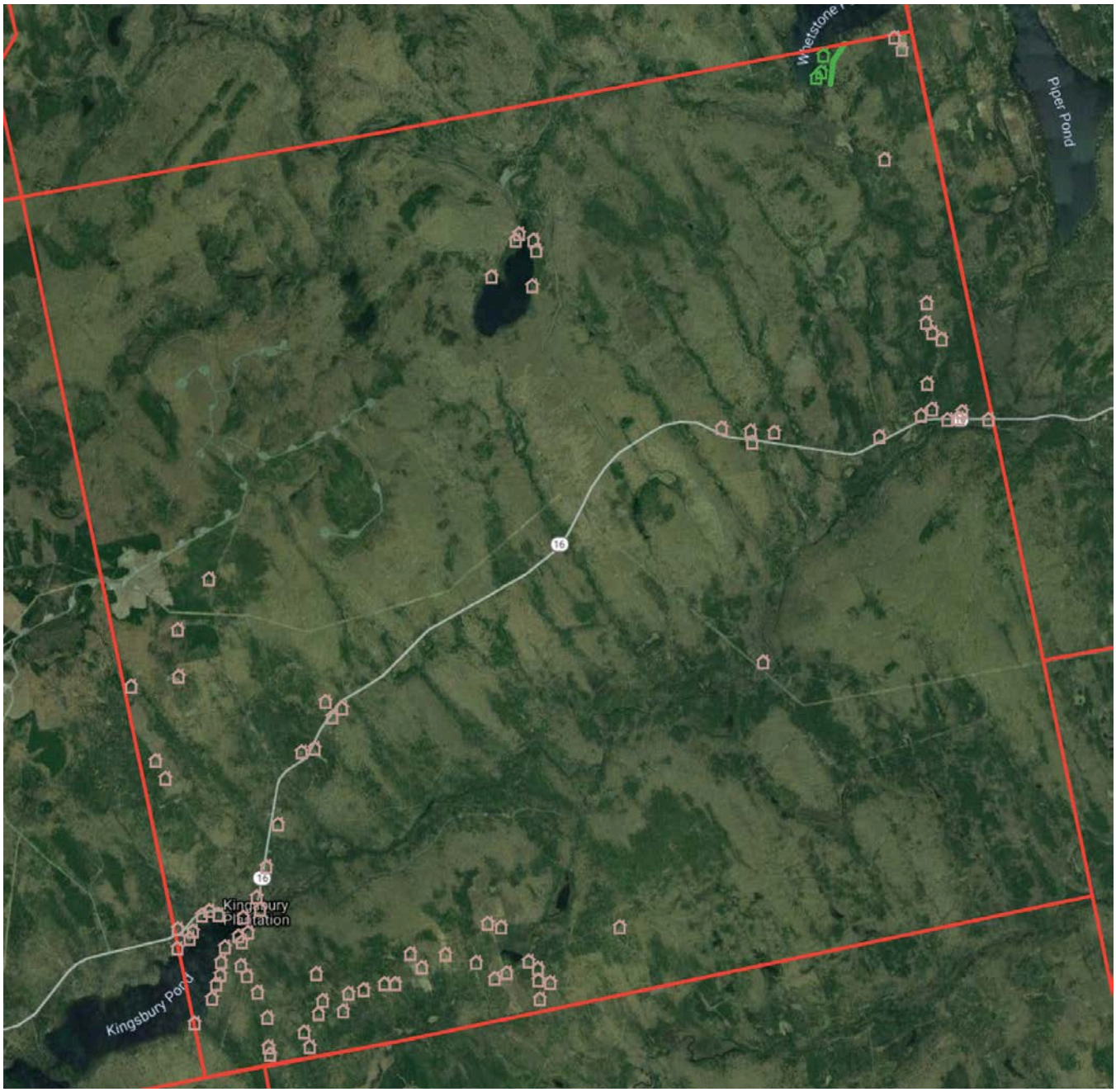
Kingsbury Plantation



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Lake View Plantation

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Lily Bay Township

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Medford

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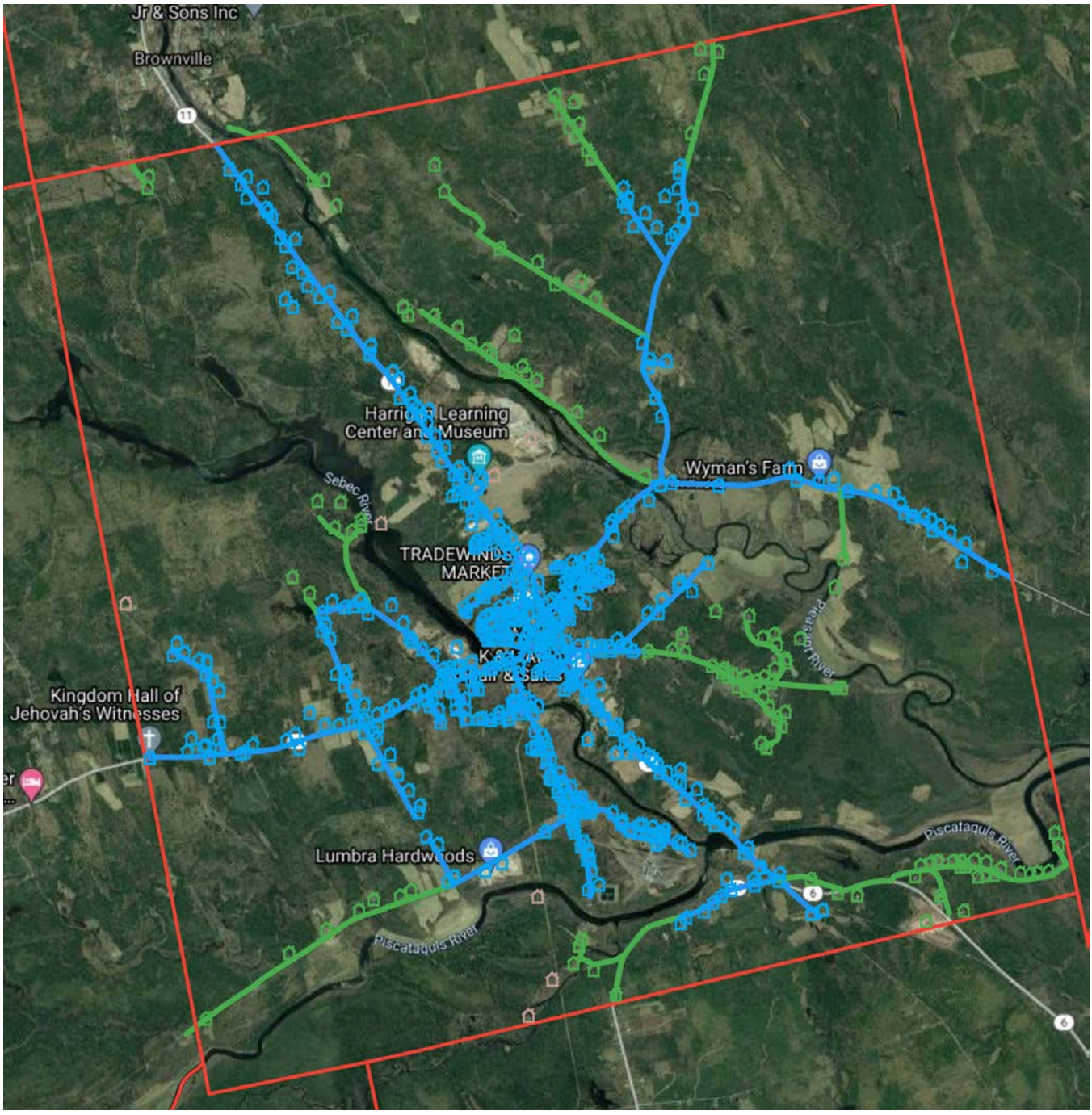
Milo



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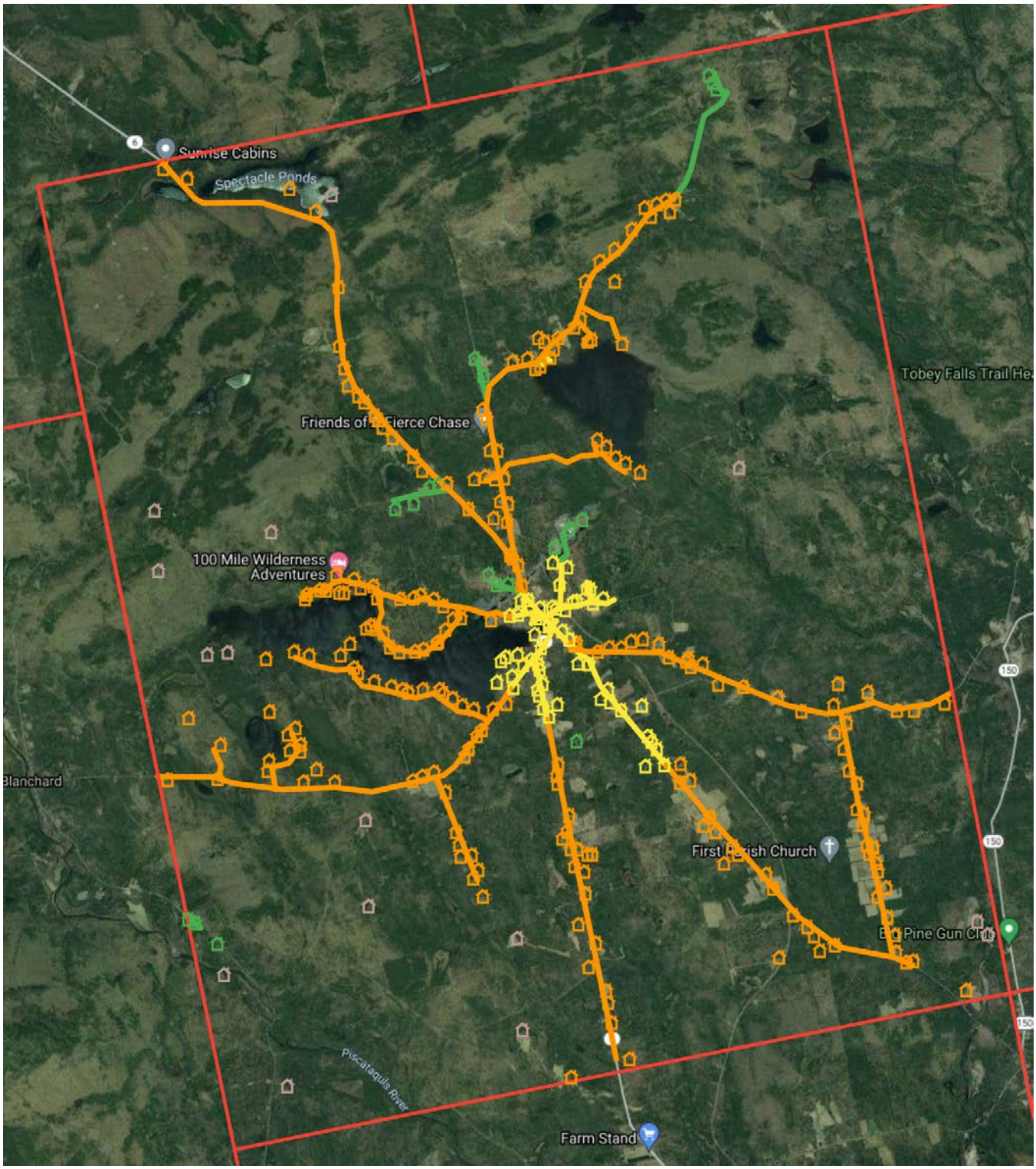
Monson



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Moosehead Junction

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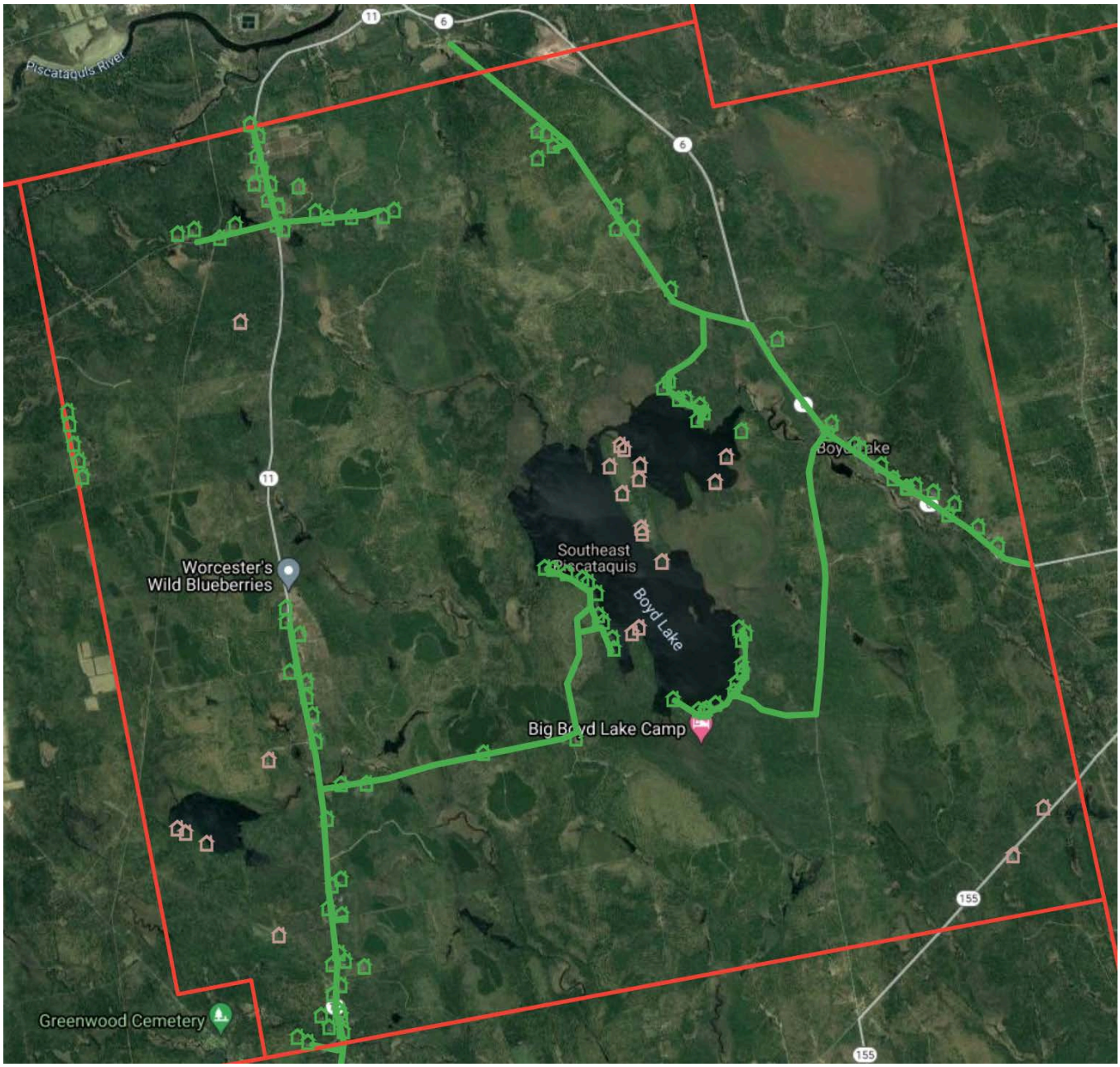
Orneville Township



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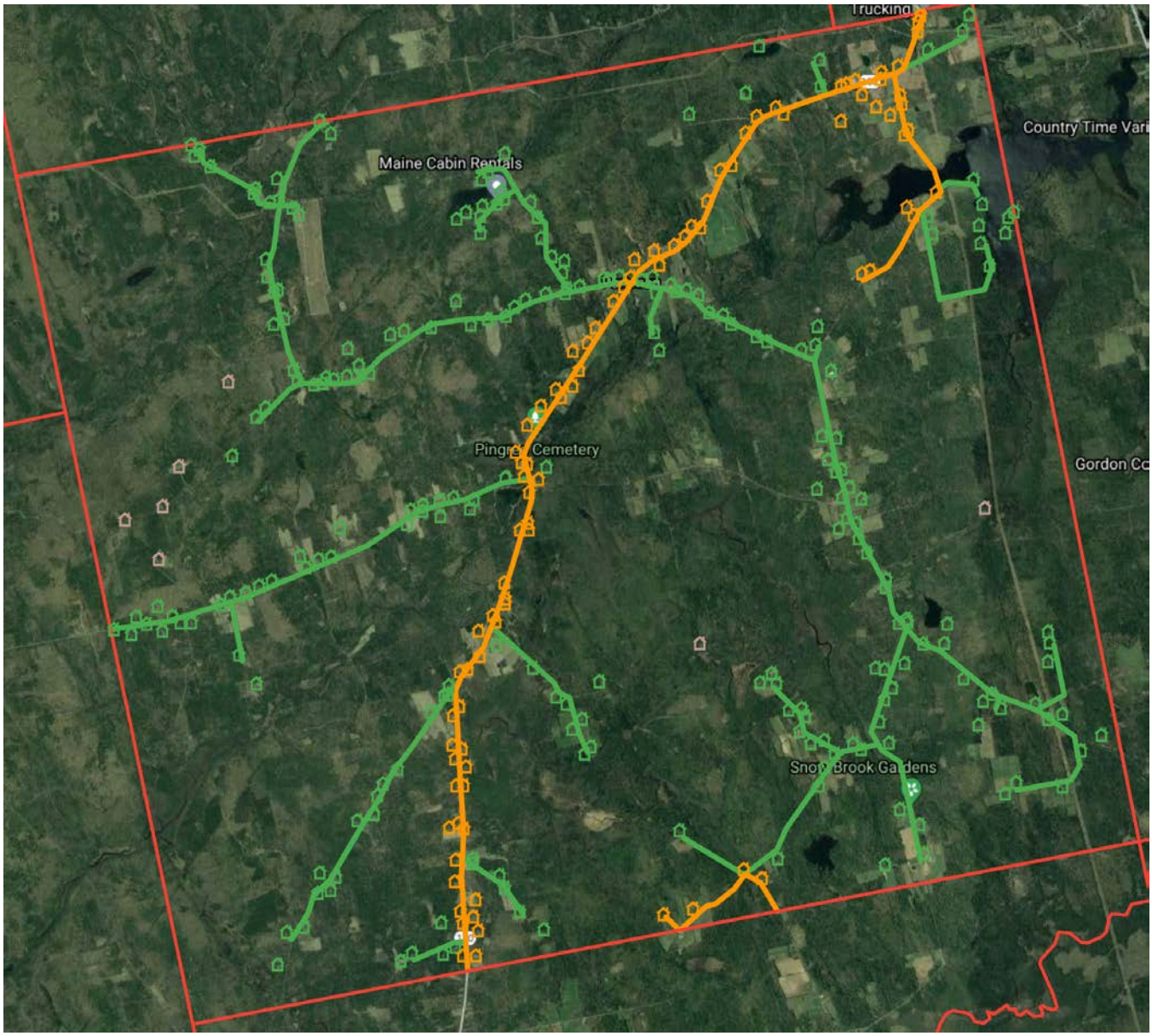
Parkman



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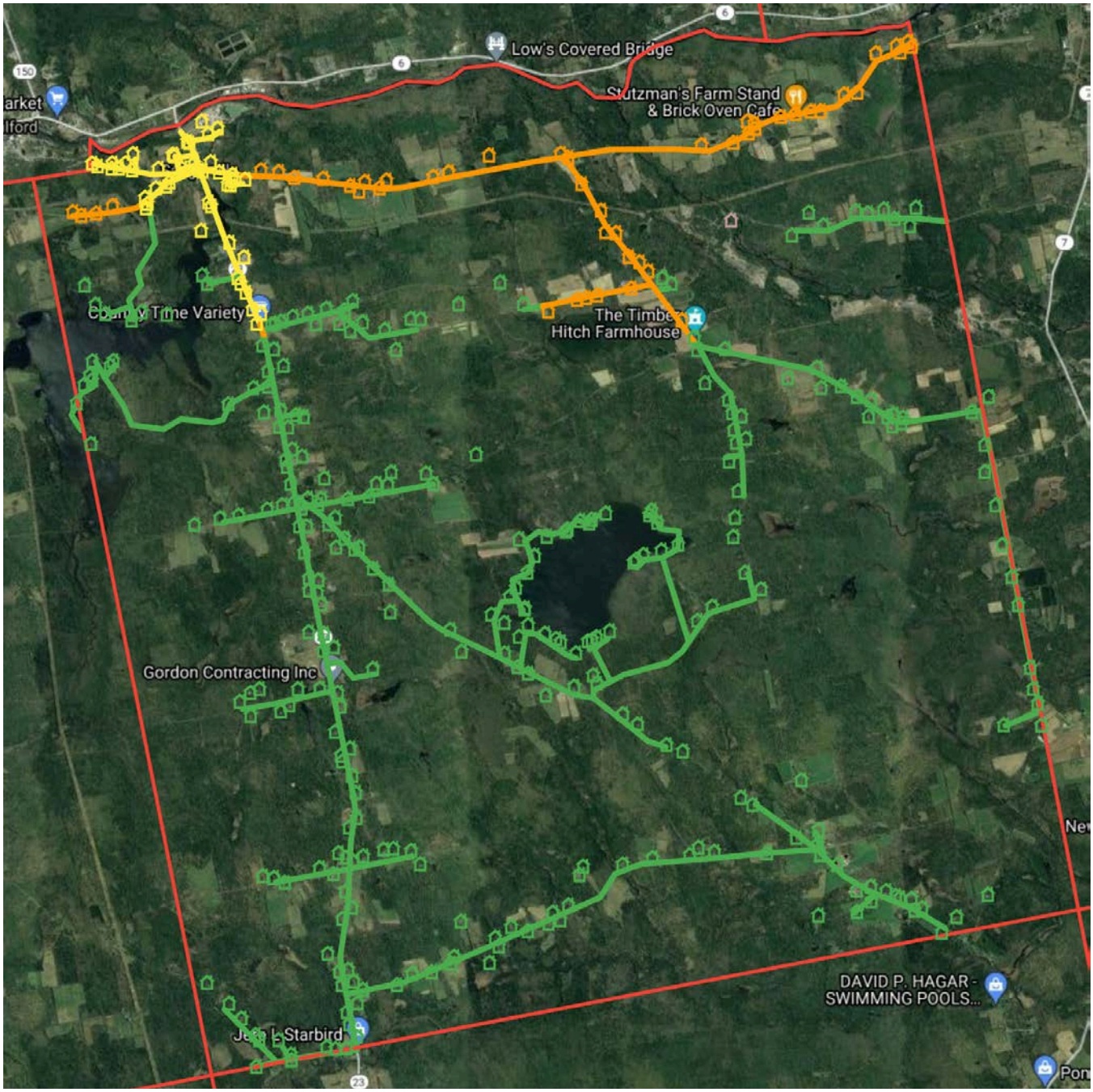
Sangerville



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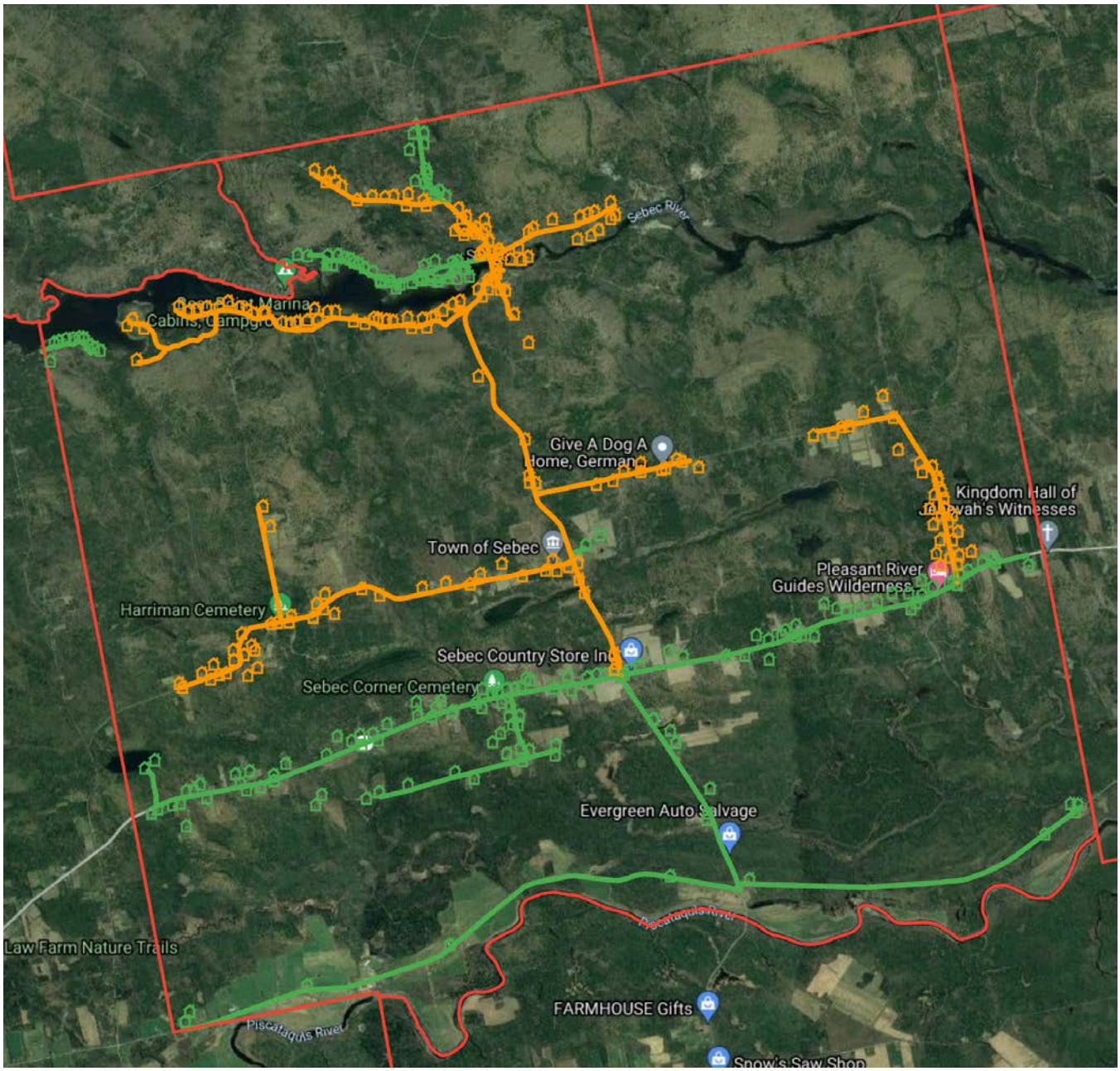
Sebec



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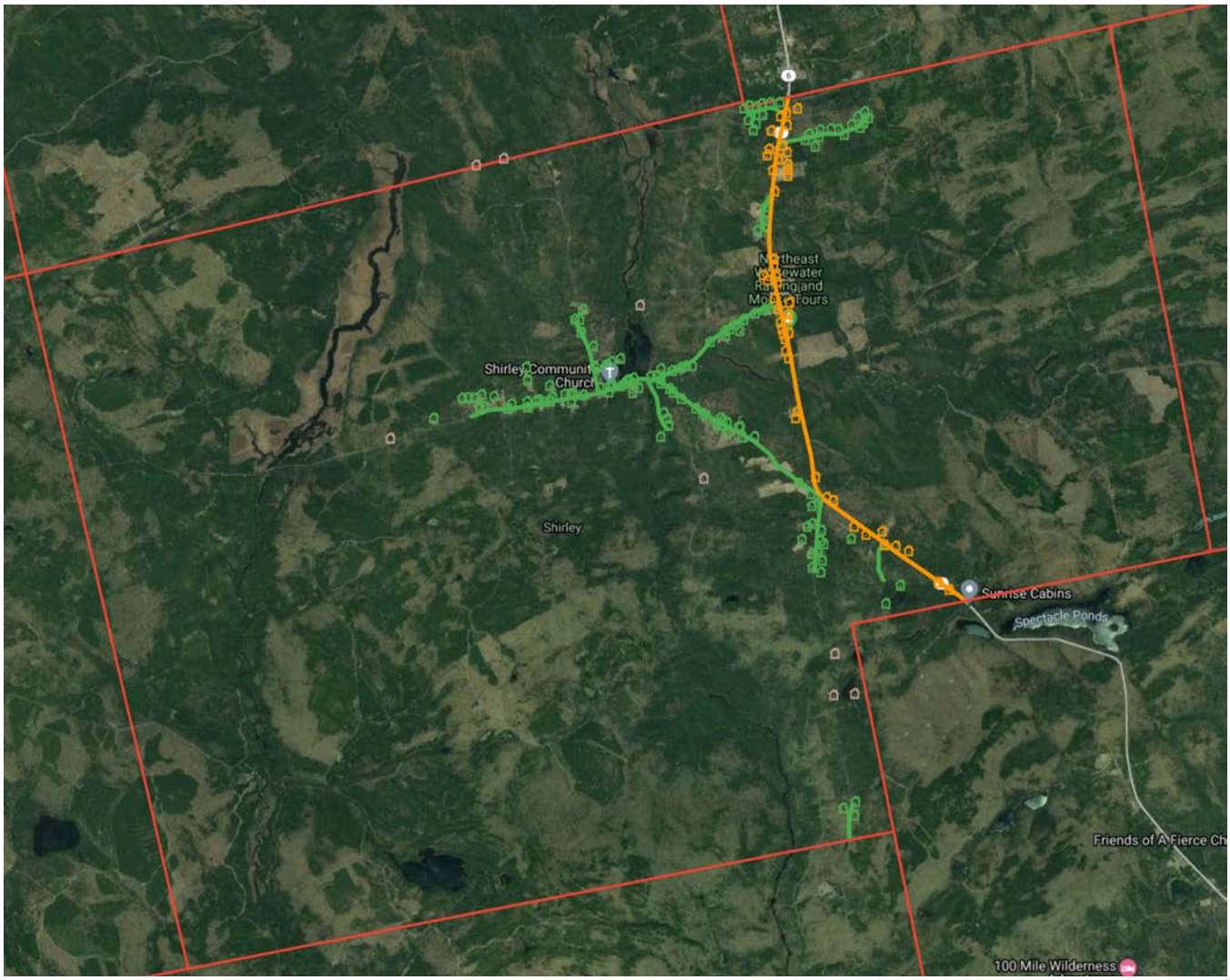
Shirley



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T4 R9 NWP

Map Key	
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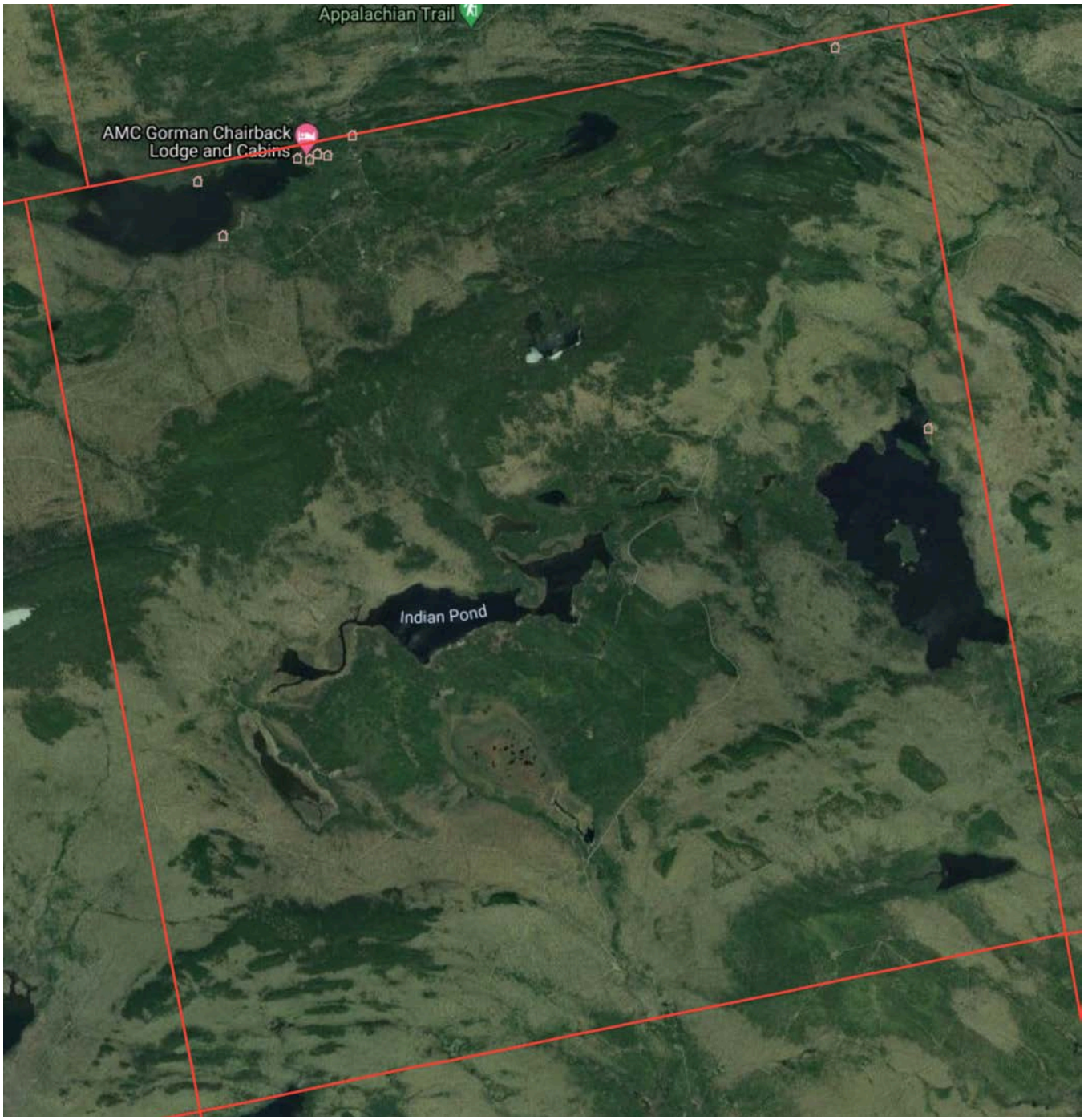
Yellow	Fiber-to-the-Home (FTTH) & Cable Tvo (CATV)
Blue	Cable TV (CATV)
Green	Uncabled *(DSL service only)*
Pink	Off-Grid or Too Remote

T7 R9 NWP



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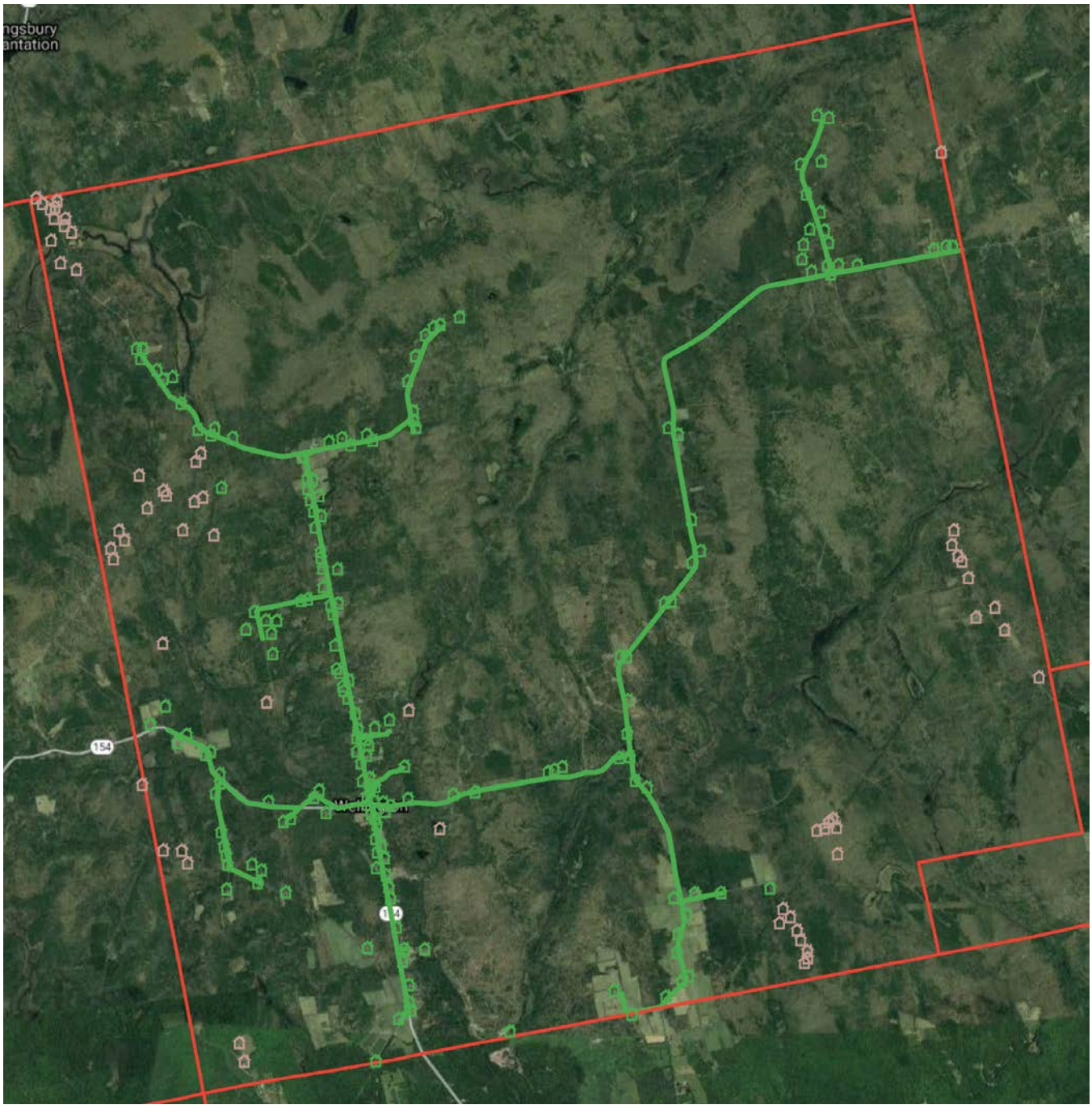
Wellington



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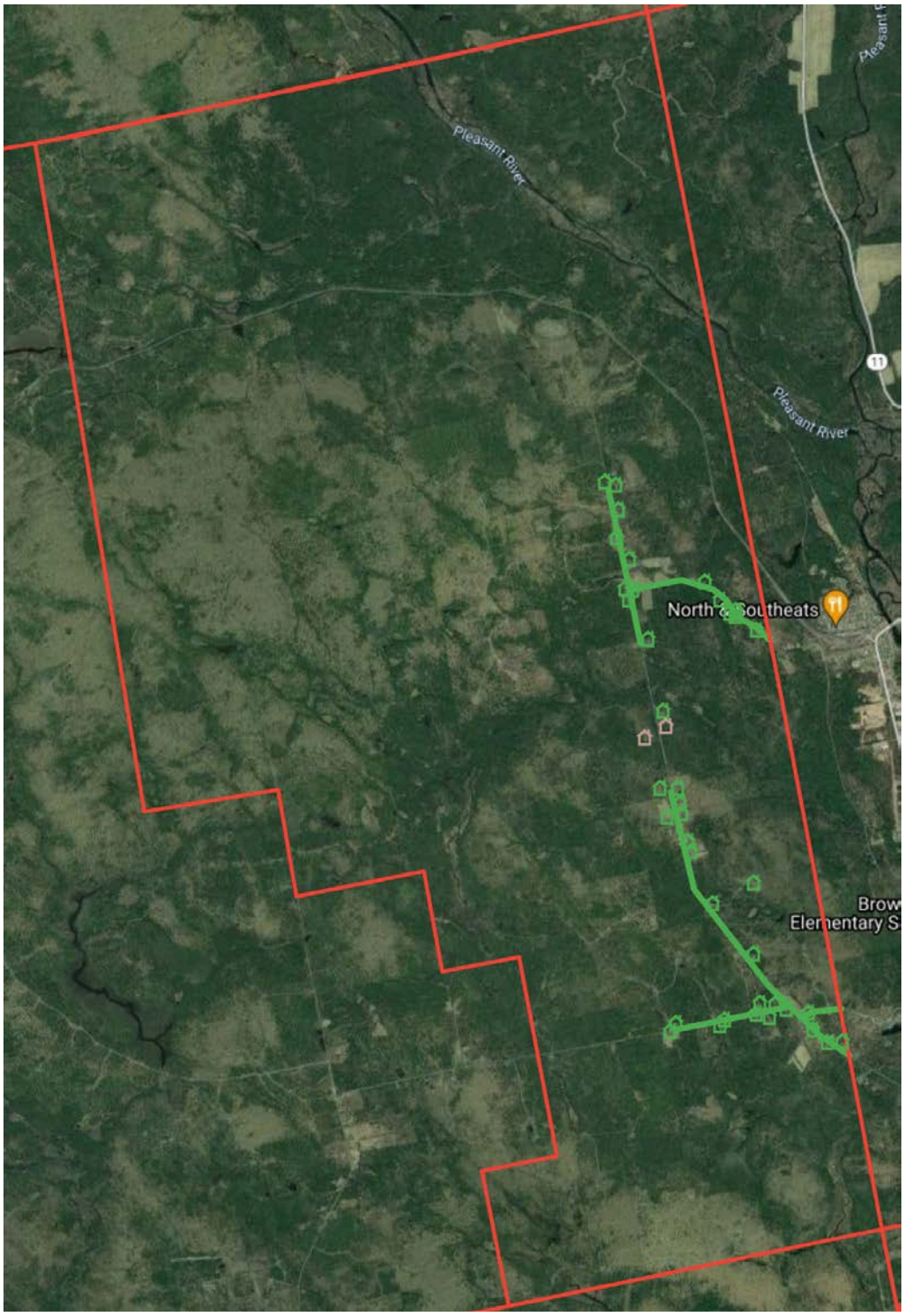
Williamsburg Twp



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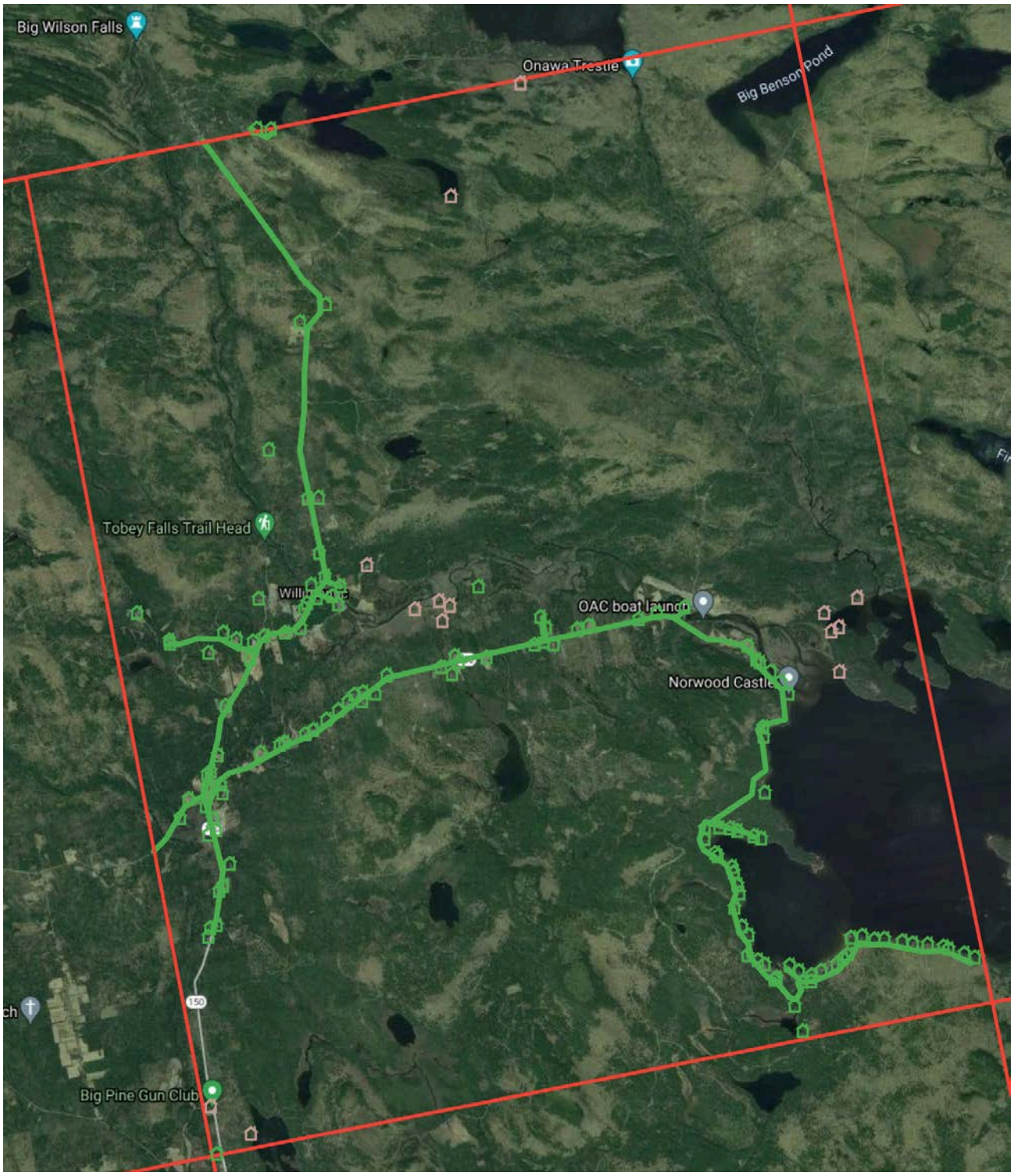
Willimantic



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