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RF Report

Proposed Wireless Facility
101 Red Brook Road
Mashpee, MA 02649

The Verizon logo, consisting of the word 'verizon' in a bold, black, sans-serif font, with a red checkmark symbol integrated into the end of the word.

April 3, 2018

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1. Overview

This RF Report has been prepared on behalf of Verizon Wireless in support of Blue Sky Towers, LLC's application to the Town of Mashpee and Cape Cod Commission for the installation and operation of a wireless facility located at 101 Red Brook Road in Mashpee, MA. Verizon Wireless' component of the proposed facility consists of ground based equipment cabinets along with antennas and associated equipment mounted on the proposed 150' monopole tower.

This report concludes that the proposed site will fill in coverage gaps and provide additional capacity to southern Mashpee in order to improve deficient service areas along Red Brook Road, Great Oak Road/Great Neck Road S, Monomoscoy Road, Rock Landing Road, and the surrounding areas in the proximity of the proposed site including the communities of New Seabury and Seabrook.

Included in this report is: a brief summary of the site's objectives, maps showing Verizon Wireless' current network plan, and predicted Radio Frequency coverage of the subject site and the surrounding sites in Verizon Wireless' network.

2. Introduction

Verizon Wireless provides digital voice and data communications services using 3rd Generation (3G) CDMA/EVDO technology in the Cellular (800 MHz) and PCS (1900 MHz) frequency bands, and is in the midst of deploying advanced 4th Generation (4G) voice and data services over LTE technology in the 700 MHz, PCS, and AWS (2100 MHz) frequency bands as allocated by the FCC. These networks are used by mobile devices for fast web browsing, media streaming, and other applications that require broadband connections. The mobile devices that benefit from these advanced networks are not limited to basic handheld phones, but also include devices such as smartphones, PDA's, tablets, and laptop air-cards. With the evolving rollout of 4G LTE services and devices, Verizon Wireless customers will have even faster connections to people, information, and entertainment.

As explained within this report, Verizon Wireless has identified the need to add a new facility to its existing network of sites in the area to improve coverage and capacity to a significant gap in service that now exists in southern Mashpee, in order to support reliable communications and meet the growing demand in the area.

To maintain a reliable and robust communications system for the individuals, businesses, public safety workers and others who use its network, Verizon Wireless deploys a network of cell sites (also called wireless communications facilities) throughout the areas in which it is licensed to provide service. These cell sites consist of antennas mounted on structures, such as buildings and towers, supported by radio and power equipment. The receivers and transmitters at each of these sites process signals within a limited geographic area known as a "cell."

Mobile subscriber handsets and wireless devices operate by transmitting and receiving low power radio frequency signals to and from these cell sites. Handset signals that reach the cell site are transferred through land lines (or other means of backhaul transport) and routed to their destinations by sophisticated electronic equipment. In order for Verizon Wireless' network to function effectively, there must be adequate overlapping coverage between the "serving cell" and adjoining cells. This not only allows a user to access the network initially, but also allows for the

transfer or “hand-off” of calls and data transmissions from one cell to another, and prevents unintended disconnections or “dropped calls.”

Verizon Wireless’ antennas also must be located high enough above ground level to allow transmission (a.k.a. propagation) of the radio frequency signals above trees, buildings, and other natural or man-made structures that may obstruct or diminish the signals. Areas without adequate radio frequency coverage have substandard service, characterized by dropped and blocked calls, slow data connections, or no wireless service at all, and are commonly referred to as coverage gaps.

The size of the area potentially served by each cell site depends on several factors including the number of antennas used, the height at which the antennas are deployed, the topography of the surrounding land, vegetative cover, and natural or man-made obstructions in the area. The actual service area at any given time also depends on the number of customers who are on the network in range of that cell site. As customers move throughout the service area, the transmission from the phone or other device is automatically transferred to the Verizon Wireless facility with the best reception, without interruption in service, provided that there is overlapping coverage between the cells.

Each cell site must be primarily designed to strike a balance between the overall geographic coverage area it will serve, and the site’s capacity to support the usage within the coverage footprint. In rural areas, cell sites are generally designed to have broader coverage footprints because the potential traffic is sparser and distributed over a larger area. In more densely populated suburban and urban environments, the capacity to handle calls and data transmissions is of increasing concern, and cell sites must limit their coverage footprint to an area where the offered network traffic can be supported by the radio equipment and resources. Due to the aggressive historical and projected growth of mobile usage, particularly for mobile data (42% in 2016-2017, 35% CAGR 2016-2021 in North America)¹, instances arise where the usage demand can no longer be supported by the site(s) serving an area, and new facilities must be integrated to provide capacity relief to the overloaded sites.

We have concluded that by utilizing the proposed wireless communication facility at 101 Red Brook Road at an antenna centerline height of 146’ AGL (above ground level), Verizon Wireless will be able to provide substantial coverage to a gap that it now experiences, and provide improved coverage and capacity to residents, businesses, and traffic corridors within southern Mashpee that are currently located within deficient service areas of Verizon Wireless’ network.

¹ “Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update, 2016-2021”, February 7, 2017, Cisco Systems, Inc. <http://www.cisco.com/c/en/us/solutions/collateral/service-provider/visual-networking-index-vni/mobile-white-paper-c11-520862.html>

3. The Proposed Facility

In reference to the plans² submitted with the Blue Sky Tower Partners application, Verizon Wireless' proposal would consist principally of the following elements:

- 1) A 12'-0" x 30'-0" equipment lease area with telecommunication equipment cabinets, a back-up power generator, and telco/power/fiber connections, all on a concrete pad within Blue Sky Towers, LLC's, proposed 70'-0" x 70'-0" fenced compound;
- 2) A propane tank, located on a proposed 4'-0" x 10'-0" concrete pad within the fenced compound;
- 3) Twelve (12) panel antennas (four per sector) mounted on the proposed 150' monopole tower, at a centerline elevation of 146' AGL;
- 4) Remote Radio Heads (RRH) with accessory junction boxes and surge suppressors mounted alongside the antennas;
- 5) An ice bridge from the proposed equipment lease area to the proposed monopole to protect cabling between Verizon Wireless' equipment and the cable entry port located near the base of the monopole.

² ProTerra Design Group, LLC's site drawings dated 9/27/2017.

4. Coverage and Capacity Objectives

As mentioned above, Verizon Wireless is in the process of rolling out its 4G LTE high-speed wireless broadband system in the 700 MHz, PCS, and AWS frequency bands, in accordance with its licenses from the FCC. In order to expand and enhance their wireless services throughout New England, Verizon Wireless must fill in existing coverage gaps and address capacity, interference, and high-speed broadband issues. As part of this effort, Verizon Wireless has determined that significant gaps in service exist in and around sections of the Town of Mashpee, MA, as described further below.

Verizon Wireless currently operates wireless facilities similar to the proposed facility within Mashpee and the surrounding cities/towns. Due in large part to the distances between the existing sites, the intervening topography, and volume of user traffic in the area, these existing facilities are unable to provide sufficient coverage to portions of Mashpee. Specifically, Verizon Wireless determined that much of southern Mashpee is without reliable service in the following areas and town roads³, including but not limited to:

- Red Brook Road;
 - Serves ~ 2,500 vehicles per day, as measured at the Mashpee/Falmouth town line (2016);
- Great Oak Road;
 - Serves ~ 3,700 vehicles per day, as measured south of Red Brook Road (2005);
- Great Neck Road S, south of Blue Castle Drive;
 - Serves ~ 5,000 vehicles per day, as measured north of Red Brook Road (2016);
- Monomoscoy Road;
- Rock Landing Road;
- The surrounding roads and neighborhoods, including the communities of New Seabury and Seabrook.

The proposed site located at 101 Red Brook Road (“New Seabury”) is needed to fill in these targeted gaps in service, in order to improve network quality and reliability for Verizon Wireless subscribers traveling along these roads, as well as to the numerous residents, businesses, and visitors in this area.

³ Traffic counts are sourced from the Massachusetts Department of Transportation, Transportation Data Management System.

5. Site Search and Selection Process

To find a site that provides acceptable service, adequate capacity, and fills the gaps in coverage, computer modeling software is used to define a search area. The search ring identifies the area within which a site could be located (assuming sufficient height is considered) that would have a high probability of addressing the significant coverage gap and/or meeting the capacity objectives established by the Verizon Wireless RF (Radio Frequency) engineers.

Once a search ring is determined, Verizon Wireless' real estate specialists search within the proximity of the defined area for existing buildings, towers, and other structures of sufficient height that would meet the defined objectives. If none are found, then the focus shifts to "raw land" sites. A suitable site must satisfy the technical requirements identified by the RF engineers, must be available for lease, and must have access to a road and be otherwise suitable for constructing a cell site of the required size and height. Every effort is made to use existing structures before pursuing a "raw land" build to minimize the number of new towers throughout the towns being served.

After the search of the area had been completed, Verizon Wireless determined that there are no existing structures suitable for a wireless installation, and that collocating on the planned wireless communications facility at 101 Red Brook Road is the most appropriate solution to address the targeted coverage and capacity objectives with respect to its network requirements.

6. Pertinent Site Data

Table 1 below details the site-specific information for the on-air, approved, and proposed Verizon Wireless sites used to perform the coverage analysis and generate the coverage plots provided herein.

Site Name	Address	City/State	Location		Structure Type	Antenna Height (ft AGL)	Status
			Latitude	Longitude			
Barnstable West	215 Old Falmouth Road	Barnstable, MA	41.6592	-70.4001	Monopole	140	On-Air
Marstons Mills	84 Industry Road	Barnstable, MA	41.6498	-70.4241	Stealth Pole	65	On-Air
Osterville	1138 Maine Street	Barnstable, MA	41.6382	-70.3908	Monopole	147	On-Air
Cataumet	Scraggy Neck Road	Bourne, MA	41.6654	-70.6046	Lattice	115	On-Air
E Falmouth	966 East Falmouth Highway	Falmouth, MA	41.5817	-70.5392	Monopole	70	On-Air
Falmouth	Thomas B Landers Road	Falmouth, MA	41.6145	-70.6086	Lattice	177	On-Air
Falmouth 2	250 Currier Road	Falmouth, MA	41.6154	-70.5387	Monopole	140	On-Air
Falmouth 3	132 East Falmouth Highway	Falmouth, MA	41.5792	-70.5685	Lattice	86	Approved
Falmouth 4	284 Old Meeting House Road	Falmouth, MA	41.5944	-70.5664	Monopole	146	On-Air
Falmouth 6	60 Spring Bar Road	Falmouth, MA	41.5589	-70.5954	Guyed	120	On-Air
Falmouth Ctr	400 Main Street	Falmouth, MA	41.5524	-70.6115	Lattice	102	On-Air
Falmouth N	210 Nathan Ellis Highway	Falmouth, MA	41.6424	-70.5979	Monopole	177	On-Air
W Falmouth	274 Blacksmith Shop Road	Falmouth, MA	41.6029	-70.6159	Guyed	150	On-Air
Mashpee	Bowdoin Road	Mashpee, MA	41.6305	-70.4615	Lattice	116	On-Air
Mashpee 2	54 Echo Road	Mashpee, MA	41.6567	-70.4975	Monopole	138	On-Air
Mashpee S	154 Industrial Drive	Mashpee, MA	41.6038	-70.4887	Lattice	142	On-Air
Forestdale	23 Falmouth Sandwich Road	Sandwich, MA	41.6711	-70.5164	Monopole	107	Approved
New Seabury	101 Red Brook Road	Mashpee, MA	41.5841	-70.4842	Monopole	146	Proposed

Table 1: Verizon Wireless Site Information Used in Coverage Analysis⁴

⁴ Some sites listed in this table are outside the plot view but are included for completeness of information.

7. Coverage Analysis and Propagation Plots

The signal propagation plots provided in this report show coverage for the 700 MHz frequency range and were produced using deciBel Planner™, a Windows-based RF propagation computer modeling program and network planning tool. The software considers the topographical features of an area, land cover, antenna models, antenna heights, RF transmitting power and receiver thresholds to predict coverage and other related RF parameters used in site design and network expansion.

The coverage plots included as attachments show coverage based on RSRP signal strengths of -95 dBm and above. All other areas (depicted in white) fall within coverage areas characterized by poor service quality, low data throughput, and the substantial likelihood of unreliable service.

Attachments A - E are discussed below:

Attachment A titled “New Seabury – Existing 700 MHz LTE Coverage” shows the coverage provided to areas of Mashpee from the “On-Air” and “Approved” sites listed in Table 1. “On-Air” sites are existing Verizon Wireless facilities, and “Approved” sites are defined as those that are in the final stages of permitting or construction and are expected to be turned on-air soon. The green areas represent the minimum desired level of coverage for much of this area. The deficient areas of coverage are defined by the unshaded or “white” areas. As shown in this plot and described in the Coverage and Capacity Objectives section of this report, portions of southern Mashpee are in areas of deficient coverage. These coverage gaps include, but are not limited to, Red Brook Road, Great Oak Road/Great Neck Road S, Monomoscoy Road, Rock Landing Road, and the surrounding roads and neighborhoods in the proximity of the proposed site, including the communities of New Seabury and Seabrook.

Attachment B titled “New Seabury - 700 MHz LTE Coverage with Proposed Site” shows the composite coverage with the proposed “New Seabury” facility at the proposed antenna centerline height of 146’ AGL. As shown by the additional areas of coverage in comparison to Attachment A, the proposed facility will provide coverage to:

- ~ 1.5 mi along Red Brook Road;
- ~ 2.2 mi along Great Oak Road / Great Neck Road S;
- ~ 1.1 mi along Monomoscoy Road;
- ~ 0.6 mi along Rock Landing Road;
- ~ 0.9 mi along Fells Pond Road and Glenneagle Drive;
- ~ 1.0 mi along Shore Drive W;
- ~ 0.8 mi along Shore Drive;
- ~ 1,400 new residents⁵ within the surrounding area;
- The surrounding roads and neighborhoods throughout southern Mashpee, including the communities of New Seabury and Seabrook.

⁵ Residential population counts referenced here and elsewhere in this report are based upon the 2010 U.S. Census data. Please note that this does not include employee, visitor, or vehicular counts in the area.

Attachment C titled “New Seabury – Existing 700 MHz LTE Sector Footprints” depicts the areas primarily served by the sectors (a.k.a. signal “footprints”) of the “On-Air” and “Approved” Verizon Wireless sites in the area, which are shown by the unique color for each particular sector of interest. For clarity, all other sectors of less interest with respect to the proposed site are shown in grey. As demand for wireless voice and data services continues to grow, Verizon Wireless manages the footprint of each sector so that it can support the demand within the area it is primarily serving. In addition to improving coverage to the area, the proposed site will also serve existing and anticipated demand in the vicinity and thereby offload some of the burden experienced by the surrounding sites. In that way, those sites will be able to more adequately serve the demand for service in the areas nearer to those surrounding sites. Please note that the outer parts of each sector footprint may include areas that presently have signal strength below the targeted value required for reliable service to Verizon Wireless’ customers. The fact that low-level signal may reach these areas does not mean that these areas experience adequate coverage. These unreliable areas of low signal level can impose a significant capacity burden on the sites primarily serving the area.

Attachment D titled “New Seabury - 700 MHz LTE Sector Footprints with Proposed Site” shows the composite coverage with the overall footprint of the proposed facility in dark green. As shown in this map, the proposed “New Seabury” facility is an effective solution to provide capacity relief to the area, particularly to the “Mashpee S” beta and gamma sectors (red & orange, respectively), and to the “E Falmouth” beta (yellow) sector. The proposed facility is centrally located in the area of deficient coverage making it particularly suited to distribute the traffic load across multiple sectors, and provide a dominant server to this gap in service. Table 2 below details the capacity relief based on the sector footprints shown in Attachments C and D.

Sector	Current		With "New Seabury"		Offload Summary	
	Residential Pops	Area (mi ²)	Residential Pops	Area (mi ²)	Total Residential Pops Offloaded	Area Offloaded (mi ² /%)
Mashpee S Beta	1699	4.4	940	1.79	759 (44.7%)	2.61 (59.3%)
Mashpee S Gamma	1505	3.03	457	1.69	1048 (69.6%)	1.34 (44.2%)
E Falmouth Beta	1785	2.49	1506	1.52	279 (15.6%)	0.97 (39%)

Table 2: Capacity Offload Summary

Attachment E titled “New Seabury – Area Terrain Map” details the topographical features around the proposed “New Seabury” site. These terrain features play a key role in dictating both the unique coverage areas served from a given location, and the coverage gaps within the network. This map is included to provide a visual representation of the terrain variations that must be considered when determining the appropriate location and design of a proposed wireless facility. The blue shades correspond to lower elevations, whereas the yellow and red shades indicate higher elevations.

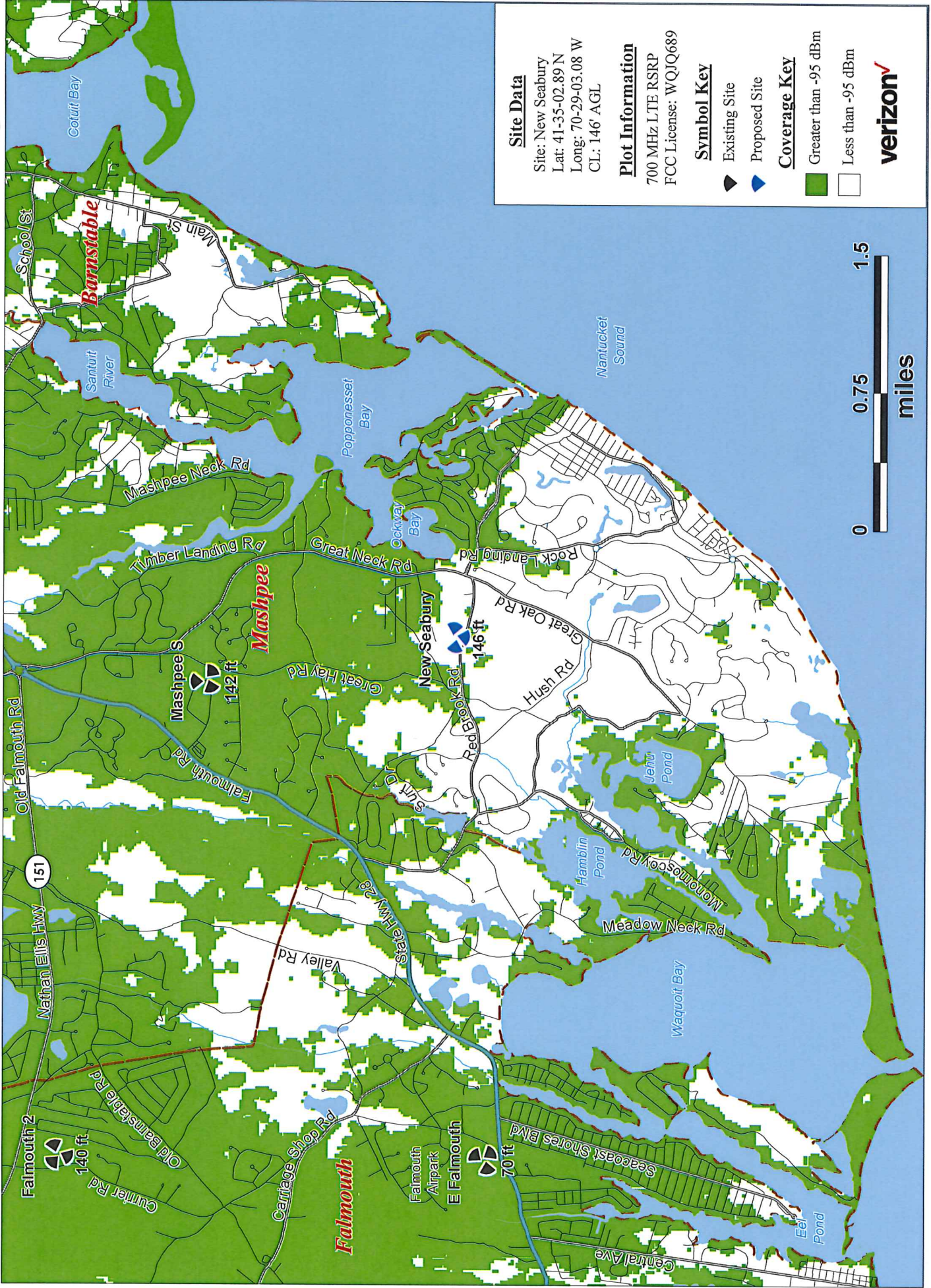
Attachment F titled “New Seabury – Existing 700 MHz LTE Drive Data (03/27/2018)” presents drive test data of Verizon Wireless’ existing network, which was collected on March 27th, 2018. Drive testing consists of traveling along the area roadways in a vehicle equipped with a sophisticated setup of equipment configured to collect a variety of system performance metrics on a specific operator’s network. The measurement displayed is RSRP of Verizon Wireless’ 700 MHz LTE network, and is the same parameter reflected in the radio frequency propagation maps presented in Attachments A & B. This data was collected with a calibrated LTE scanning receiver configured to specifically scan Verizon Wireless’ LTE network. The empirical drive data is an “apples-to-apples” comparison to the existing coverage modeling depicted in Attachment A, and further confirms the presence of an expansive gap in southern Mashpee. Please note, however, that the data presented reflects the raw measurements collected in late March under conditions of minimal foliage. Therefore, the coverage shown will be weaker in many areas from late Spring through early Fall due to the attenuation effects of foliage present during those months.

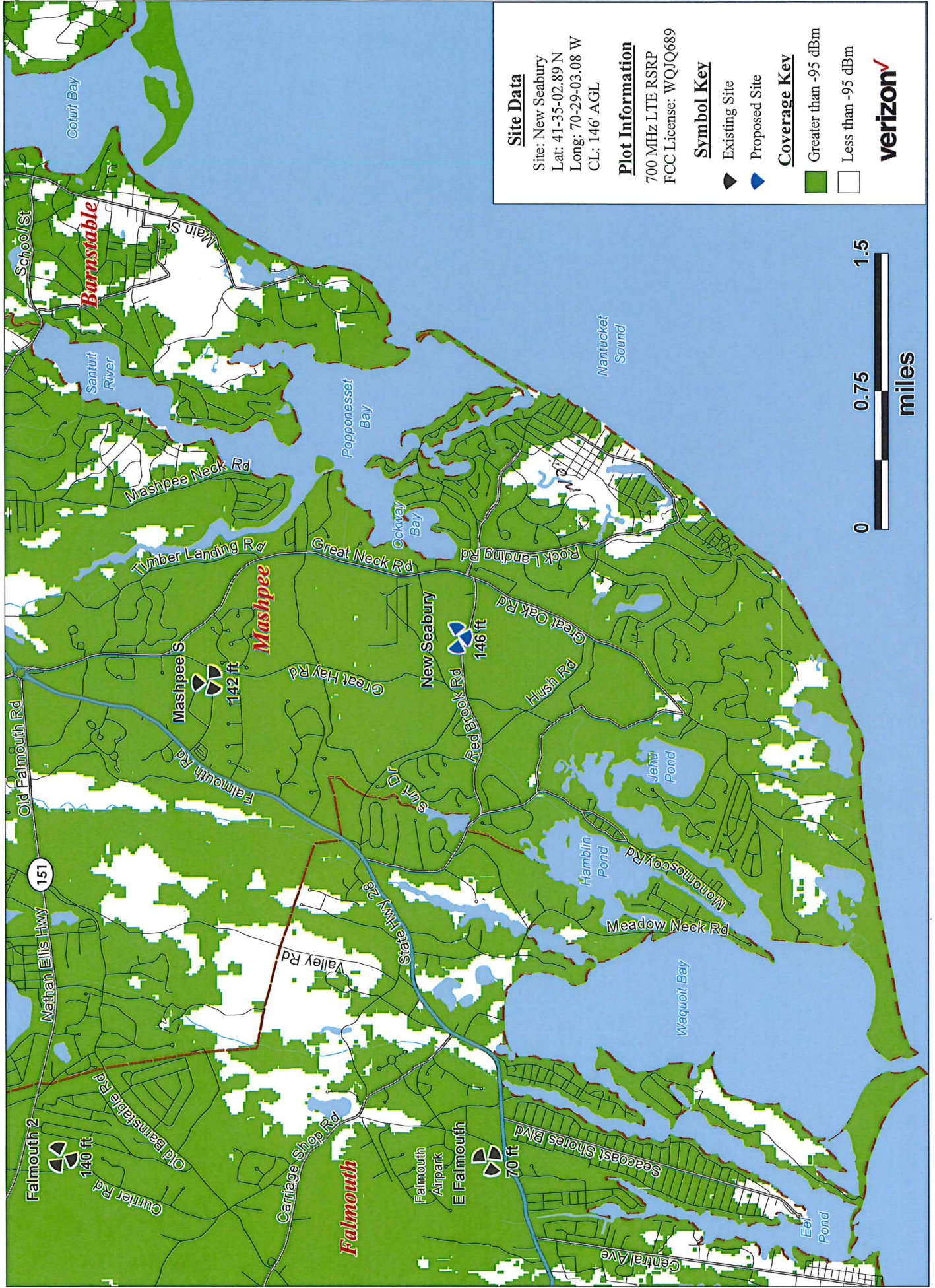
8. Certification of Non-Interference

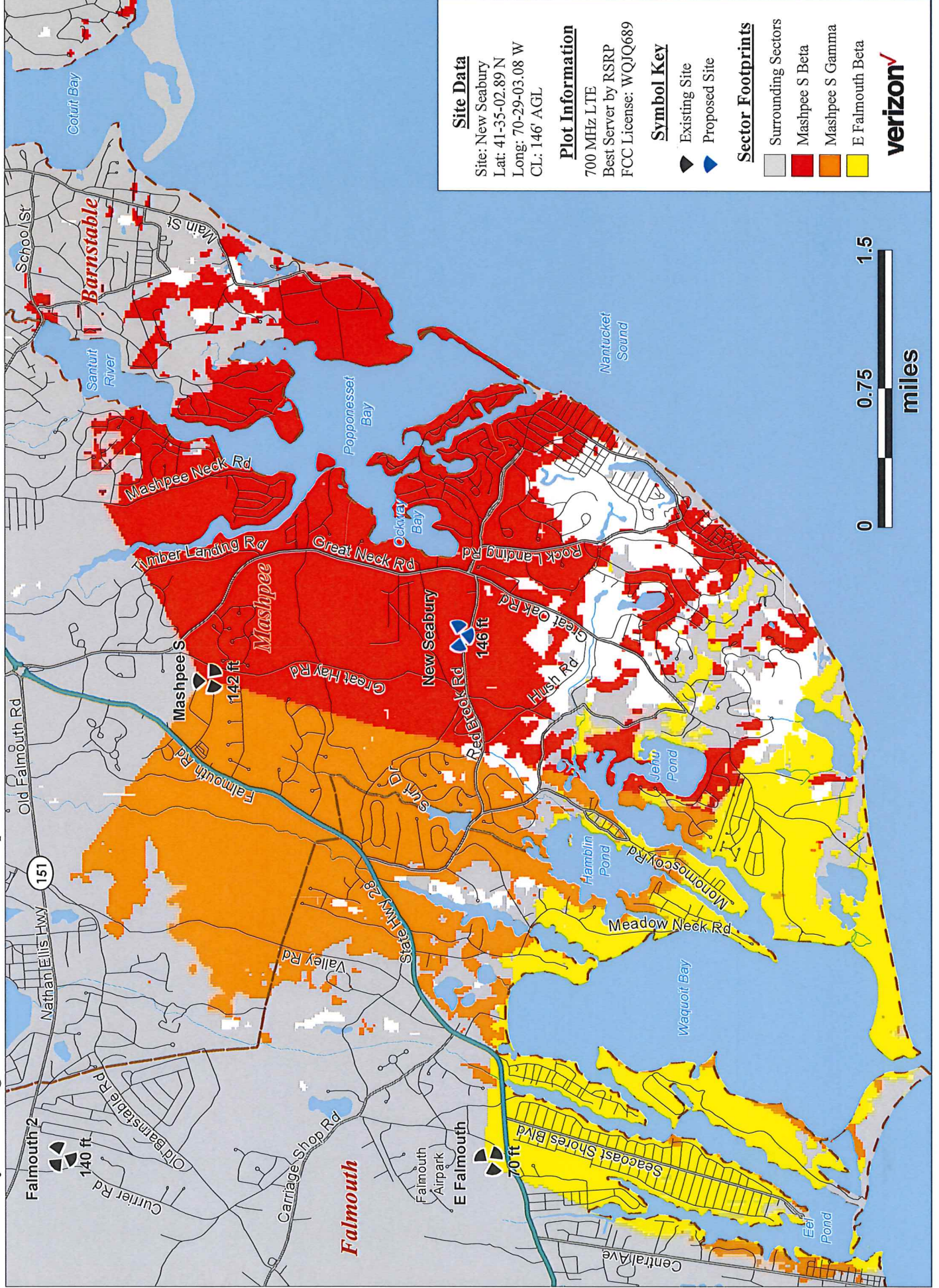
Verizon Wireless certifies that the proposed facility will not cause interference to any lawfully operating emergency communication system, television, telephone or radio, in the surrounding area. The FCC has licensed Verizon Wireless to transmit and receive in the Upper C-Block of the 700 MHz band, B Block of the Cellular (850 MHz) band, the E, F, C4, and C5 Blocks of the PCS (1900 MHz) band, and the A and B Blocks of the AWS (2100 MHz) band of the RF spectrum. As a condition of the FCC licenses, Verizon Wireless is prohibited from interfering with other licensed devices that are being operated in a lawful manner. Furthermore, no emergency communication system, television, telephone, or radio is licensed to operate on these frequencies, and therefore interference is highly unlikely.

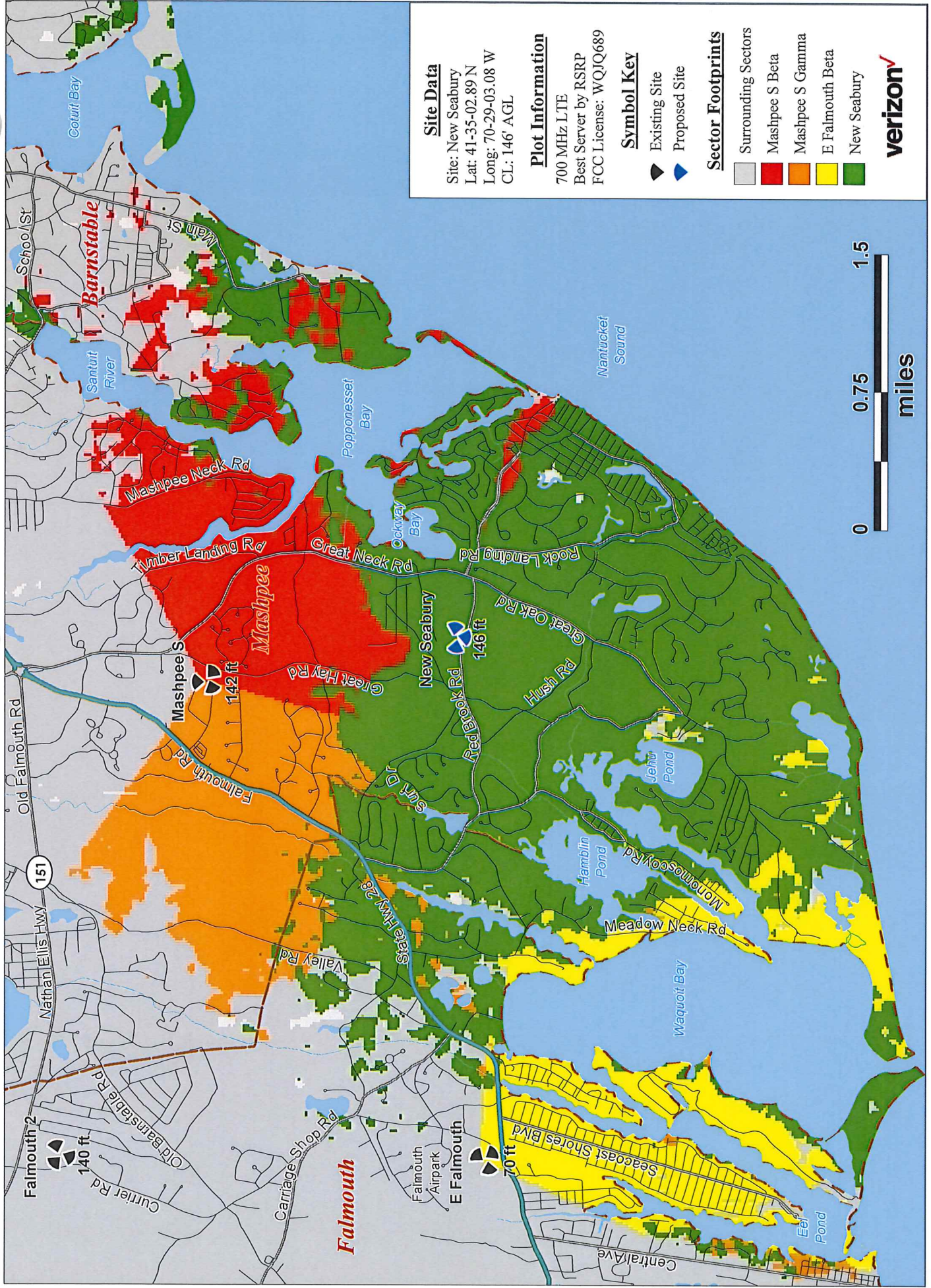
9. Summary

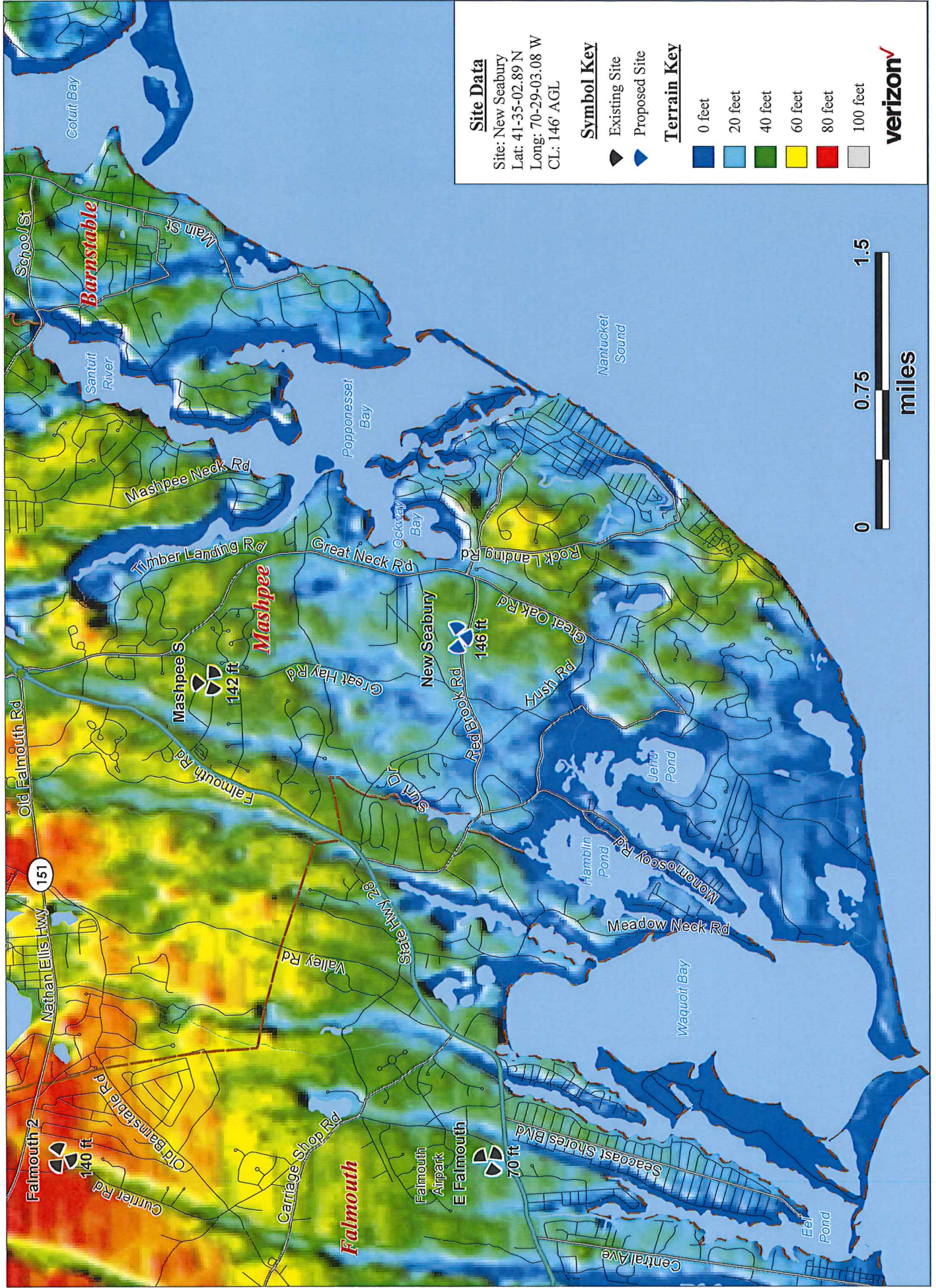
In undertaking its build-out of 4G LTE service in Barnstable County, Verizon Wireless has determined that an additional facility is needed to provide reliable service and additional capacity throughout areas of southern Mashpee, MA. Verizon Wireless determined that installing the proposed wireless communications facility at 101 Red Brook Road in Mashpee at an antenna centerline height of 146 feet (AGL) will provide additional coverage and capacity needed in the targeted coverage areas including key roadways such as Red Brook Road, Great Oak Road/Great Neck Road S, Monomoscoy Road, Rock Landing Road, and the surrounding roads and neighborhoods in the proximity of the proposed site, including the communities of New Seabury and Seabrook. Without the installation of the proposed site, Verizon Wireless will be unable to improve and expand their existing 4G LTE wireless communication services in this area of Mashpee; therefore, Verizon Wireless respectfully requests that the Town of Mashpee and the Cape Cod Commission act favorably upon the proposed facility.

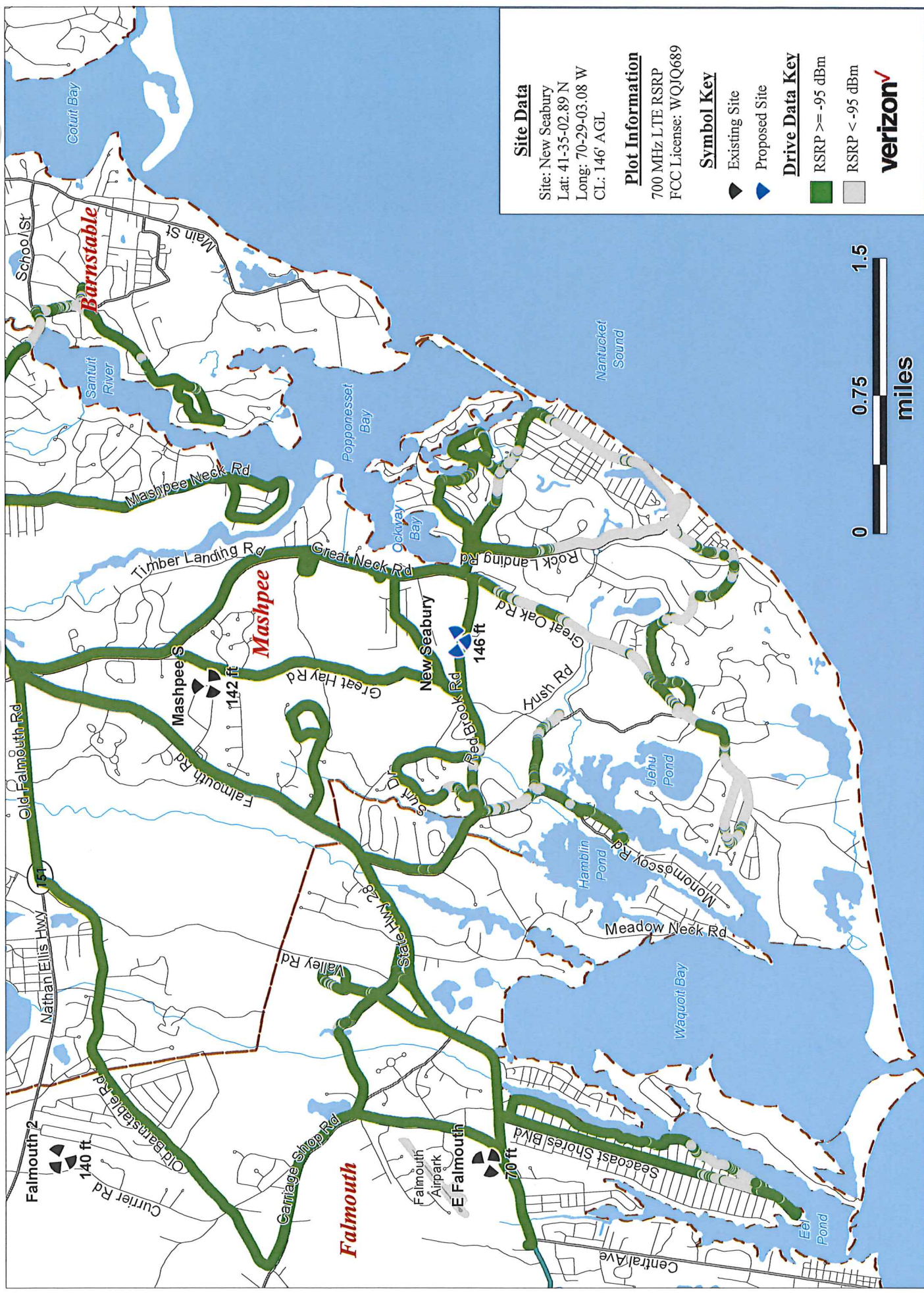












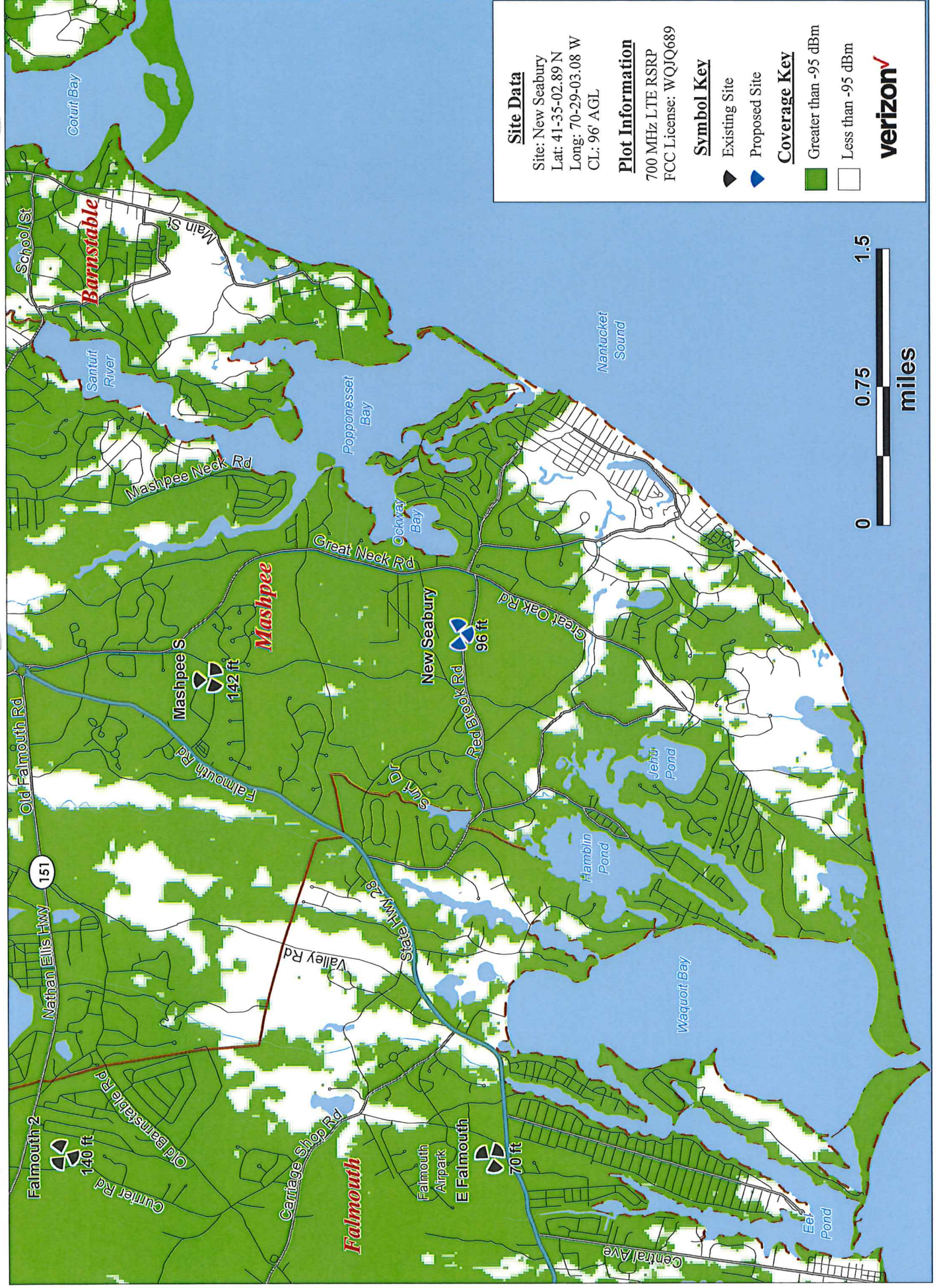
New Sea - 700 MHz LTE Coverage with Proposed Site at 121 ft

Map red 8/15/2018



New Seabury - 700 MHz LTE Coverage with Proposed Site at 96 ft

Map created 8/15/2018



Site Data
 Site: New Seabury
 Lat: 41-35-02.89 N
 Long: 70-29-03.08 W
 CL: 96' AGL

Plot Information
 700 MHz LTE RSRP
 FCC License: WQJQ689

Symbol Key
 Existing Site (black triangle)
 Proposed Site (blue triangle)

Coverage Key
 Greater than -95 dBm (green)
 Less than -95 dBm (white)

verizon

