verizon
2770 Shadelands Drive
Walnut Creek, CA 94598

July 31, 2024

To: Nevada County Board of Supervisors

From: Ehab Elaidy, Radio Frequency Design Engineer
Verizon Wireless Network Engineering Department

Subject: Statement in Support of Verizon Wireless's Proposed Facility
20896 Dog Bar Road

Executive Summary

Verizon Wireless has identified a significant gap in service in western Nevada County, in areas around southern Dog Bar Road. This area currently receives poor service coverage from Verizon Wireless's existing Mount Olive facility 3.1 miles north of the Proposed Facility, the Red Frog facility 2.7 miles northeast, the Colfax facility 2.2 miles southeast, the Eden Valley facility 2.2 miles south, and the Lime Kiln facility 3.9 miles west. Figure 1 below is a network map showing the location of these facilities and the Proposed Facility.

Due to the distance from the existing facilities and substantial intervening terrain, there is a gap in reliable Verizon Wireless voice and data service coverage and a lack of a dominant signal in the area. Additionally, the existing Verizon Wireless facilities that primarily serve the gap area are experiencing capacity exhaustion, affecting distant users in particular. Network users in the gap area experience poor service levels and low data throughput, resulting in slow data speeds and poor voice call quality.

As shown in Figure 2, the vast majority of Verizon Wireless's bandwidth in the area is in the mid-band PCS (1900 MHz), AWS (2100 MHz), CBRS (3550 MHz) and C-Band (3700-4000 MHz) frequencies, with a small amount in the low-band 700 and 850 MHz frequencies. The mid-band frequencies provide much greater data capacity than the low-band frequencies. However, the mid-band frequencies do not travel as far as low-band frequencies, requiring wireless facilities to be closer together and closer to end users to provide reliable service. Verizon Wireless designs its networks to ensure that mid-band frequencies can provide adequate capacity as well as coverage. The Proposed Facility will provide new coverage and network capacity in all of these frequencies, except CBRS (due to the power of the CBRS radio and the location of traffic demand, CBRS would be an ineffective addition to this facility.)

I describe below the significant gap in coverage that Verizon Wireless seeks to remedy (the "Significant Gap"). To provide reliable coverage, network capacity, and data speeds adequate for applications, the Significant Gap must be remedied through construction of a new Verizon Wireless facility at 20896 Dog Bar Road (the "Proposed Facility").

Figure 1: Network Map

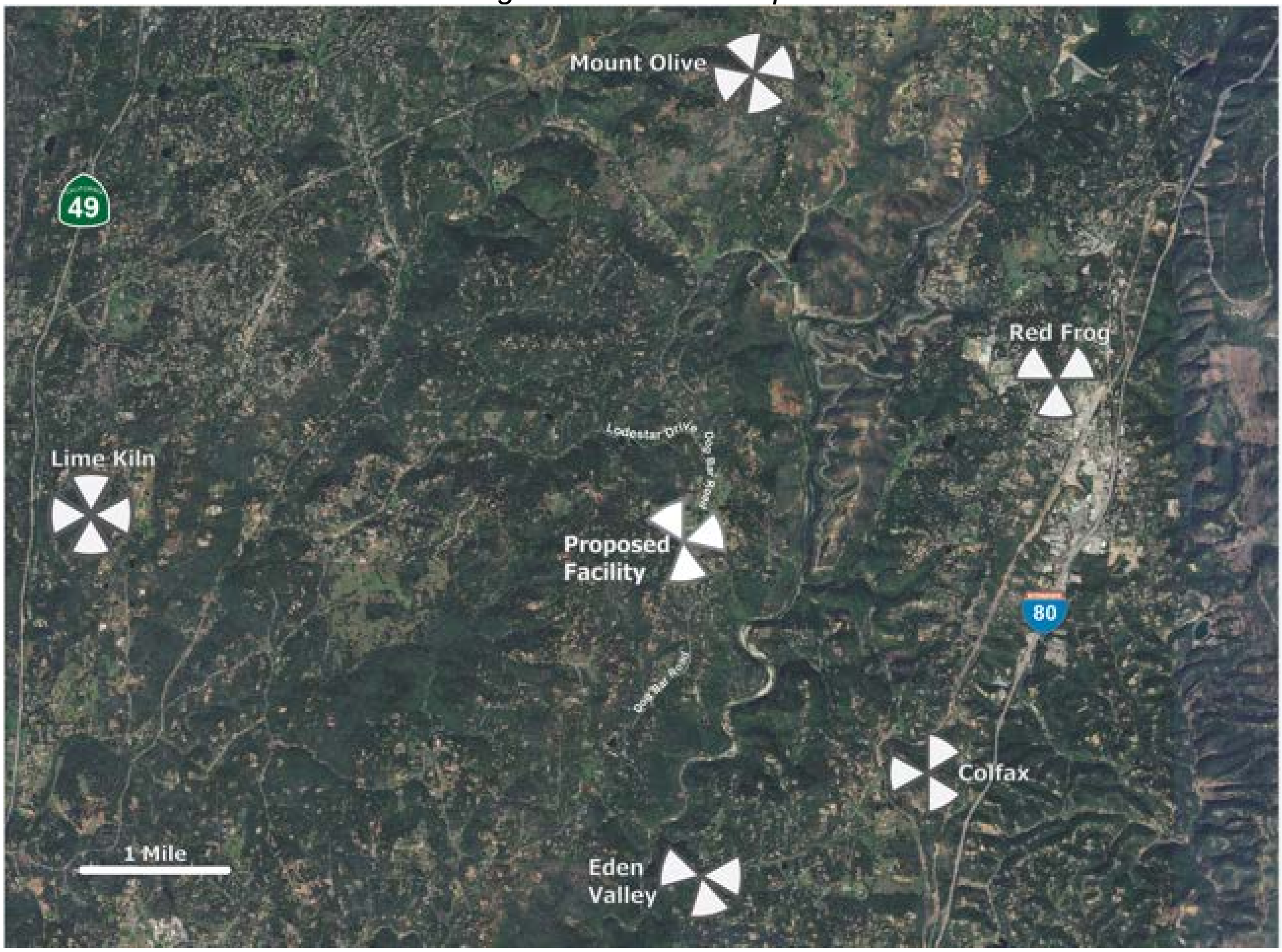


Figure 2: Verizon Wireless Bandwidth by Frequency Band, Western Nevada County

Band	FCC Designation	Frequency Band	Bandwidth
700 MHz	UHF Low Band	700 MHz	10 MHz*
850 MHz	Cellular	850 MHz	10 MHz*
PCS	Personal Communications Service	1900 MHz	5 MHz*
AWS	Advanced Wireless Service	2100 MHz	20 MHz*
CBRS	Citizen's Broadband Radio	3550 MHz	20-40 MHz* Shared
C-Band	C-Band	3700-4000 MHz	160 MHz

* Downlink only

Verizon Wireless Services

Verizon Wireless provides personal wireless services, a category of "telecommunications services," which include voice services that allow users of mobile, handheld telephones to place and receive calls to other mobile and landline telephone users through the national, switched telephone network using conventional telephone numbers. These services include the ability of such users to connect to emergency personnel by dialing 911. Verizon Wireless's network also provides information services through its wireless facilities, which will include the Proposed Facility. These information services include wireless broadband, mobile data networks, and connection to the internet, which Verizon Wireless provides using the same infrastructure as its personal wireless services. Voice and data services are commingled.

Coverage Gap

There is a Significant Gap in Verizon Wireless service coverage in western Nevada County in areas around southern Dog Bar Road, in both the low-band and mid-band frequencies.

Low-Band

As shown in Figure 3 below, reliable low-band in-building coverage is almost entirely lacking in the area, including residential and agricultural areas west and east of Dog Bar Road. There is also a lack of low-band in-vehicle coverage along a 0.75 mile stretch of Dog Bar Road between Owl Hill Court and Leitner Drive, with average daily traffic of 1,564 vehicles per *Nevada County 2022 Traffic Counts*, as well as other local roads such as eastern Lodestar Drive near its intersection with Dog Bar Road.

As shown in Figure 4, the Proposed Facility will provide new, reliable low-band coverage to residential and agricultural areas west and east of Dog Bar Road, as well as new low-band in-vehicle service where lacking along Dog Bar Road, Lodestar Drive, and other local roads.

Figure 5 is a map showing the low-band coverage of only the Proposed Facility, not including the existing facilities. This map reflects how the Proposed Facility will provide low-band outdoor coverage to a total area of 21.7 square miles, with a population of 6,990. This will include new reliable low-band in-building coverage to an area of 1.4 square miles where currently lacking.

Mid-Band

The lack of reliable service is even more pronounced in the mid-band frequencies, which provide the most data capacity. As shown in Figure 6, there is a near-complete lack of mid-band in-building and in-vehicle coverage in the gap area, and little outdoor coverage. Figure 7 shows how the Proposed Facility will add new mid-band in-building and in-vehicle coverage in the gap area, and significantly expand mid-band outdoor coverage.

Figure 8 is a map showing the mid-band coverage of only the Proposed Facility. The Proposed Facility will provide mid-band outdoor coverage to a total area of 3.6 square miles, with a population of 1,009. This will include new, reliable mid-band outdoor coverage to an area of approximately 1 square mile where currently lacking.

Coverage Map Explanation

The coverage maps are generated using Verizon Wireless's ATOLL tool, a predictive coverage modeling program.

Low-band coverage maps are based on the 700 MHz frequency band, which provides coverage similar to the other low-band frequency, 850 MHz.

Mid-band coverage maps are based on the AWS frequency band, which provides coverage similar to the other mid-band frequencies, PCS and C-Band. Over 90 percent of Verizon Wireless's available bandwidth in the area is in these mid-band frequencies. Verizon Wireless designs its networks to ensure that both low-band and mid-band frequencies can provide reliable service.

Referenced signal receive power (RSRP) is a measurement of signal level in decibel milliwatts (dBm). RSRP is measured in negative numbers on a logarithmic scale. The further the number is below zero, the weaker the power level. The RSRP coverage thresholds are:

In-building >= -85 dBm. Green depicts good coverage that meets or exceeds thresholds for reliable network coverage in homes and vehicles.

In-vehicle >= -95 dBm. Yellow depicts reliable in-vehicle and outdoor coverage.

Outdoor >= -105 dBm. Gray depicts reliable outdoor coverage only.

Unshaded areas do not receive reliable service levels.

Verizon Wireless uses a link budget to calculate the maximum allowable path loss (MAPL). Verizon Wireless engineers meticulously calculate the MAPL, which is proprietary information, and may be available on a confidential basis.

The link budget takes into account factors such as free space loss (the weakening of signal along an obstacle-free distance), and loss due to fading and interference margins. A combination of the transmit power of the antennas and the MAPL determine the receive signal threshold required for outdoor coverage. Adding the loss due to vehicle frames to the calculation determines the receive signal threshold required for in-vehicle coverage. Similarly, adding building penetration loss to the calculation determines the receive signal threshold required for in-building coverage.

Figure 3: Existing Low-Band Coverage

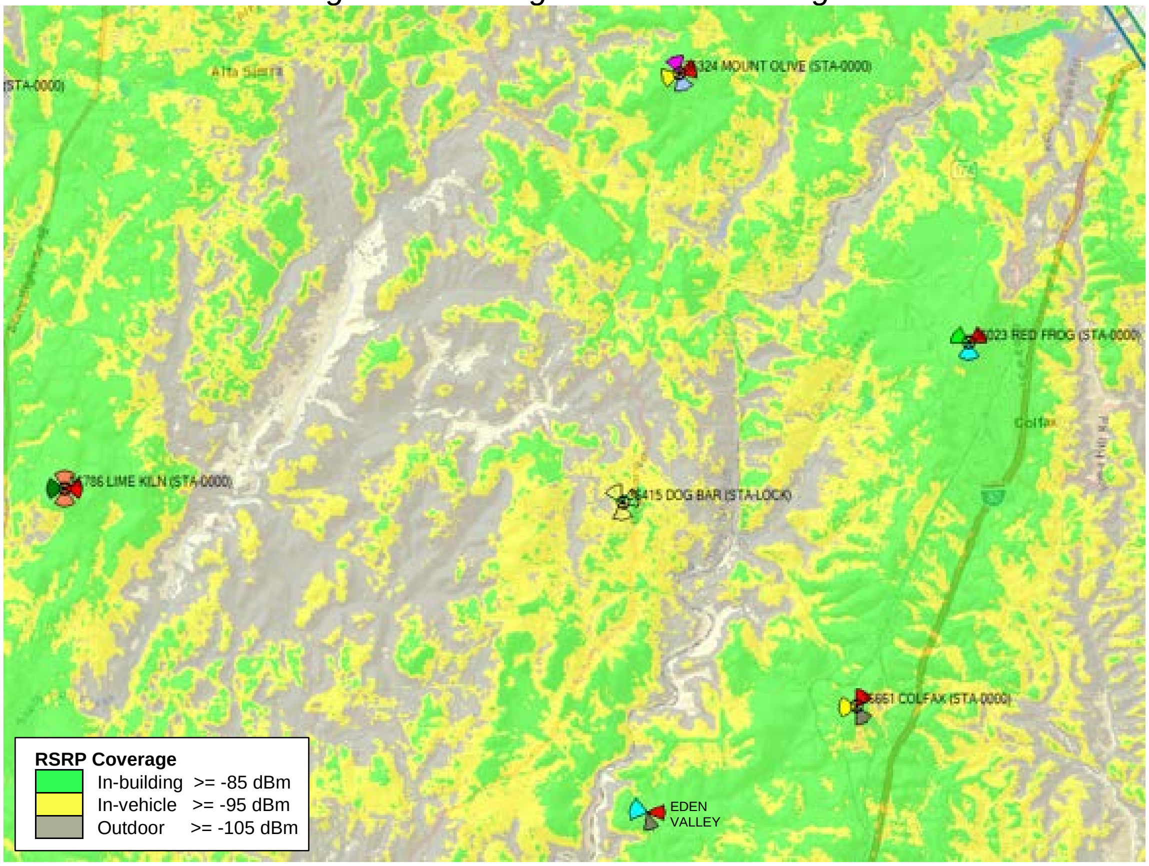


Figure 4: Low-Band Coverage with Proposed Facility
120-foot Antenna Centerline

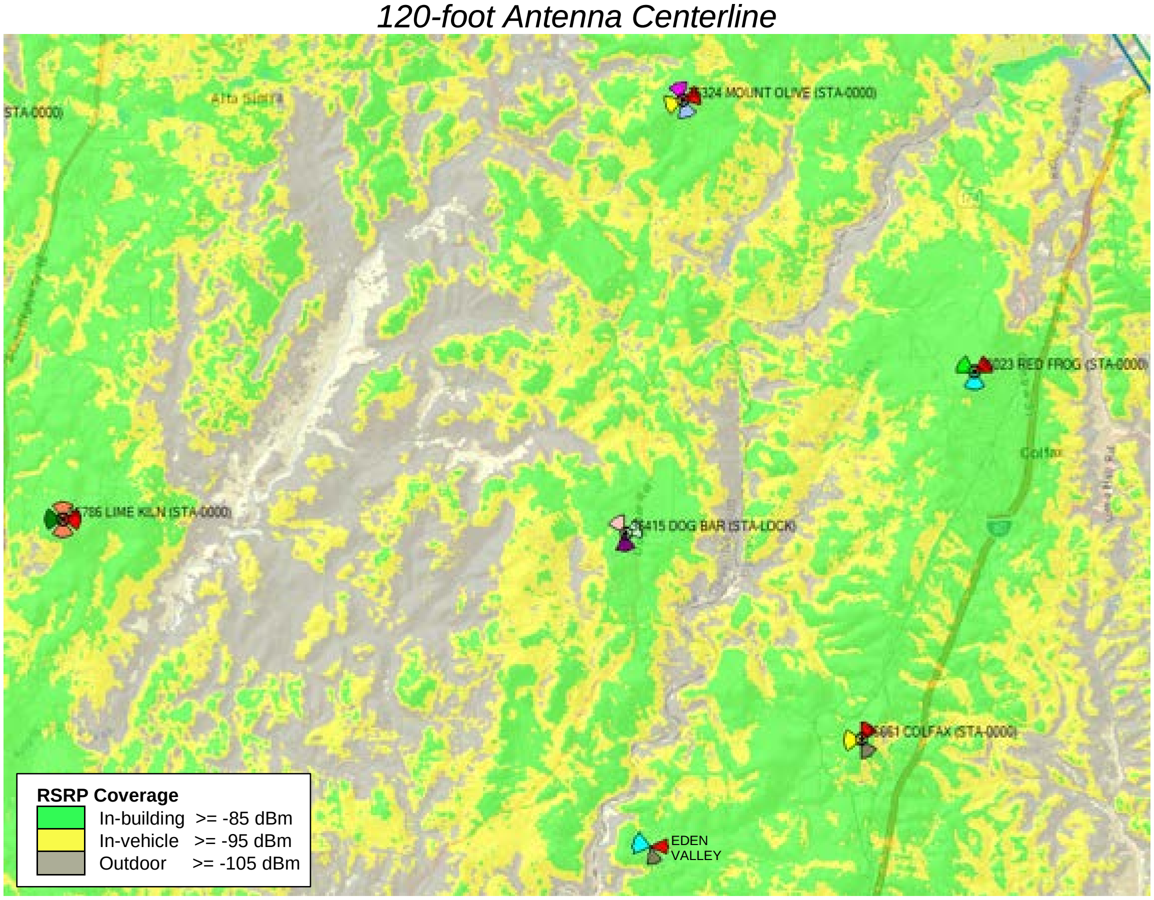


Figure 5: Low-Band Coverage of Proposed Facility Only
(without Existing Facilities)
120-foot Antenna Centerline

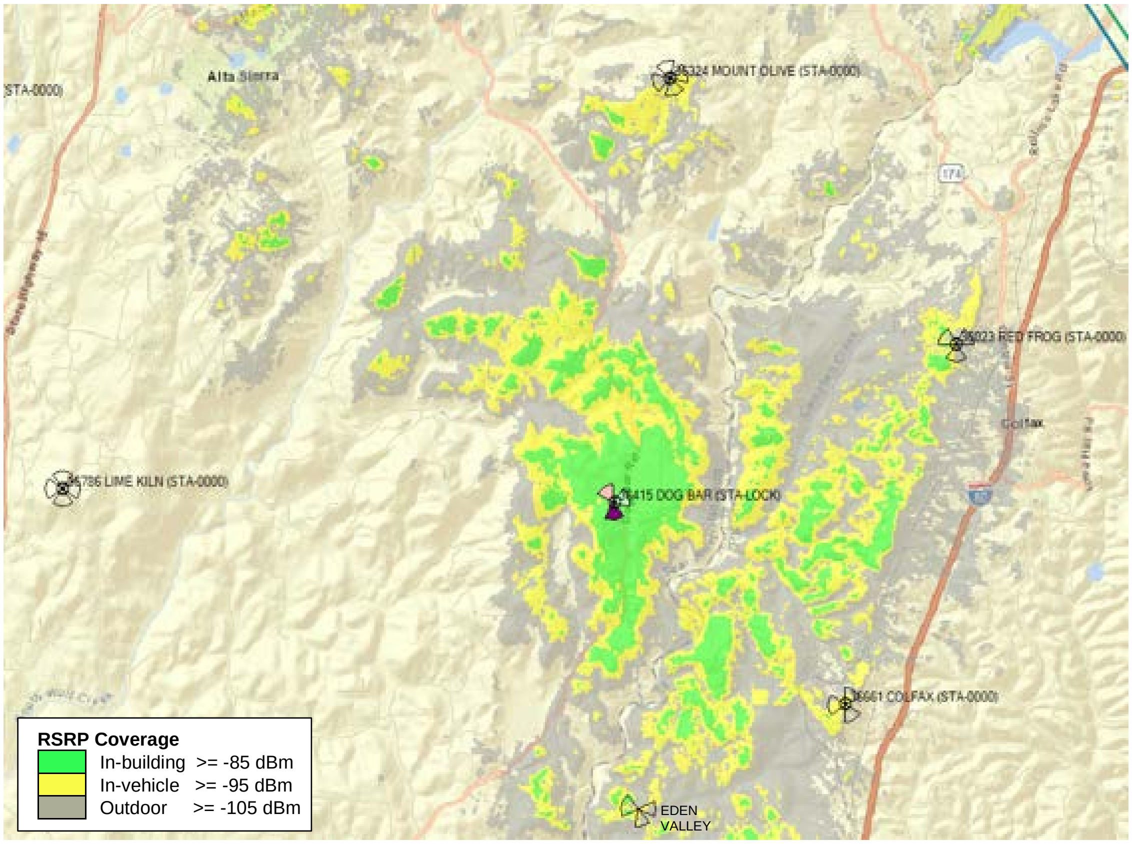


Figure 6: Existing Mid-Band Coverage

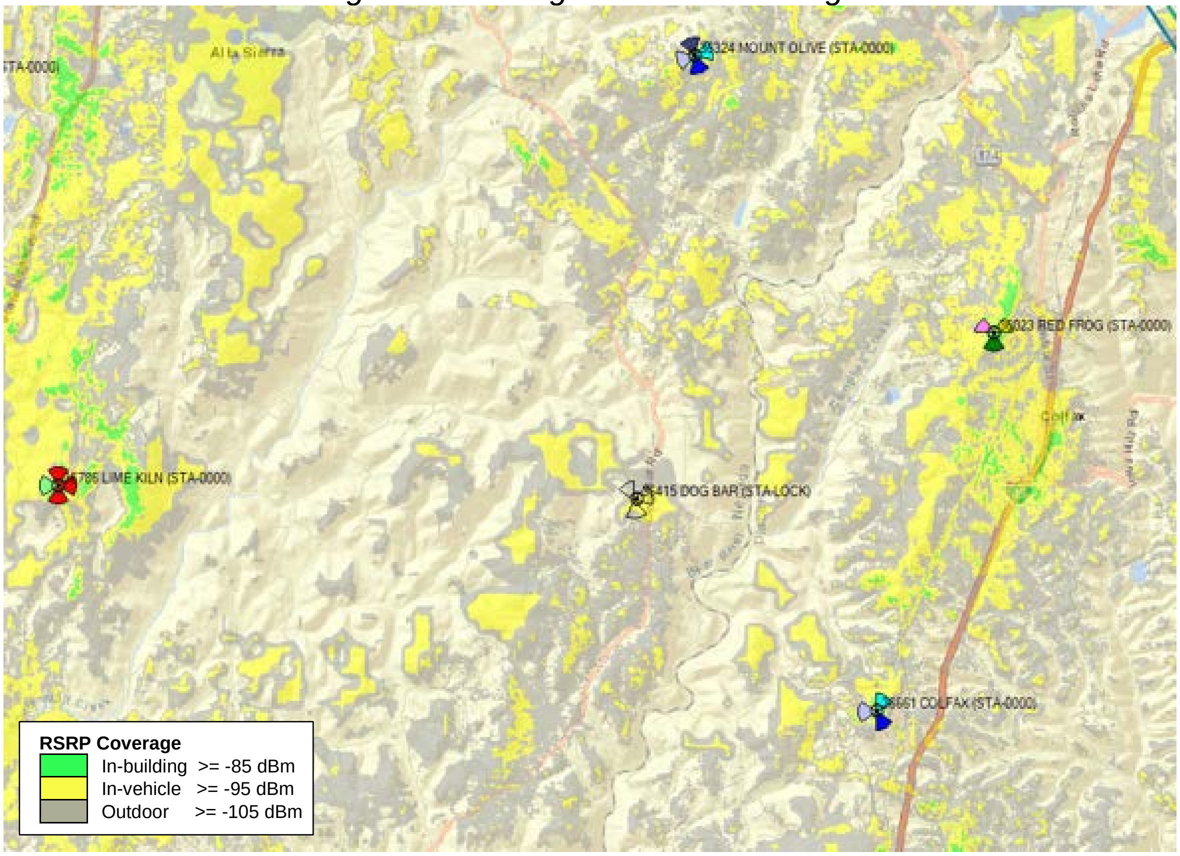


Figure 7: Mid-Band Coverage with Proposed Facility
120-foot Antenna Centerline

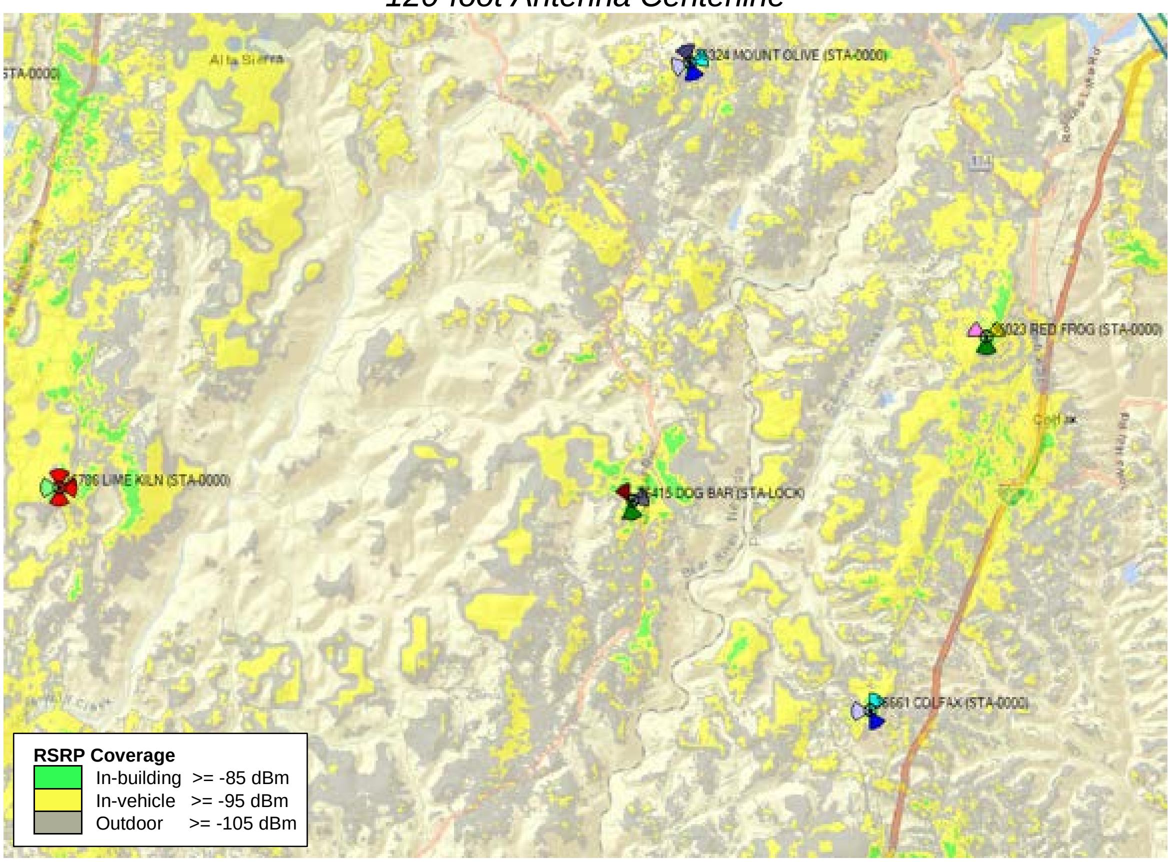


Figure 8: Mid-Band Coverage of Proposed Facility Only
(without Existing Facilities)
120-foot Antenna Centerline

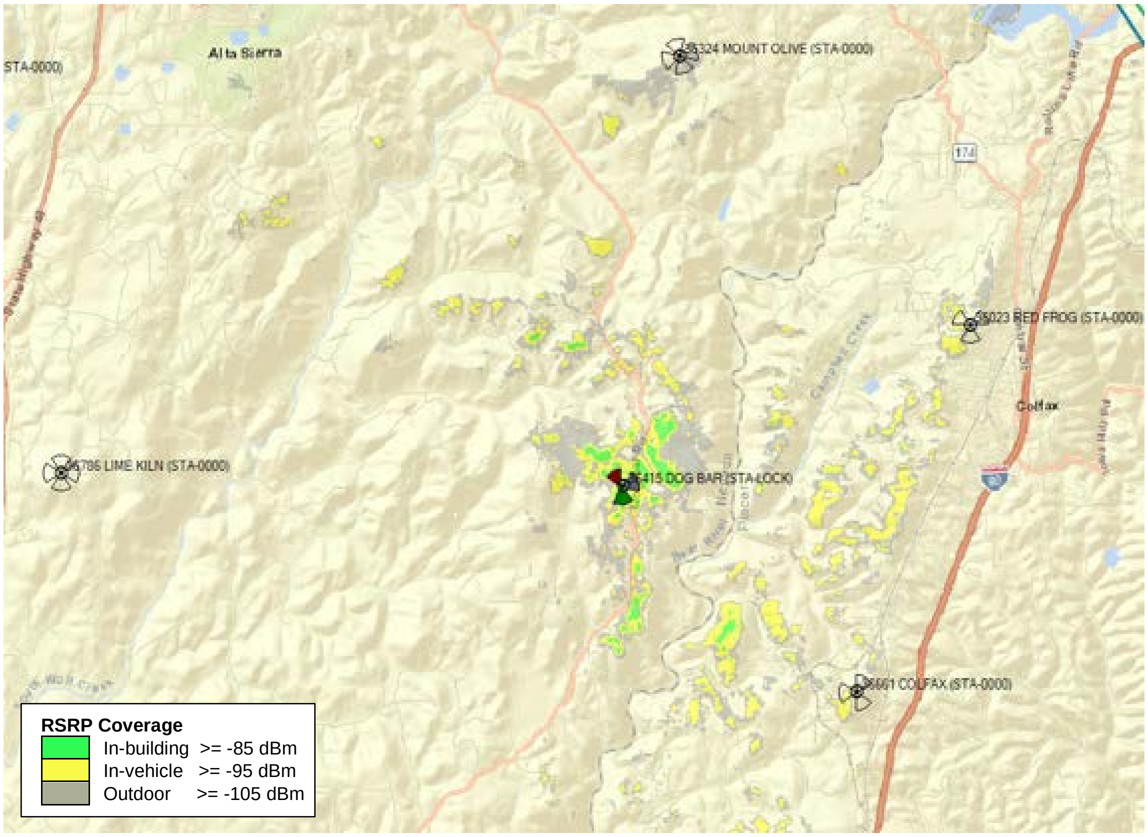


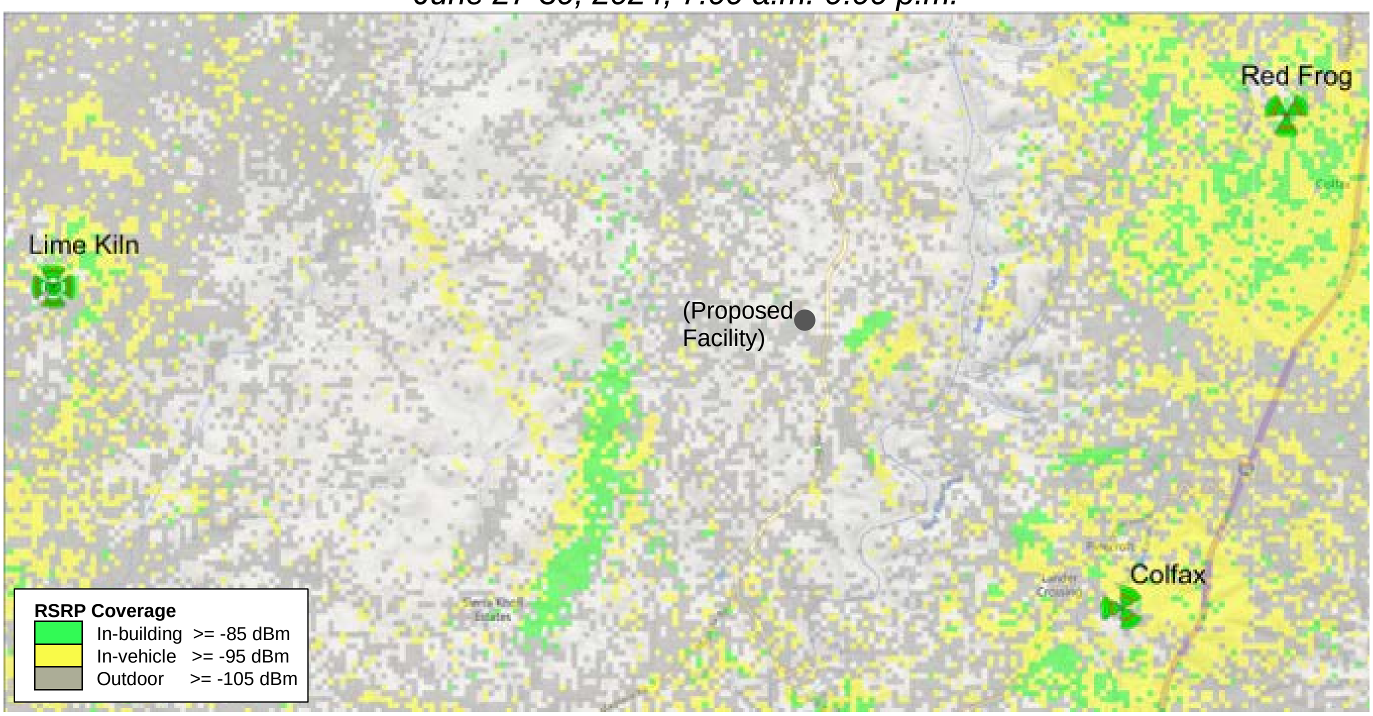
Figure 9 is a map showing the average RSRP of Verizon Wireless signal levels received by user devices in the greater area over a four-day period June 27-30, 2024, from 7:00 a.m. to 9:00 p.m. User devices report the RSRP to the network, and Verizon Wireless uses its TrueCall tool to analyze this data and optimize system performance. The data represents the RSRP of the strongest frequency assigned by the network to user devices.

Unlike the ATOLL coverage maps which will show predicted coverage, TrueCall data reflects attenuation of signal for users in buildings or in vehicles, and measures the actual signal strength received by the device during operation.

The user data map shows how service levels are inadequate throughout the gap area, with a near-complete lack of in-building and in-vehicle service in the area around southern Dog Bar Road.

While the future coverage of the Proposed Facility cannot be shown on the TrueCall map, its location is marked for orientation.

Figure 9: RSRP Average Signal Level Reported by User Devices June 27-30, 2024, 7:00 a.m.-9:00 p.m.

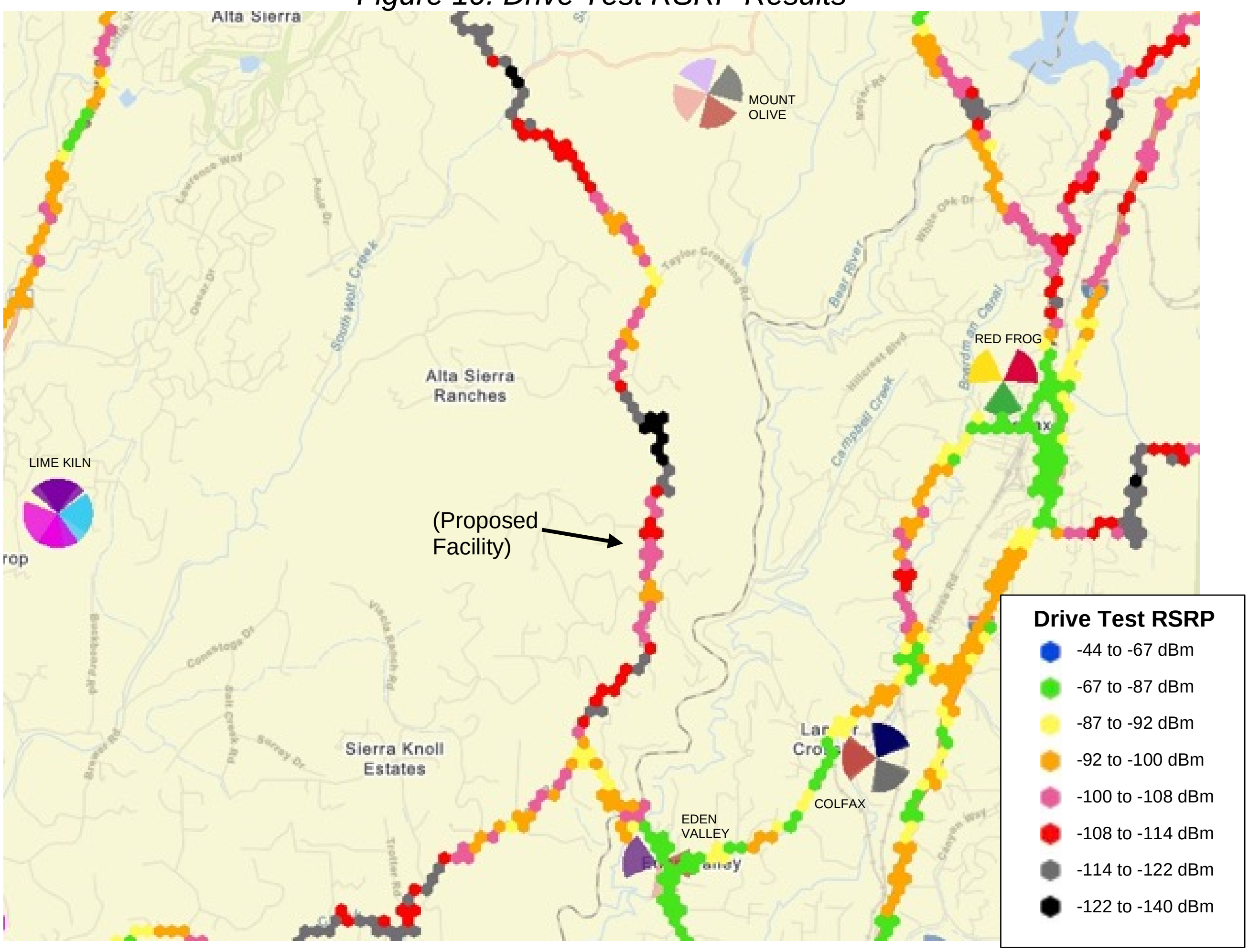


To further evaluate its service levels in the area, Verizon Wireless conducted a drive test, with results shown in Figure 10. On several days between May 30 and July 11, 2024, a Verizon Wireless RF engineer drove a test vehicle around the area to measure the signal strength received by a smartphone placed inside the vehicle. The signal level of the best serving frequency assigned by the network at the time was measured at numerous locations and plotted on the following map. The drive tester collected the real-time data using Verizon Wireless's DMAT software (Device Monitoring and Analysis Tool).

The drive test results show no in-building coverage (above -85 dBm) along Dog Bar Road within the gap area near the Proposed Facility. There were only a few results between -92 to -100 dBm that could qualify as in-vehicle coverage. Otherwise, there was no signal above -100 dBm.

The Proposed Facility location is shown for orientation.

Figure 10: Drive Test RSRP Results



Drive Tester	Tony Monoogan, Principal Engineer, Network Performance
Drive Test Dates	May 30-July 11, 2024
Equipment Used	Samsung S22
Data analysis software	DMAT (Verizon Device Monitoring and Analysis Tool)
Frequency Bands Scanned	700 MHz, 850 MHz, PCS (1900 MHz), AWS (2100 MHz)

As shown in Figure 11, the same drive test data also measured the reference signal received quality (RSRQ) reported by customer devices. RSRQ reflects the ratio of the signal level from the existing Verizon Wireless facility connected to the drive test device compared to interfering signal levels from other Verizon Wireless facilities and radio frequency noise from other sources.

RSRQ is expressed as a negative number. The higher the number and closer to zero, the lower the interference and noise, indicating better signal quality. Along with RSRP described above, RSRQ data assists the network in assigning user devices to particular Verizon Wireless facilities. A high RSRQ number indicates reliable network performance and better connectivity for users in the area.

The drive test RSRQ data shows how the presence of interfering signal and noise compromises signal quality and network connectivity around the gap area near the Proposed Facility. For example, there is no excellent RSRQ above -10 dB (green) along Dog Bar Road within the gap area near the Proposed Facility. Instead, the yellow, orange, and red marks indicate increasing interference and noise, and declining network performance.

Excellent RSRQ above -10 dB is an indication that an area receives a dominant signal, as discussed below.

Figure 11: Drive Test RSRQ

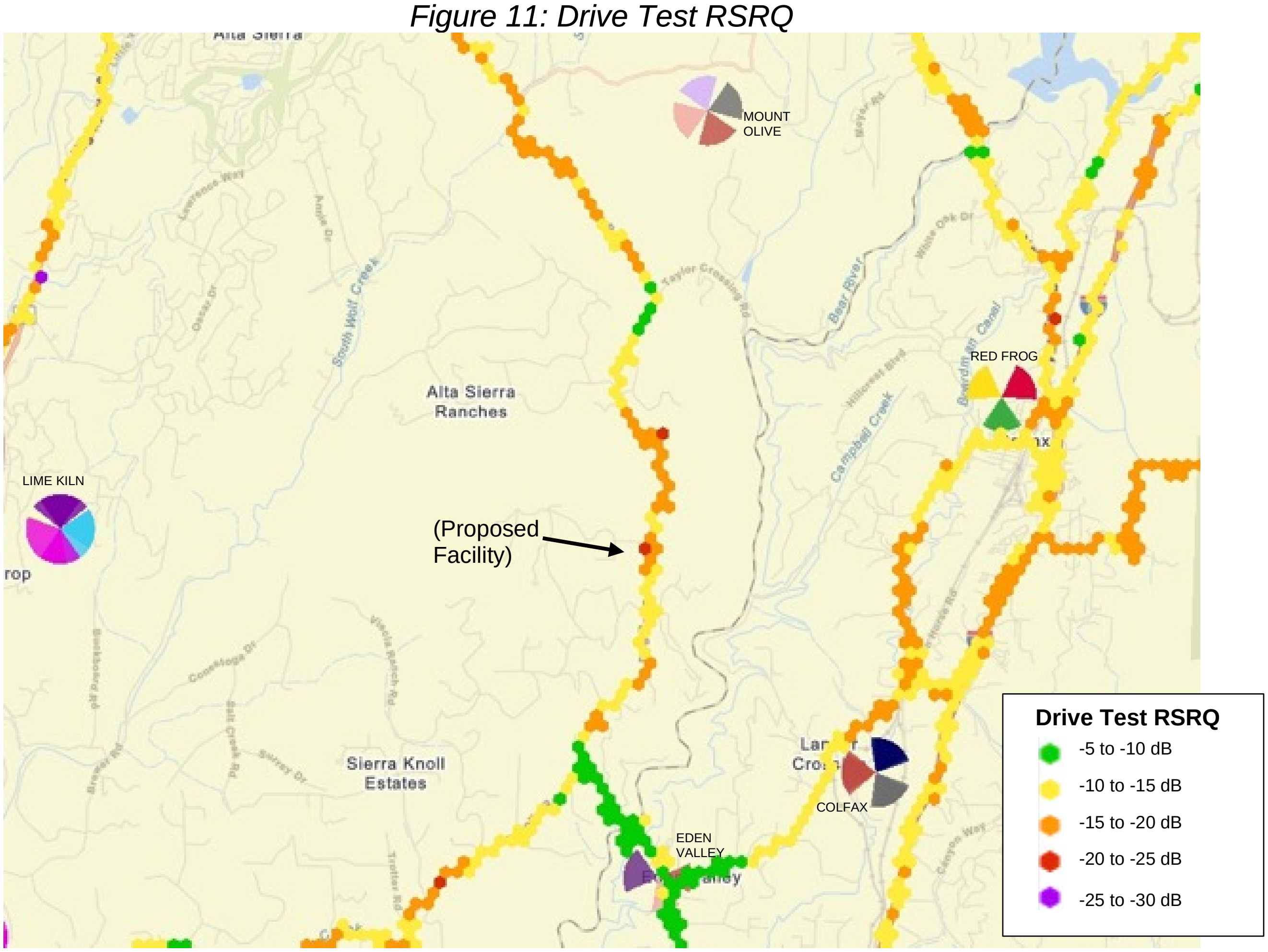
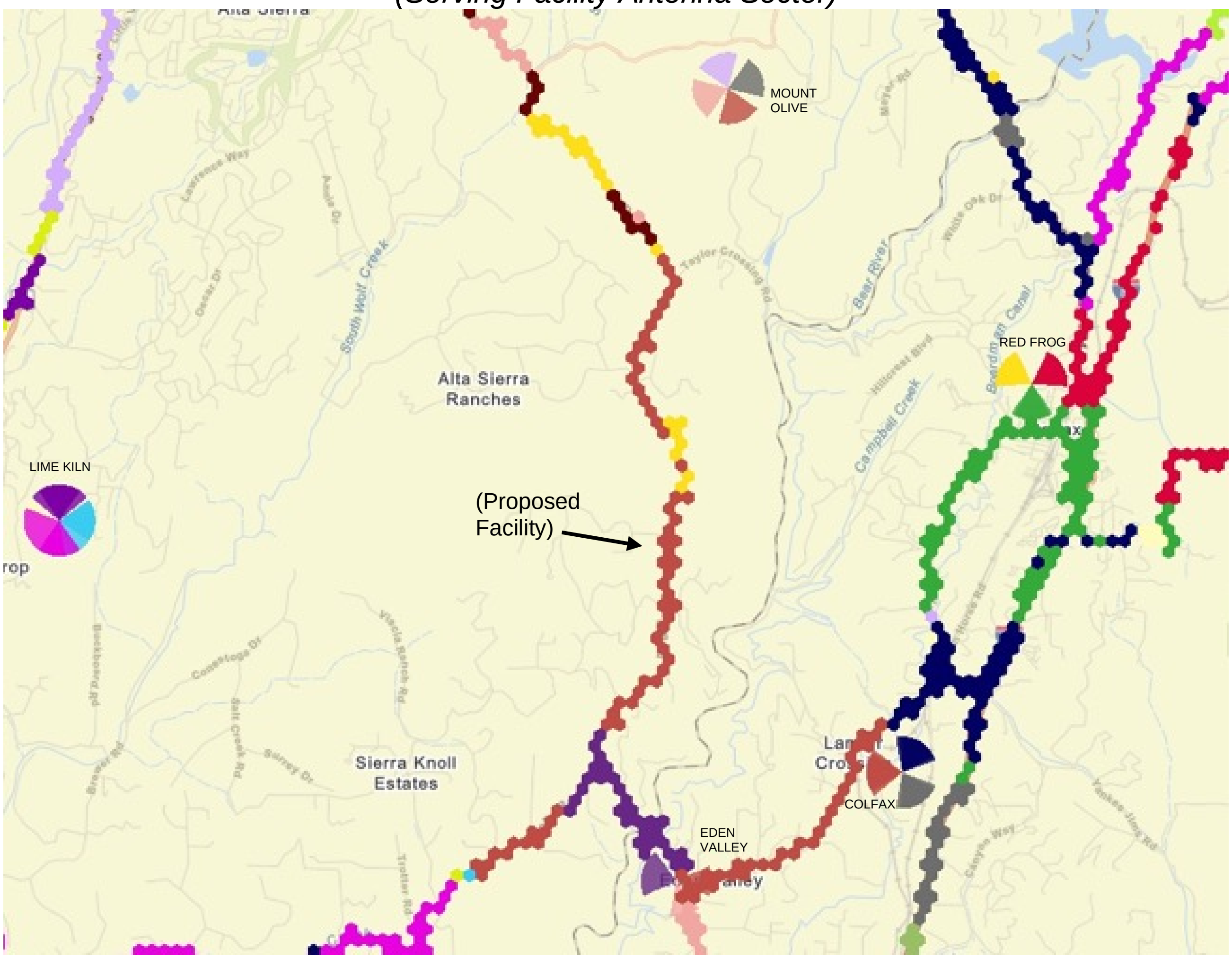


Figure 12 shows the physical cell identity (PCI) of the existing Verizon Wireless facility antenna sector that was serving the drive test device as it traveled along local roadways. The marks match the color of the existing facility antenna sector that was serving the device at that location.

The map shows that the stretch of Dog Bar Road within the gap area near the Proposed Facility was served primarily by the Colfax facility west-facing antenna sector (brown). To the north, a short stretch of the road was served by the Red Frog facility northwest-facing antenna sector (yellow).

Figure 12: Drive Test PCI
(Serving Facility Antenna Sector)



Dominant Signal and Best Serving Facility

Due to insufficient network coverage and capacity, the Significant Gap area receives inadequate service from existing Verizon Wireless facilities, which are no closer than 2.2 miles from the Proposed Facility. Those facilities provide only weak signal to the Significant Gap, as described above.

Dominant signal is signal that is strong enough to exceed interfering signal levels from other Verizon Wireless facilities and radio frequency noise from other sources. Where there is dominant signal, users can reliably access the network. Where there is no dominant signal, service is unreliable. The lack of dominant signal in the gap area is apparent in the following best server maps, Figures 13 and 14.

A best server is the Verizon Wireless facility antenna sector that provides the best signal to a certain area. Accordingly, the best server maps predict which antenna sector provides the strongest signal to user devices in a particular location, even if weak and inadequate for reliable service. Signal from each antenna sector of a facility is shown in a different color. The best server maps have been prepared for the low-band frequencies, which generally serve the most distant users. Maps were prepared using the ATOLL tool.

As shown in Figure 13, the Significant Gap area is currently served primarily by the southeast-facing sector of the Mount Olive facility (shown in light purple on the best server maps), the northwest-facing antenna sector of the Red Frog facility (green), and the northwest-facing antenna sector of the Colfax facility (yellow area to south). Signal from those facilities is substantially intermixed in the gap area, along with scattered signal from more distant facilities. This demonstrates a lack of dominant signal and poor RSRQ, which compromises network performance, including for users in transit.

The Mount Olive, Red Frog, and Colfax antenna sectors must serve large areas with many faraway users in the gap area. Distant users demand more of a facility's data resources because of increased transmission time, error correction, and other factors. As described below in the discussion of capacity demand, these facility antenna sectors are experiencing capacity exhaustion.

As shown in Figure 14, the Proposed Facility is strategically located near the center of the Significant Gap to provide strong and dominant new signal to surrounding areas (shown in shades of pink, light green, and purple). Placing a new facility near the center of the Significant Gap area and closer to users will improve local network performance. Users will be evenly distributed among the three new antenna sectors, an efficient network design intended to provide sufficient network capacity for all sectors in the future. The Proposed Facility will also relieve demand on the existing facilities so they can devote their resources to users closer to their locations. In this way, the Proposed Facility will improve overall network performance in a greater area.

Figure 13: Existing Low-Band Best Server Map

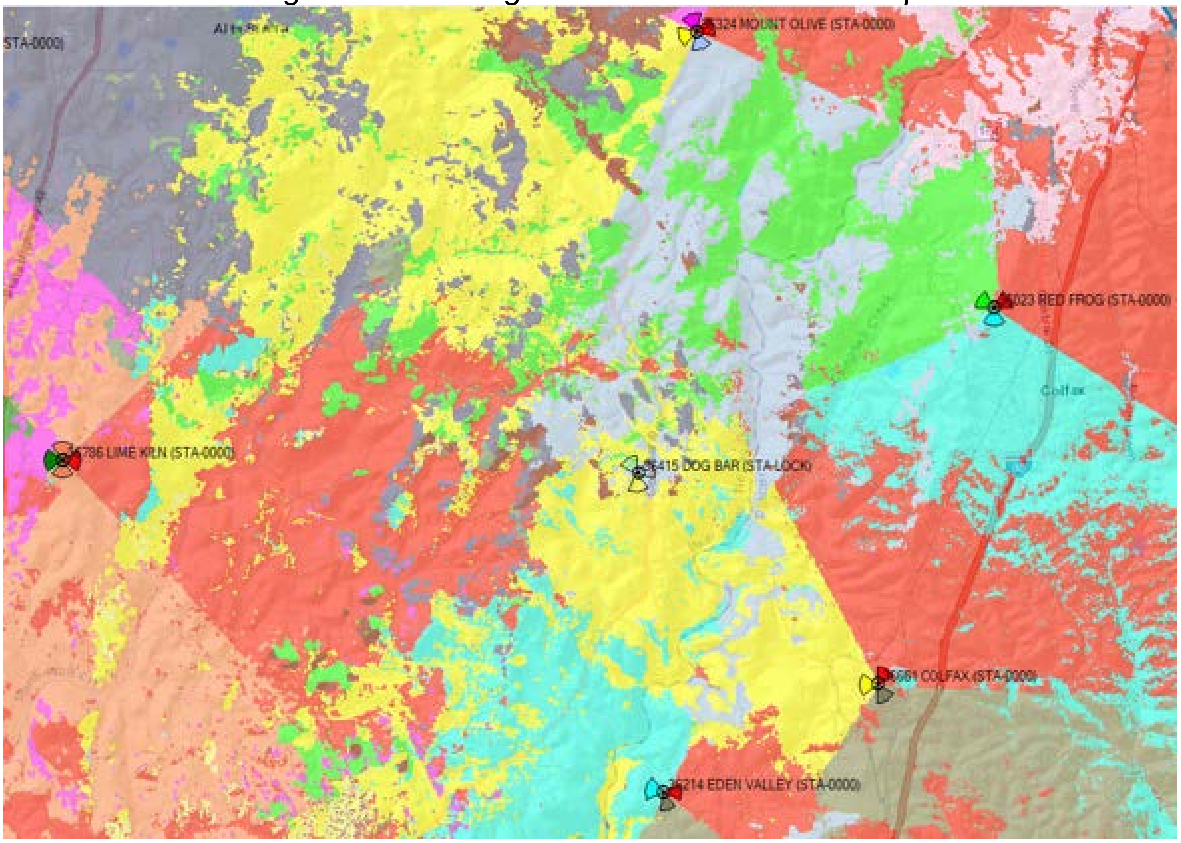
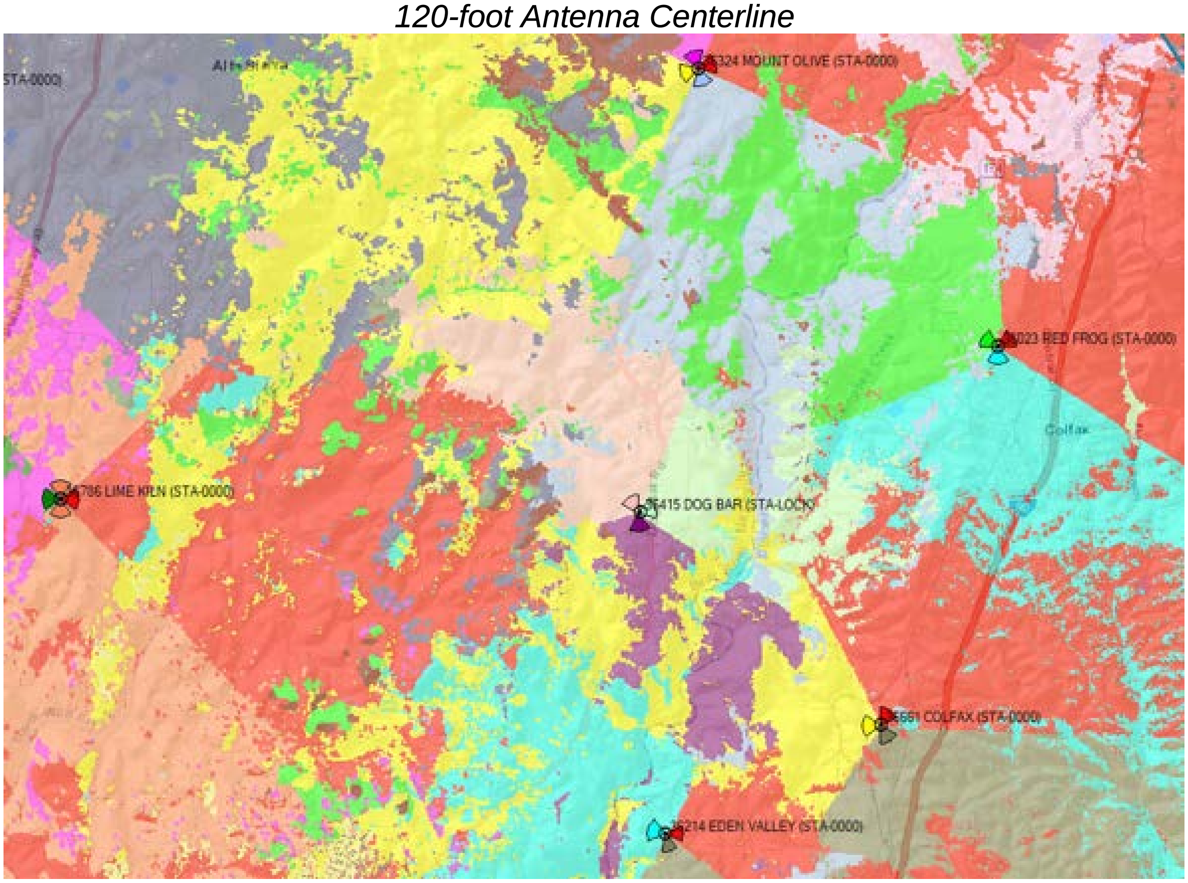


Figure 14: Low-Band Best Server Map with Proposed Facility
120-foot Antenna Centerline



The lack of strong, reliable, dominant signal degrades network performance, resulting in unreliable service, particularly during busy hours. Residents, commuters, visitors, and emergency service personnel are all affected by unreliable wireless service.

According to the National Emergency Number Association, an estimated 240 million 911 calls occur each year nationwide, with 80 percent or more of these calls originated from wireless devices in many areas. In emergencies, first responder agencies rely on dependable Verizon Wireless service, including for communication with Verizon Wireless network users.

At times of high data traffic, the coverage area of Verizon Wireless facilities shrinks to accommodate an increasing number of mobile devices closer to each facility. As a result, the coverage gap expands and is exacerbated during times of high usage. The contraction of coverage during times of high usage has become more relevant as the demand for wireless services has increased rapidly over time.

According to CTIA's *2023 Annual Survey Highlights*, the data traffic on wireless networks in the United States increased 38 percent from 2021 to 2022—double the prior year's increase. The number of active 5G devices nearly doubled from 2021 to 2022. Such devices include smartphones, tablets, medical devices, building security systems, and vehicle navigation and alert systems.

Capacity Demand

As noted above, existing Verizon Wireless facilities serving the gap area are experiencing capacity exhaustion, which compromises network performance, particularly for distant users.

Figures 15 through 18 are data capacity charts showing high usage of the nearby facility antenna sectors that primarily serve the gap area, over a one-year period from July 2023 through June 2024. FDV (Forward Data Volume) is a measurement of the total downlink data throughput of the sector in megabytes per hour, reported as a daily average. The charts are prepared for the low-band 700/850 MHz frequencies and/or the mid band PCS/AWS frequencies, depending on which are experiencing capacity exhaustion at that antenna sector.

By comparing the trend line of average usage (orange line) with the maximum capacity (red line), Figure 15 demonstrates that the Mount Olive facility southeast-facing antenna sector reached capacity exhaustion in the low-band frequencies over one year ago.

Figure 16 demonstrates that the Red Frog facility northwest-facing antenna sector reached capacity exhaustion in the mid-band frequencies in May 2024.

Figures 17 and 18 demonstrate that the Colfax facility northwest-facing antenna sector reached capacity exhaustion in the low-band frequencies well over one year ago, and will reach exhaustion in the mid-band frequencies at the end of 2024.

Capacity exhaustion compromises network performance in areas served by the exhausted antenna sectors, leading to voice call failures, and slow data speeds.

Figure 15: FDV Capacity Chart
Mount Olive Facility, Southeast-Facing Antenna Sector
Low-Band Frequencies
July 2023-June 2024

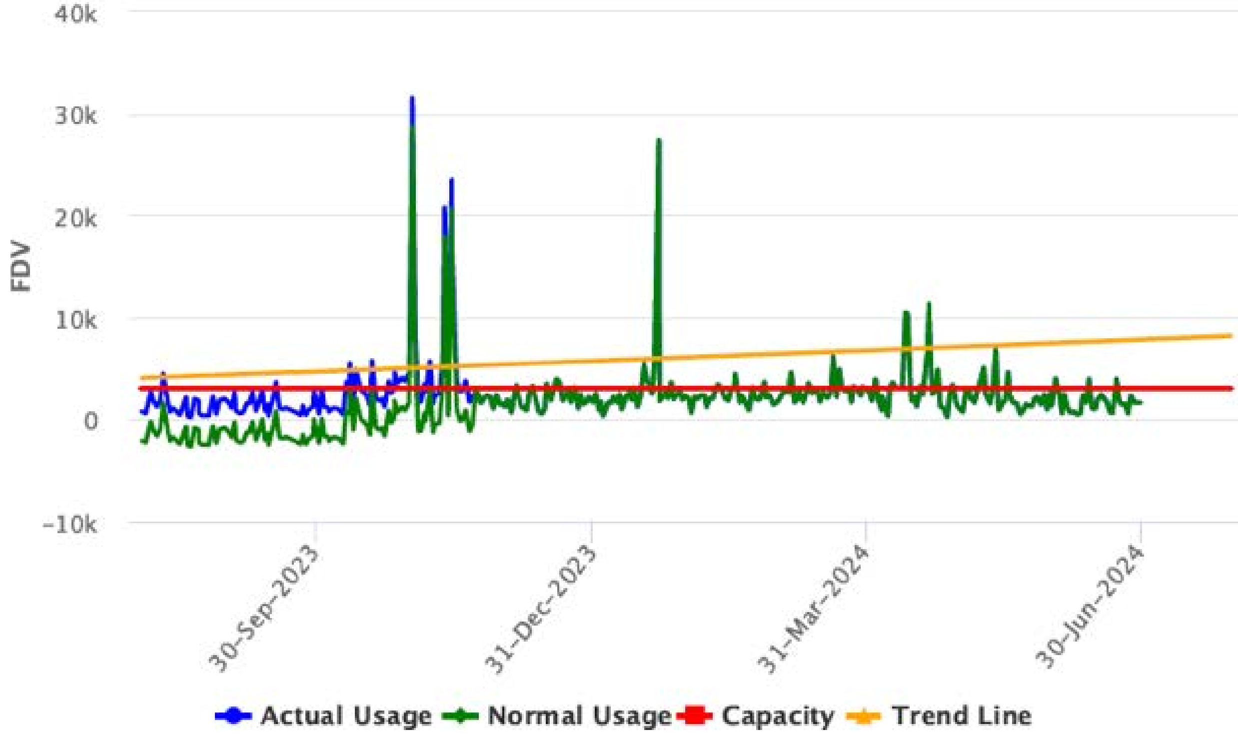


Figure 16: FDV Capacity Chart
Red Frog Facility, Northwest-Facing Antenna Sector
Mid-Band Frequencies
July 2023-June 2024

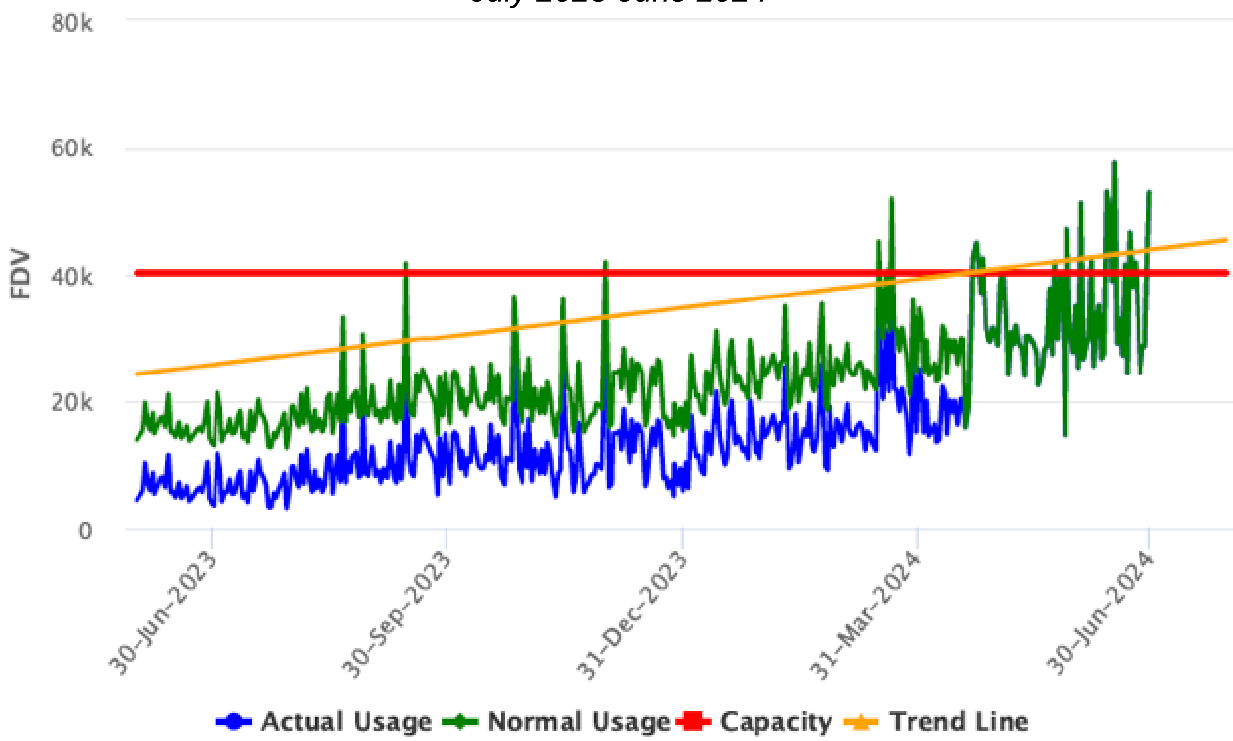


Figure 17: FDV Capacity Chart
Colfax Facility, Northwest-Facing Antenna Sector
Low-Band Frequencies
July 2023-June 2024

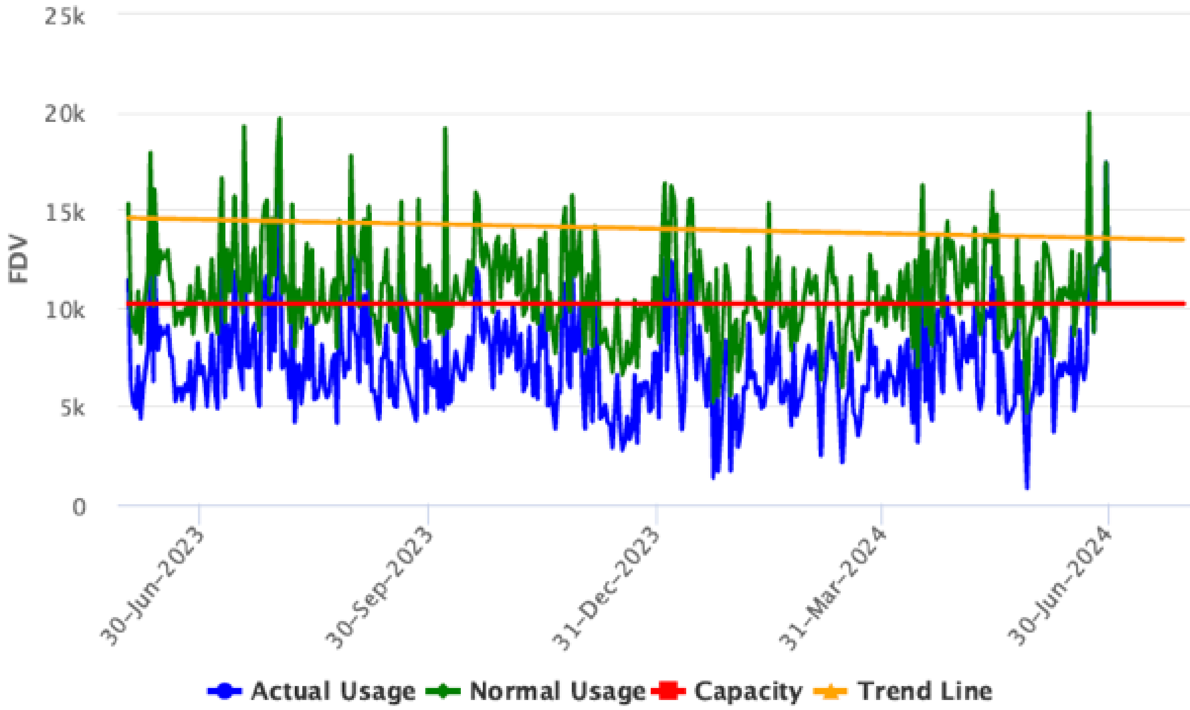
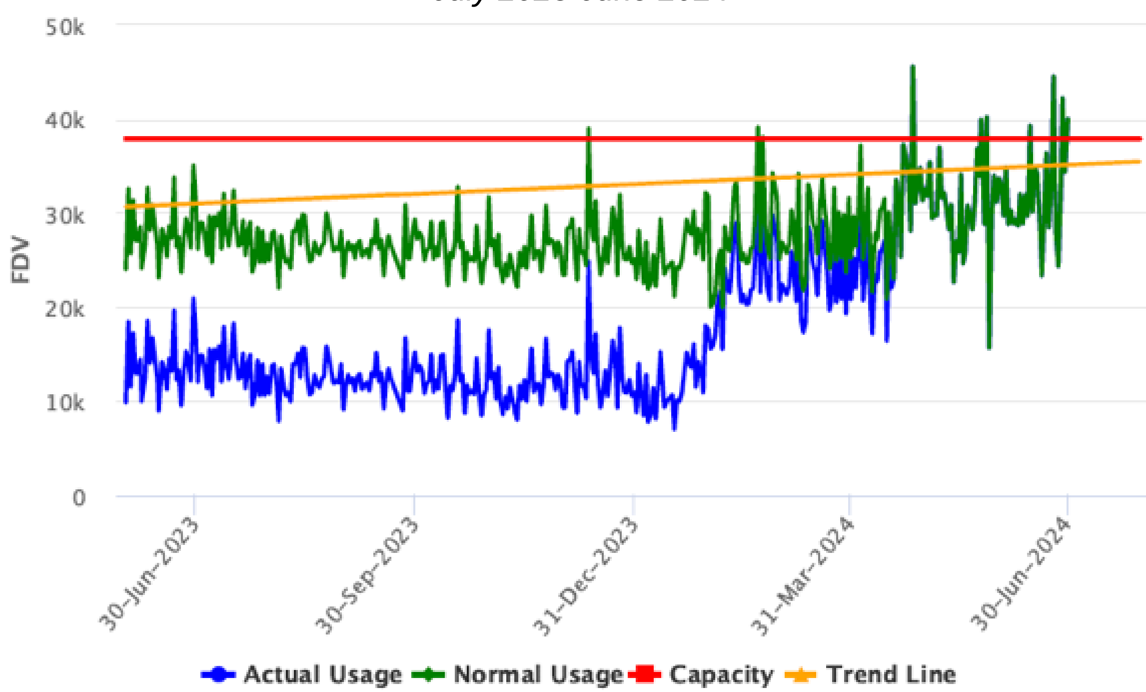


Figure 18: FDV Capacity Chart
Colfax Facility, Northwest-Facing Antenna Sector
Mid-Band Frequencies
July 2023-June 2024



On the next pages, Figures 19 through 22 compare the channel transmission time interval (TTI) occupancy of local facility antenna sectors with their data throughput during a recent one-week period from July 13 through July 19, 2024, in specific frequency bands experiencing capacity exhaustion at those facilities.

- ***Downlink Channel TTI Occupancy (red line, left axis).*** This metric shows the hourly average of the transmission time interval (TTI) occupancy, which is the percentage of an antenna sector's data resource blocks that is in use within a fixed timeframe. When TTI occupancy exceeds 80 percent, the number of data blocks available per user is reduced, data throughput is significantly reduced, and service degrades. When TTI occupancy approaches 100 percent and the facility's data resources are exhausted, existing connections are severely degraded, voice calls may drop, and users attempting new connections are rejected.

- ***Downlink Data Throughput (green line, right axis).*** This metric shows the hourly average downlink data throughput (download speed) experienced by network users, measured in megabits per second.

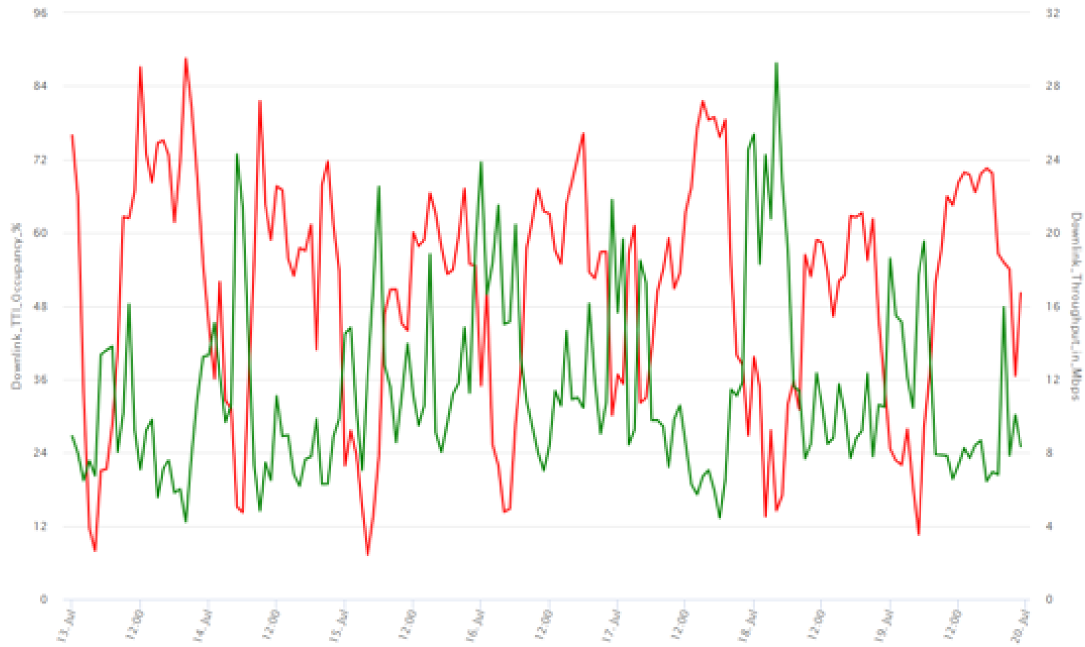
As the TTI occupancy spiked during daytime hours each day, the data throughput correspondingly fell in certain frequency bands.

For the low-band 700 MHz frequency band of the Mount Olive, Red Frog, and Colfax facility antenna sectors serving the gap area, TTI occupancy was high on many days, with a resulting severe drop in data throughput, as follows:

> **Figure 19.** TTI occupancy of the Mount Olive facility southeast-facing antenna sector reached or exceeded 80 percent on several days. Data throughput fell below 5 megabits/second on several days, and as low as 4 megabits/second at times.
>
> **Figure 20.** TTI occupancy of the Red Frog facility northwest-facing antenna sector approached or exceeded 80 percent every day. Data throughput fell to 5 megabits/second or below every day except Friday July 19, 2024, falling below 4 megabits/second on several days.
>
> **Figure 21.** TTI occupancy of the Colfax facility northwest-facing antenna sector exceeded 80 percent every day, and exceeded 90 percent on five days, reaching 100 percent on two days. Data throughput fell as low as 6 megabits/second or below on several days.

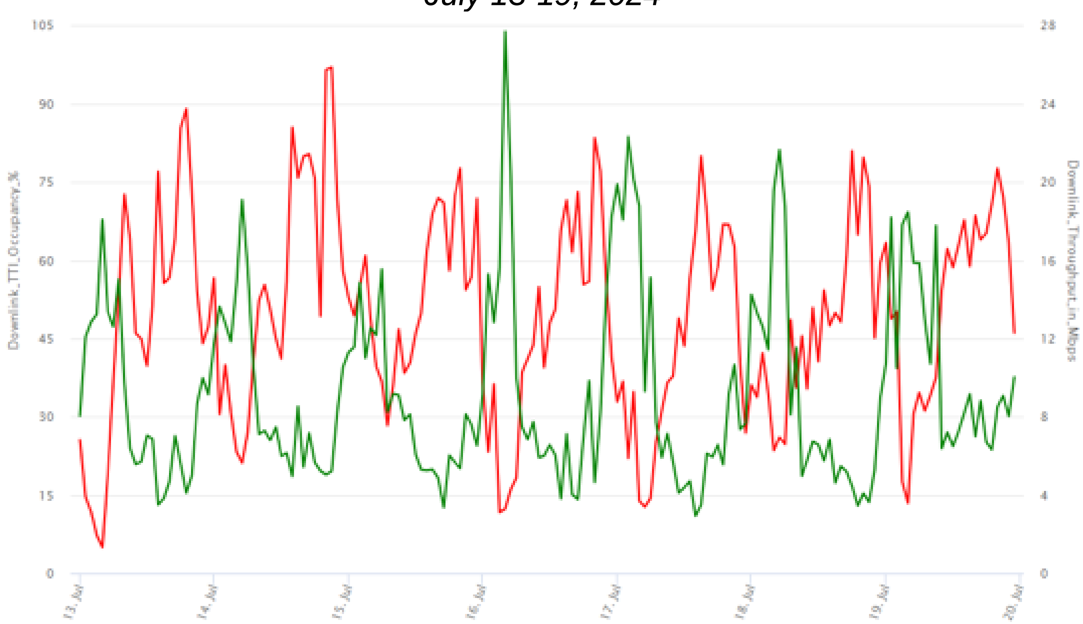
The low-band frequencies travel farther and generally serve the most distant network users. They also are the bands most likely to reach full TTI occupancy during times of high usage, when the higher frequency bands are already allocated to providing reliable service to other local users. When the low-band frequencies reach capacity exhaustion, the users allocated to those frequencies experience unreliable service. The existing facility no longer has the capacity to provide reliable service to all connected users.

Figure 19: TTI Occupancy versus Data Throughput
Mount Olive Facility, Southeast-Facing Antenna Sector
Low-Band 700 MHZ Frequency
July 13-19, 2024



TTI Occupancy % (left axis)
Downlink Throughput (Megabits/sec, right axis)

Figure 20: TTI Occupancy versus Data Throughput
Red Frog Facility Northwest-Facing Antenna Sector
Low-Band 700 MHZ Frequency
July 13-19, 2024



TTI Occupancy % (left axis)
Downlink Throughput (Megabits/sec, right axis)

Figure 21: TTI Occupancy versus Data Throughput
Colfax Facility, Northwest-Facing Antenna Sector
Low-Band 700 MHZ Frequency
July 13-19, 2024

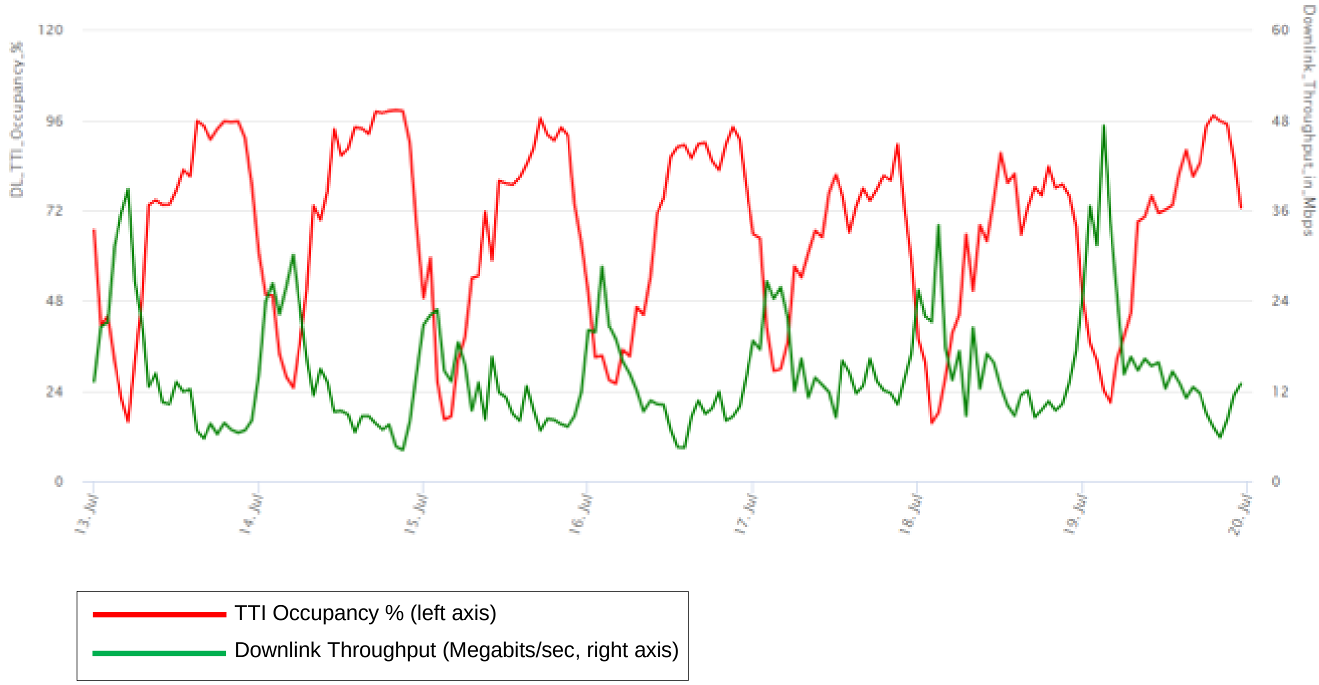


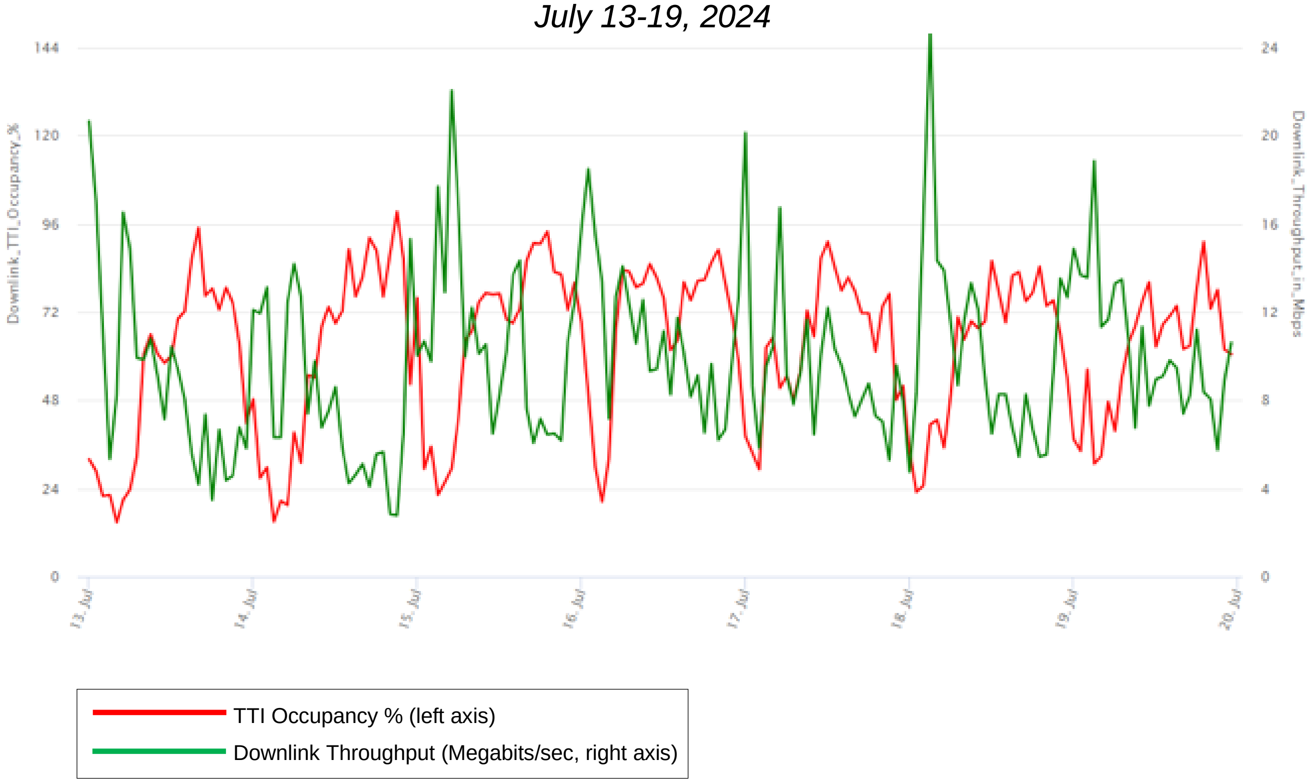
Figure 22 shows that for the mid-band AWS frequency of the Colfax facility northwest-facing antenna sector, TTI occupancy spiked over 88 percent every day. Data throughput fell below 4 megabits/second on several days.

The Colfax facility northwest-facing antenna sector serves a significant portion of the gap area, according to the best server map in Figure 13. In fact, it serves almost all of Dog Bar Road within the gap area, according to the drive test map in Figure 12.

This antenna sector is experiencing TTI capacity exhaustion in both the low-band 700 MHz frequency generally serving distant users (Figure 21) and the mid-band AWS frequency serving closer users (Figure 22). Of note, the long-range FDV capacity charts for this antenna sector (Figures 17 and 18) confirm that it is experiencing capacity exhaustion in both the low-band 700/850 MHz frequencies and the mid-band PCS/AWS frequencies.

The Proposed Facility will provide new dominant signal to the gap area, relieving the exhausted Mount Olive, Red Frog, and Colfax facility antenna sectors serving the gap area, allowing them to allocate their resources to users closer to their locations. This will improve service in a wider area.

Figure 22: TTI Occupancy versus Data Throughput
Colfax Facility, Northwest-Facing Antenna Sector
Mid-Band AWS Frequency
July 13-19, 2024



Conclusion

As the Verizon Wireless network matures, it must be supplemented with facilities closer to users, due to the increase in usage of the network. New wireless technology requires facilities closer to users, and this service cannot be provided adequately by the existing distant Verizon Wireless facilities, which provide only weak signal to the gap area, with the nearby facilities experiencing capacity exhaustion. These network challenges have led to the Significant Gap in Verizon Wireless voice and data service coverage in western Nevada County in areas around southern Dog Bar Road. Verizon Wireless must deploy the Proposed Facility to provide reliable service to users, and to avoid further degradation of its network in the area of the Significant Gap.

Please feel free to contact me with any questions or comments regarding Verizon Wireless's proposed facility.

Respectfully submitted:

Ehab Elaidy

Ehab Elaidy
RF Design Engineer
Network Engineering Department
Verizon Wireless

My responsibilities include planning, design and implementation of improvements to network infrastructure to provide reliable service. I have 30 years of experience in the wireless telecommunications industry, including wireless network design. I received my Bachelor of Science degree in Computer Engineering Technology at the University of Houston.

Approved by:

Sanjiv Sinnaduray
Associate Director – Radio Frequency
Network Engineering Department
Verizon Wireless

I direct a team of 14 RF Engineers in the planning and design of Verizon’s network in Northern California and Northern Nevada. This includes the deployment of new network assets, as well as the modification of existing assets. In total, I have 13 years of experience in the wireless industry with Verizon Wireless, including wireless network design. I have a Bachelor of Science in Electrical Engineering from the University of California – Los Angeles (UCLA).