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Witness: Neville R. Ray
ALJ: Karl Bemederfer
Commissioner: Clifford Rechtschaffen

REBUTTAL TESTIMONY OF NEVILLE R. RAY

**EXECUTIVE VICE PRESIDENT AND CHIEF TECHNOLOGY OFFICER
T-MOBILE USA, INC.**

ON BEHALF OF T-MOBILE USA, INC.

Dated: JANUARY 29, 2019

(Corrected Version: Re-served on February 4, 2019)

[PUBLIC VERSION]

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ATTACHMENT A - Declaration of Neville R. Ray in support of the Public Interest Statement
(Confidential)

ATTACHMENT B - Reply Declaration of Neville Ray (Confidential)

ATTACHMENT C - Overview of Network Model Presentation (Confidential)

ATTACHMENT D - California Projected 2021 & 2024 5G County Level Coverage
(~~Confidential~~) (Public)

ATTACHMENT E - T-Mobile West LLC NORS Report (Confidential)

1 **I. WITNESS IDENTIFICATION**

2
3 **Q: Please state your name, occupation, and business address.**

4 **A:** My name is Neville R. Ray. I am the Executive Vice President and Chief Technology
5 Officer of T-Mobile US, Inc. ("T-Mobile"). My business address is 12920 SE 38th Street,
6 Bellevue, Washington 98006.

7
8 **Q: Please describe your professional qualifications.**

9 **A:** I joined T-Mobile (then VoiceStream) in April 2000 and since December 2010 have
10 served as its Chief Technology Officer, responsible for the national management and
11 development of the T-Mobile wireless network and the company's IT services and operations. I
12 have more than 30 years of experience in the design, deployment and operational management of
13 wireless networks in the United States and worldwide. Prior to joining T-Mobile, I served as
14 Network Vice President for Pacific Bell Mobile Services. This role included material
15 contribution to the rollout of one of the first and largest GSM networks in the country from 1995
16 through 2000 with coverage in the state of California. I currently serve on the Board of Directors
17 of Next Generation Mobile Networks Alliance, a mobile telecommunications association of
18 mobile operators, vendors, manufacturers and research institutes. I also serve as the Chairperson
19 of 5G Americas, the industry trade association and voice of 5G and LTE for the Americas,
20 having returned to that role after serving as the Chairperson from 2008 through 2013, and again
21 in 2015. I have additionally served as a member of the National Telecommunications and
22 Information Administration's Commerce Spectrum Management Advisory Committee and the
23 Federal Communication Commission's Communications Security, Reliability and
24 Interoperability Council. I am an honors graduate of The City University of London and a
25 member of the Institute of Electrical and Electronic Engineers and the Institution of Civil
26 Engineers.

27
28 **Q: What is your involvement in the T-Mobile merger with Sprint?**

29 **A:** In my capacity as T-Mobile's Executive Vice President and Chief Technology Officer, I
30 have been engaged in particular with the network and engineering considerations related to T-

1 Mobile's proposed merger with Sprint Corporation ("Sprint") and the evaluation of the technical
2 benefits and opportunities presented by New T-Mobile's 5G network. I am a member of the
3 Senior Leadership Team at T-Mobile, who, along with CEO John Legere, recommended the
4 transaction to the Board of Directors.
5

II. PURPOSE OF TESTIMONY

Q: What is the purpose of your rebuttal testimony?

A: The purpose of my testimony is to respond to various claims and to rebut certain incorrect assertions made in the testimony submitted by witnesses for the California Public Advocates Office (“Cal PA”) and the Communications Workers of America (“CWA”) regarding the planned New T-Mobile network and the benefits that this world-leading 5G network will bring to California. In that context, my testimony will also address certain issues raised by the Scoping Ruling, including merger-specific and verifiable efficiencies, the effect of the transaction on coverage (availability), speed (fiber like) and capacity (lower costs and new services like in-home broadband).

Q: Can you summarize your testimony?

A: My testimony will respond to testimony submitted by Cal PA and CWA which, in brief, seem to suggest that true 5G networks and the associated benefits could somehow be realized by standalone T-Mobile and Sprint. These parties further suggest that the Applicants have not properly calculated the merger benefits and some have even suggested that the merger would negatively impact the resiliency of what the Applicants’ networks deliver today. These statements reflect a fundamental misunderstanding of (1) what it takes to deploy robust 5G available to all and (2) the merger-specific public interest benefits enabled by New T-Mobile’s nationwide 5G network.

As I will discuss below in detail, the benefits of New T-Mobile’s 5G network in terms of *coverage, speed, and capacity* – and all the potential consumer uses which depend on those metrics - are simply not possible without the combination of spectrum and other assets created by the merger. T-Mobile and Sprint, as standalone entities, do not have the spectrum, the sites, or the resources to create a network that would so significantly alter the wireless landscape as New T-Mobile. On its own, T-Mobile’s 5G network would have good coverage but relatively limited capacity, while Sprint’s 5G network would have capacity but very limited coverage. And neither company has a business case comparable to New T-Mobile’s to expand service to rural

1 and less densely-populated areas because their costs for doing so would be much higher than
2 New T-Mobile's and their customer base is much smaller.

3 As publicly announced, other wireless providers' 5G networks also have severe
4 limitations and will therefore deprive many consumers of the potential benefits of broad and
5 deep 5G. This merger will enable the combined company, New T-Mobile, to build a robust
6 nationwide 5G network at an accelerated pace, leapfrogging Verizon and AT&T in speed and
7 capacity across the country and in the state of California. The combination of New T-Mobile's
8 site density (combining T-Mobile's sites with retained Sprint sites), its complementary spectrum
9 portfolio, and increased spectral efficiency due to the accelerated move to 5G will result in a
10 massive amount of capacity and guarantee the best use of the combined spectrum.

11 As a result, customers in California – including in rural areas – will benefit from super
12 high speeds. New T-Mobile will deliver download speeds exceeding ~~{Begin Confidential~~
13 ~~Information—Attorneys Eyes Only (“BHC-AEO”)}~~ 100 Mbps to almost 80% of California
14 customers by 2021, reaching 99% with download speeds exceeding 100 Mbps and over 90%
15 with download speeds exceeding 300 Mbps by 2024. ~~{End Confidential Information—~~
16 ~~Attorneys Eyes Only (“EHC-AEO”)}~~

17 Contrary to what CWA argues, the merger will accelerate closure of the “digital divide,”
18 by bringing unprecedented capacity and 5G applications to all Californians, including those in
19 rural areas. The low-band spectrum T-Mobile is currently deploying for 5G services, including
20 in rural areas, does not provide the capacity needed to enable key applications (including home
21 broadband) or speeds deemed sufficient to “cut the cord.” T-Mobile also does not have the
22 sufficient mid-band spectrum to increase capacity without impacting LTE performance. At the
23 same time, Sprint today is not using a significant chunk of its valuable mid-band spectrum,
24 because the build-out cost is prohibitive, due to its small customer base in these areas, and it
25 lacks the low-band spectrum coverage layer that is possible with New T-Mobile. Because New
26 T-Mobile will have a broad base layer of 5G coverage, and has to complete the network
27 migration, New T-Mobile will be able to economically deploy Sprint's 2.5 GHz spectrum over a
28 much broader portion of California than could standalone Sprint. In short, the combination will
29 resolve both companies' spectrum deficiencies and will create a combined company with

1 perfectly complementary spectrum, which will form the foundation for a game-changing 5G
2 network, for the benefit of all Californians, inside and outside densely-populated areas.

3 Finally, the Sprint network migration process to create New T-Mobile will be seamless
4 and rapid. Our plan is heavily based upon our successful experience in migrating MetroPCS
5 customers to the T-Mobile network, which analysts refer to as the “template for almost any
6 telecom merger.”¹ As we will use the same game plan, and many of the same tools and team for
7 the migration of the Sprint customer base, I am confident that California subscribers will rapidly
8 receive the full benefits of the combined network without negatively affecting their experience in
9 the interim.

10
11 **Q: Are you generally familiar with these proceedings at the Commission?**

12 **A:** Yes. I understand that my company and Sprint have submitted two joint filings with the
13 Commission. One is an application that seeks approval for the transfer of control of ownership
14 of the wireline authorizations held by Sprint for services in California to New T-Mobile. The
15 other filing is a notification that provides the Commission with information concerning the
16 wireless merger. My understanding is that the Commission has set these hearings to address any
17 potential factual issues regarding these applications.

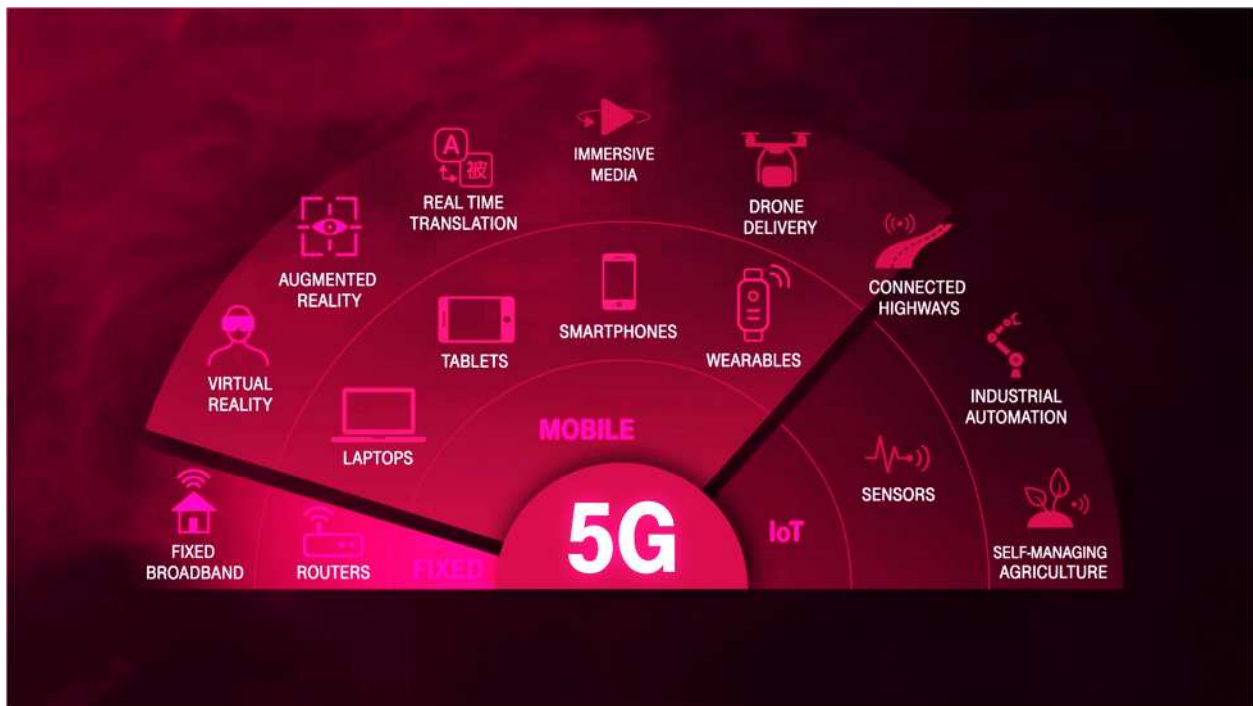
18
19

¹ Aaron Pressman, *How T-Mobile Turned a Tough Merger Into an Industry Success* (May 5, 2017),
fortune.com/2017/05/05/t-mobile-metropcs-merger/.

III. BACKGROUND

Q: Why is 5G relevant to the interests of California consumers?

A: 5G will deliver a transformative leap forward in wireless speed and capacity that will enable dramatic improvements in existing services and open the door to innovations that spark profoundly important new services. The chart below provides a scan of some of the prominent advances 5G will move from ideas to realities:



The improvements inherent in 5G will usher in a new wave of applications and spawn new business opportunities and customer benefits. It will not only be an evolution of mobile broadband networks, it is also envisioned to enable new unique network and service capabilities. The connectivity increase supported by 5G networks will be essential to support fiber-like data speeds, low latency for real-time interactivity, more consistent performance and user experience, and massive capacity for unlimited data (for things like 4K video streaming, online gaming and other capacity hungry applications) that cannot be served across a substantial number of users by 4G. The new 5G ecosystem will enable new forms of mobile media and entertainment—no

1 longer will consumers be required to subscribe to multiple network providers to watch television
2 and movie content wherever and whenever they want. Subscribers will be able to develop and
3 share rich user-generated content, regardless of file size or location. Congested environments,
4 such as sporting events, concerts, and large enterprises, will no longer be constrained.
5 Commuters will have high-speed data available—allowing video streaming of state-of-the-art 4K
6 content and the ability to download any file nearly instantaneously while traveling on public
7 transit. And novel and innovative new applications such as virtual and augmented reality,
8 connected vehicles and highways, real-time translation, and drone control/monitoring could
9 dramatically reshape the way consumers engage and enjoy new content and experiences.

10
11 **Q: Won't 5G happen without a merger? Cal PA contends that many of the purported**
12 **merger benefits are really just the result of the deployment and adoption of 5G-enabled**
13 **services in general, and are not merger-specific benefits (Reed Testimony at p. 10). How do**
14 **you respond?**

15 **A:** For consumers to enjoy the immense benefits of 5G, they will need access to a robust 5G
16 network that provides a consistent experience across California. That is what we will deliver to
17 consumers, wherever they are. While each company will deploy 5G, neither company's 5G
18 network will deliver anything close to what the combined company's 5G will deliver in terms of
19 breadth, depth, speed and capacity, and certainly not in any timeframe close to that which New
20 T-Mobile's network will be deployed. The benefits of that accelerated technological
21 development will bring permanent benefits to consumers in California and across the country.

22
23 **Q: What would you say to CAL PA about the key factors for 5G and why you need a**
24 **merger as opposed to just doing 5G on your own?**

25 **A:** As a general matter, 5G will bring faster networks with greater capacity due to
26 improvements in the underlying wireless technology as well as in spectral efficiency. This is
27 because the 5G standard enables significantly greater spectral efficiency as compared to LTE.
28 However, as I will discuss in greater detail below, Cal PA entirely misses that spectral efficiency
29 is only one piece of delivering a robust 5G network to California consumers. The important

1 missing pieces include (1) access to additional cell sites and (2) additional complementary
2 spectrum deployed at each of these cell sites.

3 Our merger combines complementary sites and spectrum to deliver a 5G network with
4 capabilities far beyond anything that could be accomplished by T-Mobile and Sprint. New T-
5 Mobile's complementary spectrum portfolio will allow us to deliver a broad and deep 5G
6 network, as compared to a standalone T-Mobile 5G network that would be broad but thin, and a
7 standalone Sprint 5G network that would be deep but narrow. Our merger is so compelling
8 because the differences between the world with and without the merger are in orders of
9 magnitude and not just small degrees. They add up to massive benefits for California
10 consumers.

11
12 **Q: You mentioned that New T-Mobile's 5G will result in increased capacity being**
13 **available to consumers. What determines capacity of a wireless network?**

14 **A:** The basic formula for determining wireless network capacity is:

$$\text{Number of cell sites} \times \text{Spectrum (MHz) Deployed Per Site} \times \text{Spectral Efficiency} = \text{Capacity}$$

15
16
17 As the formula makes clear, adding to any one of these three elements multiplies the
18 capacity benefits. Here, the combination of Sprint and T-Mobile will enable the combined
19 company to: (1) access more cell sites, thereby increasing network coverage and density, (2)
20 utilize the complementary spectrum of both companies across those sites, and (3) achieve higher
21 spectral efficiencies from faster refarming of spectrum from LTE to 5G. The combination of
22 these three elements will dramatically increase the overall capacity of the new network and
23 deliver world-class speed and user experiences to consumers.

24 I have explained in detail how the combination of complementary sites and spectrum, and
25 spectral efficiency, has a multiplier effect for network benefit in my declarations submitted to the
26 Federal Communications Commission ("Commission" or "FCC") in support of the Public
27 Interest Statement and in the Joint Opposition. I am including a copy of both of those
28 declarations to my testimony as Attachments A and B respectively.

1 **Q: Can you briefly describe some of the key 5G network improvements resulting from**
2 **the merger; especially here in California?**

3 **A:** Yes. As compared to the standalone Sprint and T-Mobile 5G networks, the benefits are
4 very impressive, in particular in California. Those key benefits, which I will describe more fully
5 below include:

- 6 • Significantly greater 5G coverage area across California, especially for Sprint
7 customers—providing high-capacity, mid-band 5G coverage for the overwhelming
8 majority of Southern California, California’s Central Valley, the greater Bay Area, and
9 much of rural California;
10
- 11 • Far faster speeds to more Californians—delivering data rates greater than 150 Mbps to
12 97 percent of the population and greater than 300 Mbps to 93 percent of the population
13 by 2024. In the Benefits to California Consumers section I discuss specifically how
14 these gains compare to the combined standalones;
15
- 16 • Greater network capacity which allows more consumers to use the network at the same
17 time while allowing those same consumers to demand even more of the network—
18 providing almost two times the total capacity (5G and LTE) of the combined standalones
19 and more than twice (2.3X) the total 5G capacity of the combined standalones in 2024;
20 and
21
- 22 • Robust and uninterrupted LTE coverage during the transition to 5G—leveraging
23 combined spectrum resources to enable rapid transition of low- and mid-band spectrum
24 to 5G, without compromising LTE coverage or performance for customers waiting to
25 transition.
26

27 **Q: Cal PA testifies that there is no need for a rush to 5G and that T-Mobile is off the**
28 **mark in building capacity to meet demand that doesn’t exist. Cal PA asserts that that you**
29 **have built your network model on unrealistic adoption rates, inflated data consumption,**
30 **overaggressive refarming projections and that you underestimate the standalone networks’**
31 **performance (Reed SQ Testimony at pp. 20-23; Reed Network Testimony at pp. 12–16.).**
32 **What is your response?**

33 **A:** My experience is that each generational transition in wireless technology has led to a big
34 step-change in wireless data consumption. Higher connection speeds, improved devices, and
35 content have led to demand consistently outstripping estimates of what capacity would be.

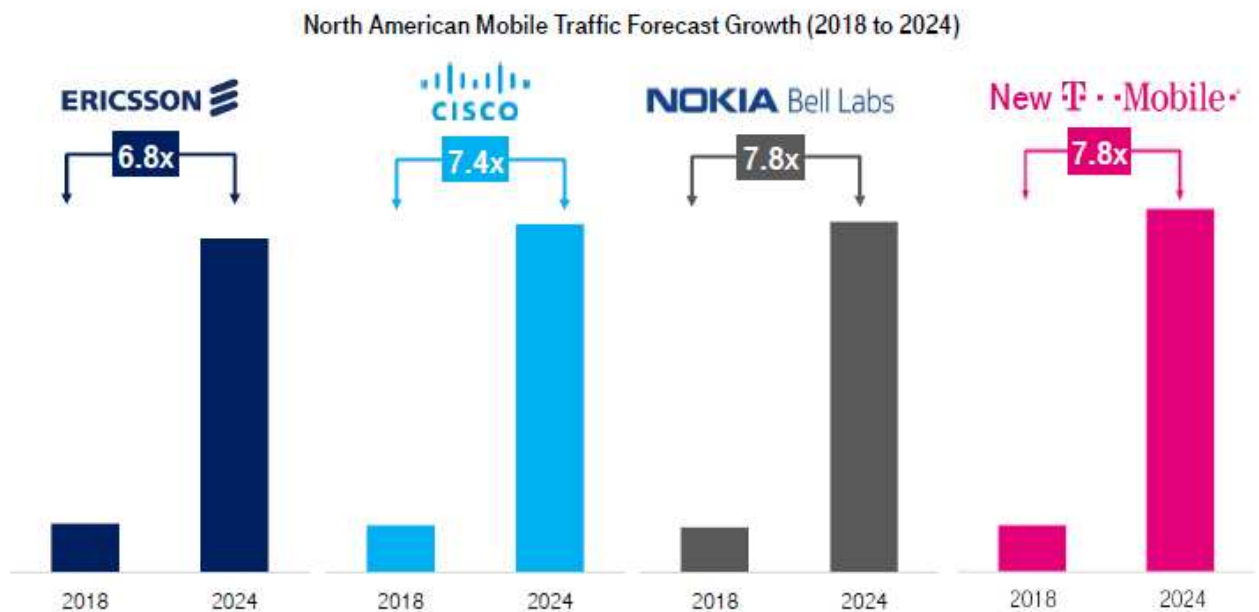
1 Also, as we discuss in our Public Interest Statement, our demand forecasts for the next 6
2 years indicate that consumers are likely to continue growing their demand by over 30 percent per
3 year, a rate of data growth that standalone T-Mobile would be unable to meet without either
4 merging with Sprint or degrading the quality of service. Our network and demand models and
5 forecasts of network traffic are extremely detailed and were meticulously prepared. While Cal
6 PA seems to rely principally on online articles and blog posts to speculate future demand for 5G,
7 we are basing our \$40 billion investment over the next three years on thoroughly vetted and
8 tested analytics.

9 Anticipating shifts in mobile wireless consumption requires an understanding of the
10 sources of demand growth. T-Mobile's ordinary course demand forecasting method incorporates
11 root drivers of demand, which are a combination of both consumer behavior (i.e., the amount of
12 time spent on a mobile application), and content richness (i.e., how much network throughput is
13 required). This method has proven to be a very reliable input into T-Mobile's network capacity
14 model. T-Mobile's 5G demand forecast uses this same methodology to understand both (1) how
15 consumers' rising expectations in a 5G world will lead to a demand for increased quality of
16 existing applications, and (2) how 5G will enable growth of emerging applications that will
17 further increase the demand for data.

18 In order to predict 5G demand, T-Mobile projected both consumer behavior and the
19 content richness expected for both current applications on a 5G network and new applications
20 enabled by 5G. For instance, T-Mobile's 5G demand forecast considers higher video
21 resolutions, including both 1080p and 4K video options available in the future, in an attempt to
22 understand what will be needed to continue offering innovative and competitive wireless
23 offerings. It also considers augmented reality ("AR") and virtual reality ("VR") applications that
24 5G throughput and capacity will be positioned to handle. More generally, the forecast considers
25 multiple existing and emerging applications and performs a thorough analysis to provide a best
26 estimate of the demand those applications will put on wireless networks in the near
27 future. Taking these applications into account the model projects that the average 5G subscriber
28 will demand 38.2 GB/month in 2021, increasing to 83.5 GB/month in 2024.

We then further validated our 5G demand forecast by comparing the data growth rates to similar projections from Cisco, Nokia Bell Labs, and Ericsson:

Industry Forecasts reflect similar growth trend from 2018 to 2024



Source: North American Data; TMUS Analysis of Industry reports
Ericsson Mobility Report (June 2018) "Mobile Data per Active Smartphone"
Estimated Cisco "Average Mobile Connection Traffic Per Month" (retrieved May 2018);
Estimated Nokia-Bell Labs (Consulting Report 2016) "Wireless Data Demand per Device"
Various external studies shows that T-Mobile customers use more data than competition on average

- Cisco's 2017 Visual Network Index predicted that mobile data usage would increase at a CAGR of 47 percent through 2021. Applying this growth rate to T-Mobile's end-of-year 2017 sub/month network usage of 10.1 GB calculates to approximately 47 GB/sub/month in 2021.
- The June 2017 Ericsson Mobility Report estimated that mobile data usage would increase at a CAGR of 42 percent between 2016 and 2022. Applying this growth rate to T-Mobile's end-of-year 2017 sub/month network usage of 10.1 GB calculates to approximately 41 GB/sub/month in 2021.
- The Nokia Bell Labs Mobility Report estimated that data demand per device would increase at a CAGR of approximately 43.5 percent from 2016 to 2020.

1 Applying this growth rate to T-Mobile's end-of-year 2017 sub/month network
2 usage of 10.1 GB calculates to approximately 43 GB/sub/month in 2021.
3

4 Therefore, T-Mobile's estimated demand is conservative by comparison to these three industry
5 bellwethers. Finally, although T-Mobile's 5G forecast projected the demand of emerging use
6 cases such as AR and VR, the forecast is nonetheless conservative in that it does not account for
7 currently unknown use cases. History has shown that application developers craft new and
8 creative ways to consume data as wireless carriers increase capacity. Our estimates are bounded
9 by the extrapolation of existing and emerging use cases, and thus likely fails to capture new,
10 data-intensive applications that 5G will inspire. In short, our projected adoption rates and
11 consumer demand forecasts are, if anything, on the low side.

IV. SPECTRUM AND 5G

Q: Can you please explain the characteristics of each type of spectrum, and why each spectrum band is critical to New T-Mobile's 5G network?

A: Three complementary types of spectrum band are critical to successful 5G development: 1) low-band spectrum (below 1 GHz); 2) mid-band spectrum (from 1 to 6 GHz); and 3) high-band spectrum (often referred to as millimeter wave band spectrum or mmWave):

- Low-band spectrum, like T-Mobile's 600 MHz spectrum, allows for better coverage in-building as well as in rural areas. These bands can support cell site operating radii of up to 18 miles, allowing for broad coverage without the need for as much capital expenditure, such as backhaul and tower rents, especially in rural areas.
- Mid-band spectrum, like Sprint's 2.5 GHz and 1900 MHz spectrum, has greater availability in suburban and urban areas. Operating areas around mid-band cell sites are approximately four miles, creating excellent capacity and coverage in populated areas, be that a rural town or a core urban area.
- Finally, high-band, mmWave spectrum (above 20 GHz), which T-Mobile currently has in certain markets, enables extremely high capacity over very short ranges and is preferable in dense urban markets to address extreme demand, the need for low latency, and high-speed data applications. Cell operating areas are significantly less than half a mile in the millimeter wave bands, making use of this spectrum economical only in very densely populated areas. However, the greater availability and bandwidth of millimeter wave spectrum allows for much higher data rates (multiple gigabits per second) than mid-band or low-band spectrum. It will take a combination of mid-, low-, and high-band spectrum to develop and unlock the benefits of 5G networks.

Q: Cal PA seems to suggest that AT&T and Verizon's reliance on mmWave spectrum is the prudent way to build out 5G (Afflerbach/DeHaven at p. 27). Can you comment?

A: While mmWave spectrum is an important component for 5G as it provides multiple gigahertz of available capacity (allowing very fast data rates), it suffers from physical

1 shortcomings that can only be remedied by access to additional low-band and mid-band
2 spectrum. MmWave spectrum does not provide extensive coverage as a single mmWave band
3 radio would provide less than one-half mile radius of coverage. This means that a single city
4 would require thousands upon thousands of mmWave radios to provide full coverage – an
5 outcome that is not economically viable to cover entire cities, let alone the suburban and rural 5G
6 coverage that New T-Mobile will provide. AT&T and Verizon are relying in the first instance
7 primarily on mmWave spectrum solely because their other spectrum holdings are utilized by
8 existing California customers for LTE. Moreover, neither AT&T nor Verizon have provided any
9 public information on the coverage provided by their initial deployments of 5G in the mmWave
10 spectrum bands – demonstrating that the coverage for this spectrum is most likely very limited.
11 Tellingly, after the Applicants announced plans for New T-Mobile’s 5G services using low-,
12 mid- and high-band spectrum, AT&T has now shifted and begun discussing deployment of 5G
13 using “sub-6” spectrum—low- and mid-band spectrum below 6 GHz. As I have discussed
14 above, a truly robust 5G network will require spectrum from the low-, mid-, and high-bands to
15 provide the coverage, capacity, and data rates anticipated for 5G.

16
17 **Q: Cal PA testifies that 5G deployment depends on network and cell site improvements**
18 **rather than acquiring spectrum (Reed Testimony at pp. 10-12). Why do you need the**
19 **complementary spectrum acquired as a result of the merger to build the New T-Mobile 5G**
20 **network?**

21 **A:** Mr. Reed is incorrect. While the elements Mr. Reed mentions are important
22 improvements for 5G technology, they are not the sole drivers of increases in capacity and
23 network performance. Instead, it is the combination of the complementary spectrum, number of
24 cell sites, and spectral efficiency that will deliver the robust, nationwide 5G for New T-Mobile.
25 Currently, T-Mobile has: a substantial amount of low-band 600 MHz spectrum; a small amount
26 of mid-band spectrum (*i.e.*, AWS and PCS bands) currently dedicated to LTE usage; and limited
27 amounts of high-band, mmWave spectrum in certain geographic areas. Sprint, conversely, has
28 very little low-band spectrum, large amounts of mid-band spectrum (*i.e.*, 2.5 GHz, and PCS
29 bands), and no high-band spectrum. On a standalone basis, neither company has enough, or the
30 right combination of, spectrum or cell site resources to deliver the full scope of 5G benefits (*i.e.*,

1 capacity, speed, coverage) that New T-Mobile will provide in the near term. New T-Mobile's
2 complementary spectrum portfolio will be the best starting point for 5G, with spectrum across all
3 bands.

4
5 **Q: If spectrum is necessary, why can't you acquire it through an FCC auction like Cal**
6 **PA seems to suggest (Reed Testimony at p. 12)?**

7 **A:** The only FCC spectrum auction currently scheduled is for mmWave band spectrum,
8 which, while valuable and needed for dense urban deployments, would not remedy the spectrum
9 deficits faced by either standalone company. Mid-band auctions are speculative and untimely in
10 any event. No such auctions have been scheduled, and any auctioned spectrum would not be
11 available in the timeframe during which New T-Mobile will initiate deployment of its
12 nationwide 5G network. And of course, it is uncertain that T-Mobile could obtain the necessary
13 spectrum at any such future auction as it has been very difficult for us to secure spectrum at
14 auction due to AT&T and Verizon's superior resources and ability to aggressively outbid all
15 others. These are not viable alternatives to the spectrum resources available in the transaction.

16 Furthermore, obtaining an equivalent amount of mid-band spectrum, nationwide, through
17 secondary market transactions is also infeasible because there is not enough supply in the
18 secondary market to match the amount obtained as a result of the merger. Obtaining necessary
19 licenses for a viable nationwide deployment on the secondary market can take years. For
20 example, it has taken T-Mobile over four years to acquire 700 MHz spectrum covering 272
21 million POPs. Mid-band spectrum is very desirable currently, given its known value for 5G
22 deployment. Even assuming that there are willing sellers of comparable mid-band spectrum,
23 cobbling together nationwide licenses would be uncertain, expensive, and time-consuming to
24 such a degree as to render New T-Mobile's rapid 5G deployment goals an impossibility.
25 Moreover, even if such spectrum were available, it does not address the other key components of
26 building this network, including cell sites and financial resources. In sum, hoping to obtain the
27 necessary spectrum at auction or on the secondary market is not an option that will provide the
28 same benefits to California consumers as New T-Mobile.

1 **Q: Isn't the T-Mobile and Sprint spectrum that you are discussing already in use?**

2 **A:** Much of the spectrum to be deployed by New T-Mobile for 5G is in use currently for LTE
3 service to California consumers. However, a portion of the spectrum (600 MHz for T-Mobile,
4 2.5 GHz for Sprint) has been reserved for non-statewide 5G deployments. The substantial
5 benefit of the transaction will enable us to repurpose, or "refarm", spectrum from LTE to 5G
6 quickly without disrupting our existing LTE customers because of the complementarities
7 between the T-Mobile and Sprint spectrum and the broader spectrum portfolio provided by New
8 T-Mobile. Only through this merger, and the spectrum combination that it creates, could either
9 T-Mobile or Sprint transition to 5G so quickly. In addition, because New T-Mobile will have an
10 extensive low-band coverage layer of 600 MHz spectrum and a much greater customer base, we
11 will be able to deploy more mid-band spectrum throughout California, especially the 2.5 GHz
12 spectrum that Sprint will be unable to economically deploy due to its lack of low-band spectrum,
13 customer base, and financial resources. This broader deployment of mid-band spectrum will
14 allow the vast increases in capacity and data speeds for California consumers that are not
15 possible without the merger.

16
17 **Q: CWA notes the merger exceeds the spectrum screen in many markets and that will**
18 **harm competition (CWA Testimony at pp. 19-20). Can you respond?**

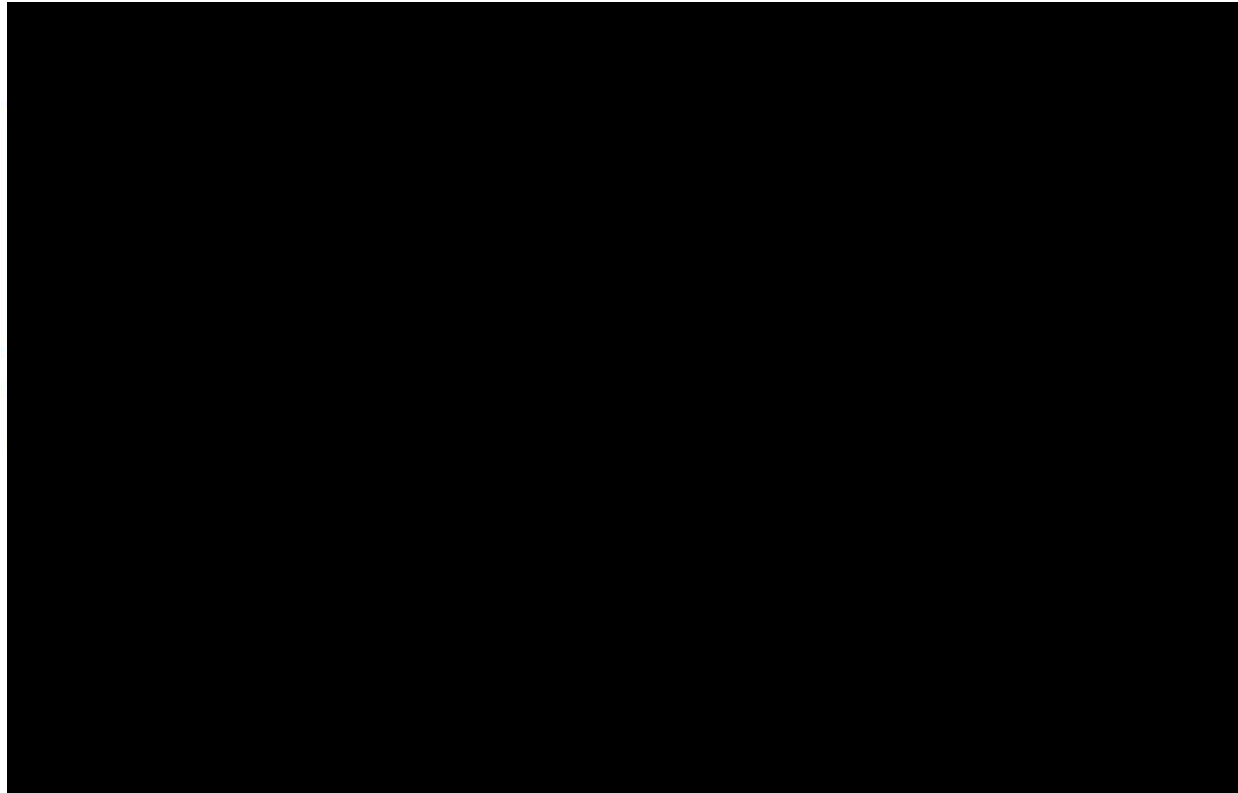
19 **A:** The spectrum screen is *not* a cap. It is merely a tool to identify local markets that can be
20 exempted from routine competitive review. The FCC has never used triggering the screen as
21 dispositive evidence of competitive harm, but rather to determine whether a case-by-case review
22 is necessary to assess the competitive impact in a specific market. My understanding is that not
23 one merger opponent to date has identified any local harm arising from our spectrum holdings
24 being above the screen.

1
2
3 **V. SITES AND 5G**

4 **Q: Cal PA also testifies that mmWave spectrum and certain network and cell site**
5 **improvements are the most important aspect of 5G wireless infrastructure improvements**
6 **(Reed Testimony at pp. 10-12). Do you agree?**

7 **A:** The factors that Cal PA cites are very important elements of improved 5G performance.
8 However, Cal PA misses the point by focusing only on mmWave spectrum and treating these
9 improvements and the benefits of our merger as mutually exclusive. The addition of more cell
10 sites and complementary spectrum allows for massive gains in capacity, driving faster data rates
11 and more capabilities for California consumers. As you can see from the chart below, as a result
12 of the merger, New T-Mobile will have far more 5G enabled sites than either standalone
13 company. For example, New T-Mobile will have 800 more cell sites with 600 MHz and 3,700
14 more cell sites with 2.5 GHz in California by 2024. The difference is because we (1) have access
15 to more tower sites; and (2) have access to more spectrum, so we can deploy more radios to more
16 sites. The synergies from the deal also free up more capital, and the larger customer base allows
17 for more ability to recapture investment costs.

1 [BHC-AEO]



2
3 [EHC-AEO]

4 The greater number of cell sites will allow New T-Mobile to apply more radio resources at more
5 cell sites, increasing the amount of spectrum deployed per site dramatically.

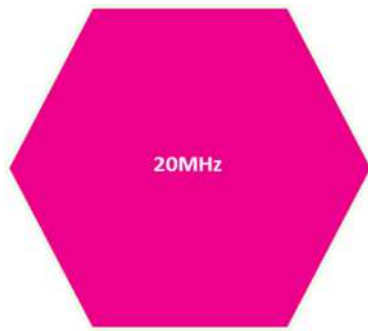
6 By having the option to use cell sites from either company, the transaction will allow the
7 merged entity to have almost immediate access to more cell sites than either company would
8 have absent the merger. Normally, a wireless provider seeking a cell split would need to work
9 with a tower company to obtain access to a new site. This can add time and cost to deployments.
10 There are also substantial logistical barriers to cell site access. If T-Mobile requires a cell site in
11 a particular location, but no tower companies have an existing structure or space on an existing
12 tower, there will be a need for new construction. New construction requires a number of time-
13 consuming and costly steps. Initially, obtaining local zoning approvals can take as long as 18
14 months for a new cell site. This is particularly true in California, which has one of the toughest
15 zoning environments in the country, and hence the opportunity to “build our way” to success in
16 California without the deal is highly uncertain. And, as part of that process, there are costs

1 associated with obtaining the new tower permits that are typically borne by T-Mobile. Finally,
2 there will be a need to confirm the availability of backhaul for the site and, in some cases, the
3 need to bring new backhaul (fiber or Ethernet) to the site, which can also cause delays and add
4 costs. However, New T-Mobile will implement cell splitting by anchoring on the existing T-
5 Mobile cell site infrastructure and augmenting the density of deployed cell sites by retaining
6 approximately 11,000 cell sites from Sprint (the retained cell sites will be selected to optimize
7 coverage and capacity for the New T-Mobile network). Current analysis shows that T-Mobile
8 expects to retain approximately [BHC-AEO] [REDACTED] [EHC-AEO] Sprint sites in California,
9 although no final decisions on site retention have been made at this time and the number of sites
10 may change as the plans are finalized or when deployment begins. In many instances, this will
11 obviate the need to work with the tower companies for new site leases and, accordingly, reduce
12 the time and cost of deployment.

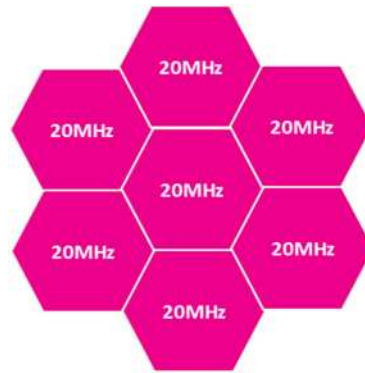
13
14 **Q: Can you explain what cell site splitting means?**

15 **A:** A “cell” is shorthand for the coverage area surrounding the transmission from a base
16 station. A “cell split” means that in that same coverage area, rather than a single base station,
17 there are multiple base stations reusing the spectrum more intensely to improve network
18 capacity. The effect is to multiply the capacity available to the network (if the same amount of
19 spectrum is used in each new cell site as on the original single cell) by the number of new cell
20 sites. However, in the New T-Mobile context, not only will there be multiple new cell sites in a
21 coverage area, each of those cell sites as well as T-Mobile’s anchor sites will also have
22 additional spectrum resources deployed on them, further multiplying the capacity gains for the
23 network.

24 A simplified example of cell splitting is provided below:



*Single Cell with 20 MHz of
Bandwidth*



*Cell Split to 7 Cells Covering Same Area
(7X improvement in capacity)*

Q: Won't New T-Mobile still need to obtain local approvals to update the cell sites as described above?

A: So long as New T-Mobile can replace existing antennas and radio equipment at existing T-Mobile and Sprint cell sites with new equipment (in most cases, improved equipment that can handle more spectrum bands and more capacity) without increasing the amount of physical space or mass (weight of the equipment) used at a site, it may only incur limited new lease payments and may be able to avoid new zoning approvals. The ability to create cell splits nearly immediately in this fashion, in many cases without incurring substantial new costs or delays, will allow New T-Mobile to more rapidly deploy a wider and deeper network while simultaneously reducing the cost of adding incremental capacity.

Q: Are there cost savings or synergies associated with combining the network assets of the standalone companies?

A: Yes. There are huge network synergies that will be gained by eliminating the massive and inefficient duplication of T-Mobile's and Sprint's existing networks. These synergies consist of: (1) synergies from decommissioning duplicative or otherwise unneeded network sites, and (2) reduced capital expenditures resulting from the scale benefits of combined network assets. Together, nationally, network synergies amount to \$25.7 billion in net present value cost savings. In California, we have estimated, based on available data, that the net present value of network synergies from deduplication of the T-Mobile and Sprint networks could be

1 approximately [BHC-AEO] [REDACTED] [EHC-AEO] with a total cost range to achieve of
2 approximately [BHC-AEO] [REDACTED] [EHC-AEO].

3 I would add that our current analysis shows that T-Mobile expects to decommission
4 approximately [BHC-AEO] [REDACTED] [EHC-AEO] Sprint sites, although no final decisions on site
5 retention or decommissions have been made at this time and the number of sites may change as
6 the plans are finalized or when deployment begins.

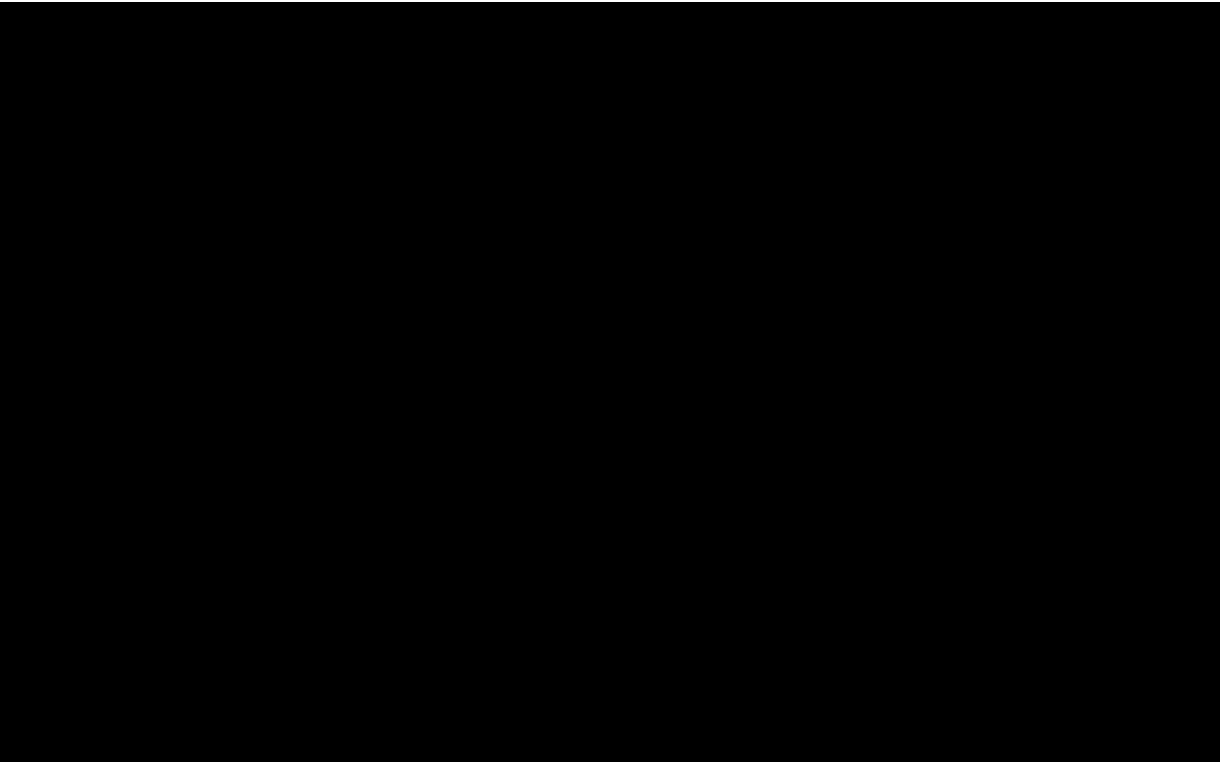
VI. REFARMING

Q: You mentioned “refarming” above. Can you explain what that means and why it is an important part of New T-Mobile’s 5G plans?

A: Spectrum resources are scarce but, as technologies advance, methods of using spectrum improve, requiring spectrum to be repurposed from one standard to another to take advantage of the benefits of the new technology. “Refarming” of spectrum resources is accomplished by repurposing frequency assets that have historically been allocated to a preceding technology (*e.g.*, LTE) to accommodate a new technology (*e.g.*, 5G). Accomplishing such refarming, however, is often complicated by the need to avoid disrupting existing users of the target spectrum. This issue is mitigated when we have spectrum that is not currently being used to provide service like our mmWave spectrum, because we don’t have to worry about existing consumers on that spectrum.

Refarming depends upon two critical factors: (1) new technology device penetration levels (*i.e.*, the rate at which users adopt devices using 5G) and (2) service continuity (the need to continue to support existing customers with legacy 4G devices). Without access to the 2.5 GHz spectrum provided by the transaction, we would be forced to redeploy our PCS and AWS spectrum from existing LTE services to 5G—further constraining our LTE capacity and bandwidth during the critical transitional period from 4G to 5G and resulting in a slower transition and potentially compromising LTE service for existing customers. Standalone Sprint would need to split the portion of its 2.5 GHz spectrum it plans to use between LTE and 5G, resulting in a dramatically slower transition. However, with the combined spectrum of the two companies, New T-Mobile would be able to move Sprint LTE customers to T-Mobile’s AWS spectrum, thereby freeing the 2.5 GHz band and enabling a pure 5G network in the 2.5 GHz band as rapidly as possible. The difference in these transition timelines is significant. LTE migration for the 2.5 GHz band is projected to be complete by 2022 for the combined entity, while standalone Sprint would likely still be required to reserve at least 43 percent of its 2.5 GHz spectrum for LTE through 2024 (and would reserve at least some 2.5 GHz spectrum for LTE for the foreseeable future). To the contrary, New T-Mobile would be able to use 100 percent of its 2.5 GHz spectrum, as well as most of its PCS and 600 MHz for 5G by 2024.

1 [BHC-AEO]



2
3 [EHC-AEO]

4 Furthermore, because of its size and scale, and ability to offer a better value proposition
5 to equipment manufacturers as a result of its expanded customer base, New T-Mobile will be
6 able to more quickly move more spectrum to 5G than either standalone company. New T-
7 Mobile will be able to: (1) increase 5G device penetration levels, and (2) therefore reduce the
8 number of customers still relying upon LTE for service. New T-Mobile will be able to drive 5G-
9 capable device penetration rates up by 10 percent, year over year. A more rapid transition to
10 new 5G devices will enable New T-Mobile to refarm more spectrum from LTE to 5G and
11 simultaneously ease LTE demand for spectrum, ensuring that the user experience for remaining
12 LTE customers in California will be the same, or better, level of performance during the
13 refarming process. Finally, our network modeling projections demonstrate that there will be no
14 negative effects on LTE performance throughput during the refarming process to 5G.
15

1 **Q: Cal PA argues New T-Mobile's plan for refarming 5G spectrum is unduly**
2 **aggressive considering consumer demand and adoption timeframes (Reed Testimony at pp.**
3 **12-13). Do you have a response?**

4 **A:** Cal PA incorrectly underestimates the rapidly increasing consumer demand for data and
5 the projected pace of 5G adoption. Cal PA essentially argues that there is no rush to build a high
6 capacity and high speed 5G network because consumers will not be ready to adopt new
7 technology in New T-Mobile's deployment timeframe. As we discuss in our Public Interest
8 Statement, our demand forecasts for the next 6 years indicate that consumers are likely to
9 continue growing their demand by over 30 percent per year, a rate of data growth that standalone
10 T-Mobile would be unable to meet without either merging with Sprint or degrading the quality of
11 service. Furthermore, even if Cal PA were correct about the pace of consumer technological
12 adoption, during generational transitions between technologies (e.g., 3G to 4G and 4G to 5G)
13 adoption has always followed, and must necessarily follow, network deployment. For example,
14 smartphones did not exceed 50 percent of all mobile connections until 2012, four years after the
15 launch of the first 4G network and two years after the launch of the first 4G LTE network. In
16 other words, delaying the build out of the 5G network will further delay consumer adoption and
17 the benefits that go along with it. By this measure, New T-Mobile will need to move faster, not
18 slower, to keep pace with 5G demand and our refarming plans are appropriately aggressive.
19 Also, as described in my declaration and below, our network and demand models and forecasts
20 of network traffic are extremely detailed, were meticulously prepared and have proven to be
21 reliable in building out our current network. We make all of our network decisions based on
22 these models – not just those associated with this merger – and we are very confident in their
23 accuracy. In the ordinary course of business, to help project where the existing T-Mobile LTE
24 network will reach resource exhaust, we developed an engineering model to target congestion
25 and to help target annual spending to achieve that goal. The key components to a capacity model
26 of this type are a loading forecast (amount of traffic to be supported) and the congestion criteria
27 (based on target levels for quality of experience). We have relied on the model to direct
28 approximately [BHC-AEO] [REDACTED] [EHC-AEO] in annual expenditures for our network, totaling
29 [BHC-AEO] [REDACTED] [EHC-AEO] in the past 5 years. This effort has led to a 71 percent
30 reduction in congestion while traffic growth has increased by [BHC-AEO] [REDACTED] [EHC-AEO]

1 (in addition to customer growth from 33M to 74M in the past five years)—with the highest
2 average throughput of the national wireless providers the past 18 quarters (as measured by
3 Ookla).

4 We are very aware that refarming requires considerable care as an overly aggressive
5 approach would adversely affect existing subscribers, leading to increased churn. New T-Mobile
6 will have the spectrum and resources and subscriber base to more rapidly refarm from LTE to 5G
7 without sacrificing the existing LTE network performance. Our network modeling projections
8 demonstrate that there will be no negative effects on LTE performance during the refarming
9 process, while the 5G network will vastly exceed the standalone capabilities of either T-Mobile
10 or Sprint. The spectrum efficiency gains from expeditious refarming are possible only through
11 this merger.
12
13

VII. NETWORK MODEL

Q: Cal PA argues there are major flaws in the network model filed with the FCC (Reed at pp. 20-23). How was the model developed?

A: I strongly disagree with Cal PA about the robustness and accuracy of our modeling. The network model was developed utilizing an extended version of the same model T-Mobile uses in the ordinary course of business, which we have found to be a highly accurate and reliable predictor of actual network performance for years and a valuable means of predicting the network investment needed to satisfy future capacity needs. T-Mobile has based billions of dollars of investment on the output of this model, and we have total confidence the model provides accurate predictions. I have described the model on several occasions now to various entities including the FCC, the DOJ and various States' Attorneys General. I am attaching a copy of the model presentation I have used as Attachment C.

Q: Cal PA argues that the network model underestimates the performance of the standalone networks (Reed Testimony at pp. 20-23). Can you explain how T-Mobile uses the model to build its network?

A: T-Mobile's ordinary-course practice is to allocate network funding through a multi-stage process: the first stage forecasts future traffic on the network; the second stage determines the optimal capacity solutions (*e.g.*, spectrum overlays and cell splits) starting with the least cost solution based on the output of the Network Build Model. Specifically, the model seeks to identify solutions (or "builds") sufficient to have all sectors satisfy T-Mobile's congestion criteria while serving the forecasted demand – *i.e.*, to have zero percent of the sectors congested in the busy hour. These builds serve as the basis for the Network Capacity Plan (NCP). In the third stage, local and regional teams assess the feasibility of implementing the solutions identified in the NCP and release a final implementation plan, called the Capacity Mitigation Plan (CMP), which becomes the plan of record.

The complete model uses an extended version of our ordinary course LTE capacity planning model and integrates it with a 5G module. We developed three separate worksheets that determined capacity for New T-Mobile, T-Mobile, and Sprint, with separate modules for

1 LTE and 5G. The LTE modules (while not identical for T-Mobile and Sprint to account for each
2 operator's ordinary course practices) were derived from the ordinary course model described
3 above. The same processes were used for the assessment of capacity and performance
4 augmentation needs for T-Mobile and Sprint—and aggregated to form the parameters for
5 modeling of the combined company. Once we had the national model, we were able to isolate
6 the California specific numbers to determine the speed, capacity, and coverage increases realized
7 by Californians as a result of the merger.

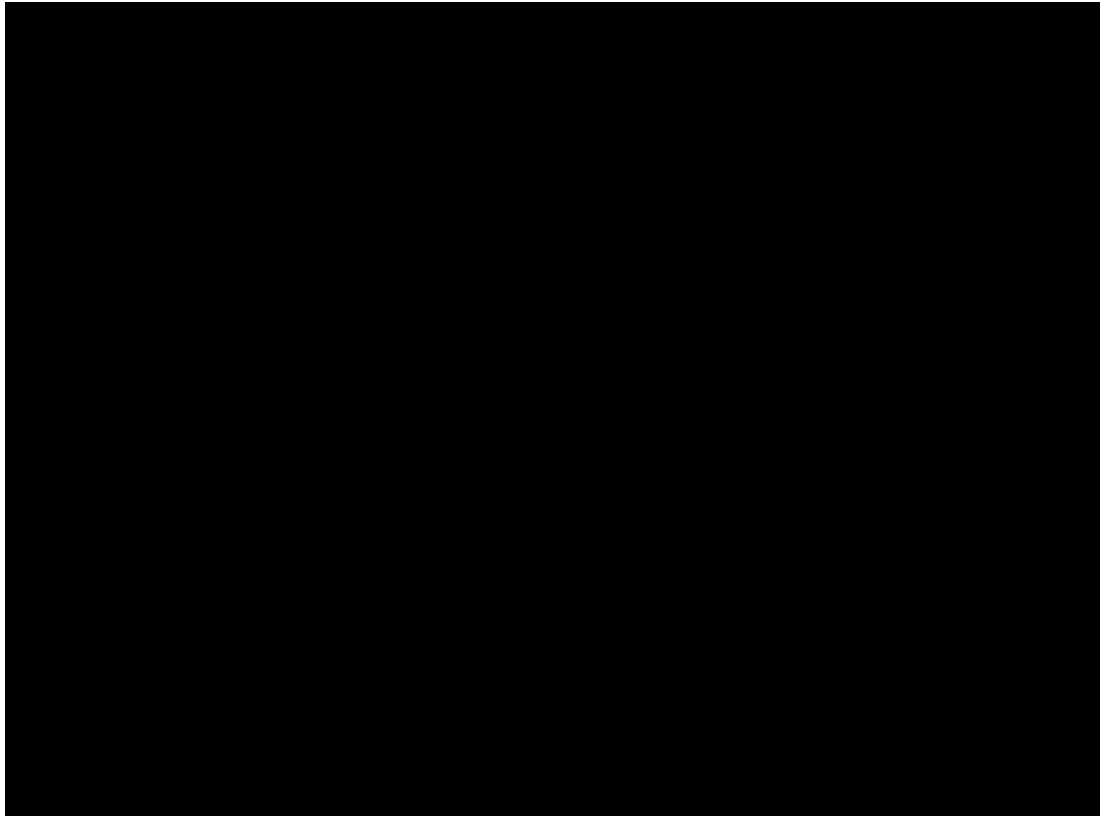
8
9 **Q: Can you provide further comment on your calculations of network capacity and**
10 **speed for New T-Mobile's 5G network?**

11 **A:** T-Mobile's engineering team has performed extensive technical throughput modeling of
12 the standalone and combined networks. These models project, based on our ordinary course
13 traffic modeling, that New T-Mobile's 5G network will be substantially faster than either
14 standalone network. The combined network will more than *double* 5G monthly capacity by
15 2021 and nearly *triple* 5G monthly capacity by 2024 when compared to the combined 5G
16 capacities of the standalone networks. By 2024, the total capacity of the new network—
17 inclusive of LTE—will be approximately *twice* the combined capacity of the standalone firms.

18 With respect to speed, by 2024, New T-Mobile's 5G network will deliver average data
19 rates above 100 Mbps to approximately 292 million covered POPs, average data rates above 150
20 Mbps to approximately 278 million covered POPs, average data rates above 300 Mbps to
21 approximately 252 million covered POPs, and average data rates above 500 Mbps to
22 approximately 209 million covered POPs. The 5G network will also deliver 3.9x to 5.8x average
23 throughput (Mbps) and 1.5x to 5.8x peak throughput (Mbps) compared to the standalone
24 networks.

25 As I explained more fully in my Public Interest Statement and Joint Opposition
26 declarations, the increases in capacity and data rates for the New T-Mobile 5G network are
27 summarized in the charts below:

1 [BHC-AEO]



2
3
4
5 [EHC-AEO]

Entity	Average 5G Data Rates (Mbps)	Peak 5G Data Rates (Mbps)
T-Mobile	100	2800
Sprint	116	700
New T-Mobile	451	4200

6 *Average and Peak Data Rate Comparisons (Year 2024)*

7
8 **Q: Cal PA asserts that T-Mobile is already spending billions on 5G and argues it is**
9 **fully capable of building a 5G network as a standalone (Reed Testimony at 12; Selwyn**
10 **Testimony at 14-15). Isn't it true that T-Mobile has plans to build out a 5G network in the**
11 **absence of the merger with Sprint?**

1 A: Cal PA makes the persistent mistake of assuming that all “5G” is equivalent. It is true
2 that T-Mobile is building a 5G network on its own, but to be clear, it would be a limited
3 deployment compared to New T-Mobile’s and would simply not bring the same benefits to
4 Californians. There is a distinct difference between the standalone T-Mobile 5G network and the
5 robust, nationwide 5G network that will be built by New T-Mobile. For T-Mobile, it would be
6 cost-prohibitive to build out enough sites to reach comparable capacity and quality to what New
7 T-Mobile can achieve. In addition, T-Mobile’s standalone capability to refarm spectrum to
8 provide 5G service is limited because its spectrum is extensively used for LTE. Its ability to roll
9 out a robust 5G network is further challenged by its lack of available mid-band spectrum and the
10 fact that additional mid-band spectrum suitable for 5G is not expected to become available via
11 spectrum auctions in the near term. For these reasons, and because LTE is significantly less
12 spectrally efficient than 5G, T-Mobile’s ability to expand capacity to maximize the value of its
13 spectrum assets and roll out robust 5G cannot come close to matching that of New T-Mobile.
14 The differences are highlighted by the county by county comparison of the standalone Sprint and
15 T-Mobile networks vs. New T-Mobile’s for 2021 and 2024, a copy of which I am including as
16 Attachment D.

17
18 **Q: Similarly, Cal PA seems to suggest that Sprint’s standalone 5G build out plans**
19 **confirm that the merger is not necessary. (Reed Testimony at 16). Do you have any**
20 **comment?**

21 A: Once again Cal PA misses the mark and equates Sprint’s standalone 5G deployment with
22 what New T-Mobile’s 5G network will be capable of. As Mr. Draper testifies, Sprint faces a
23 number of constraints that do not allow it to roll out a nationwide, robust 5G offering. Sprint
24 cannot maximize the value of its spectrum without the robust coverage layer that T-Mobile
25 provides with its 600 MHz spectrum and without the combined customer base created by the
26 merger as it would be cost-prohibitive for it to build out enough sites using only its 2.5 GHz
27 spectrum to enable capacity, coverage, and quality comparable to New T-Mobile’s network
28 especially, in many rural areas, or provide strong in-building coverage. Sprint on a standalone
29 basis would only cover much more limited geographic areas with 5G services using its 2.5 GHz

1 spectrum. Finally, Sprint's ability to fully dedicate its 2.5 GHz spectrum to 5G is limited by its
2 need to use a significant portion of that spectrum for LTE under its standalone plans.

3
4 **Q: Cal PA argues that T-Mobile provides excellent service already, and that Sprint's**
5 **service is likely to improve even absent the merger. How do you respond to that?**

6 **A:** It is true that T-Mobile has an impressive service record, and it is one that I am proud of.
7 It is also likely that Sprint's service will improve if and when it can successfully transition to
8 VoLTE. However, the transition to 5G and consumers' ever-increasing appetite for mobile data
9 will create challenges for both companies, and these challenges mean that both companies are
10 going to struggle to provide the level of service necessary to be really effective competitors
11 against their better capitalized rivals who have superior spectrum holdings. Past performance is
12 exactly that, in the past, and this merger is a forward-looking one designed to allow the merged
13 firm to build an exciting network capable of delivering the best the next generation of technology
14 can provide.

1 **VIII. BENEFITS FOR CALIFORNIA CONSUMERS**

2

3 **Q: Cal PA suggests that California consumers will get the same benefits from 5G**
4 **without the merger (Reed Testimony at p. 10). What will the merger mean for California**
5 **consumers' network experience?**

6 **A:** The impact of the merger for California consumers is striking. First, in terms of capacity,
7 as described above, the combined network enables almost 2X the 5G capacity by 2021 and more
8 than 2X 5G capacity by 2024, when compared to the combined standalone networks. With
9 respect to coverage and speeds, however, a picture is indeed worth a thousand words. As shown
10 in Figure 1 below, without the merger, T-Mobile would be able to provide 5G coverage by
11 deploying its 600 MHz spectrum across the state, including in many rural areas, but would only
12 be able to deploy its limited amount of higher-capacity mid-band spectrum in a handful of
13 population dense areas—the Sacramento, San Francisco Bay, Los Angeles, and San Diego
14 metropolitan areas. In most areas, this would mean 5G coverage, but not a lot of capacity.
15 Conversely, as shown in Figure 2, Sprint as a standalone, because it lacks adequate low-band
16 spectrum would need to rely on its mid-band spectrum for 5G deployment. Therefore, Sprint
17 would be unable to provide any 5G coverage for the overwhelming majority of California's
18 geography because its mid-band deployment would be limited to a few population dense areas.
19 However, as shown below in Figure 3, T-Mobile and Sprint have complementary spectrum
20 portfolios and their combination would allow New T-Mobile to deploy mid-band spectrum
21 (AWS, PCS, and 2.5 GHz) far more expansively than either company could as standalones,
22 providing mid-band coverage over much of California's geography and thus expanding capacity
23 and improving performance.

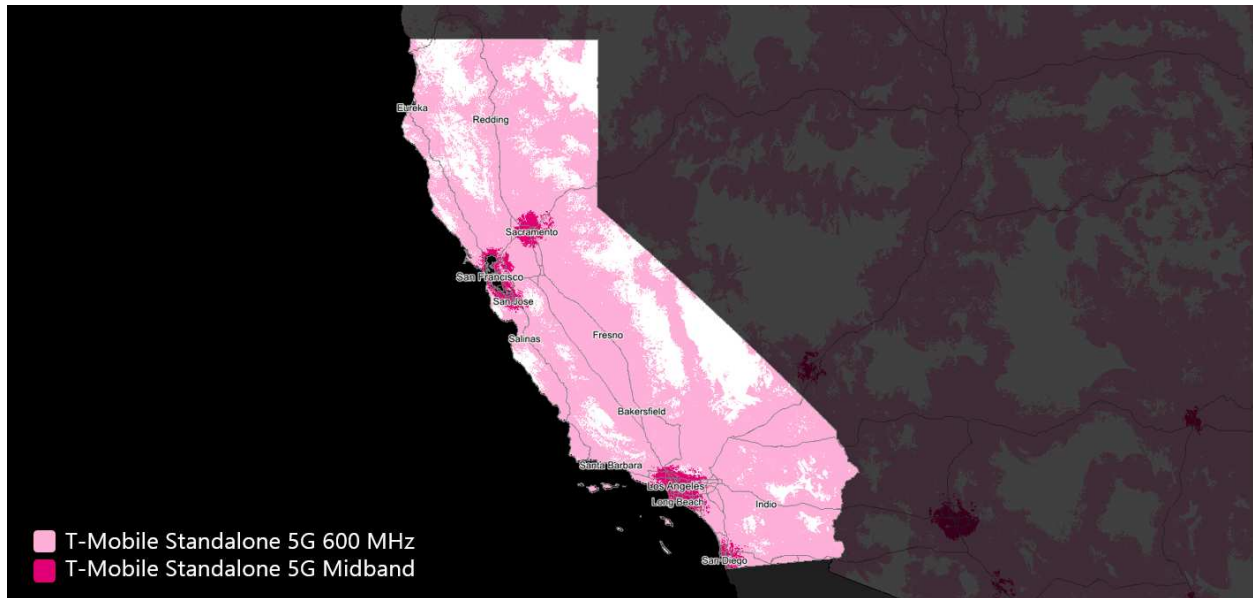


Figure 1: T-Mobile Standalone Projected 5G Coverage in California in 2021

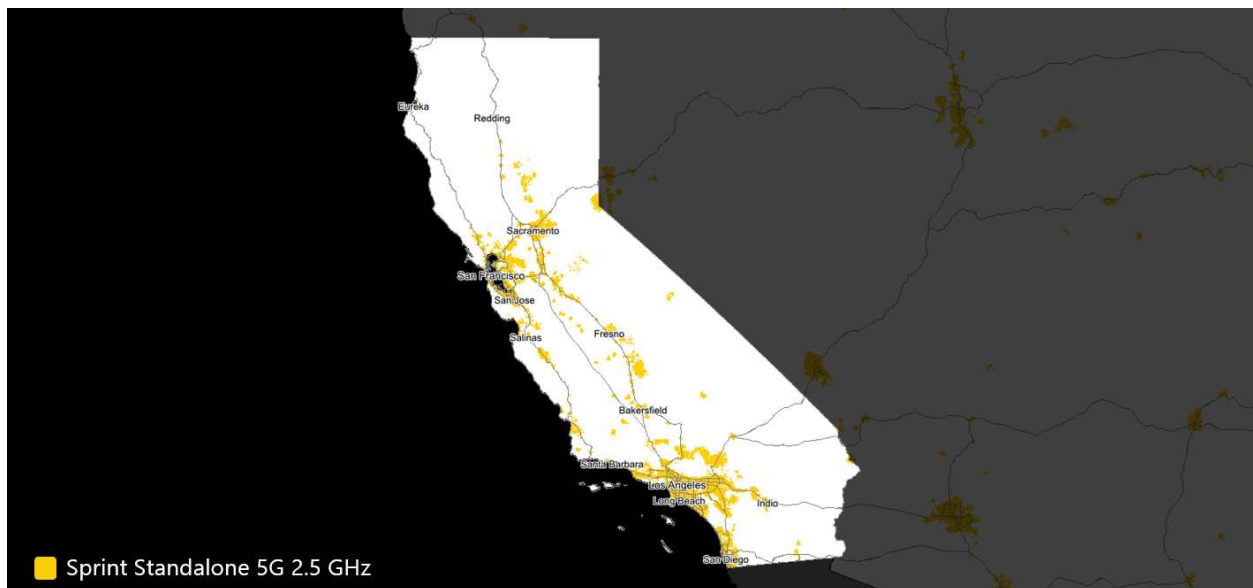


Figure 2: Sprint Standalone Projected 5G Coverage in California in 2021

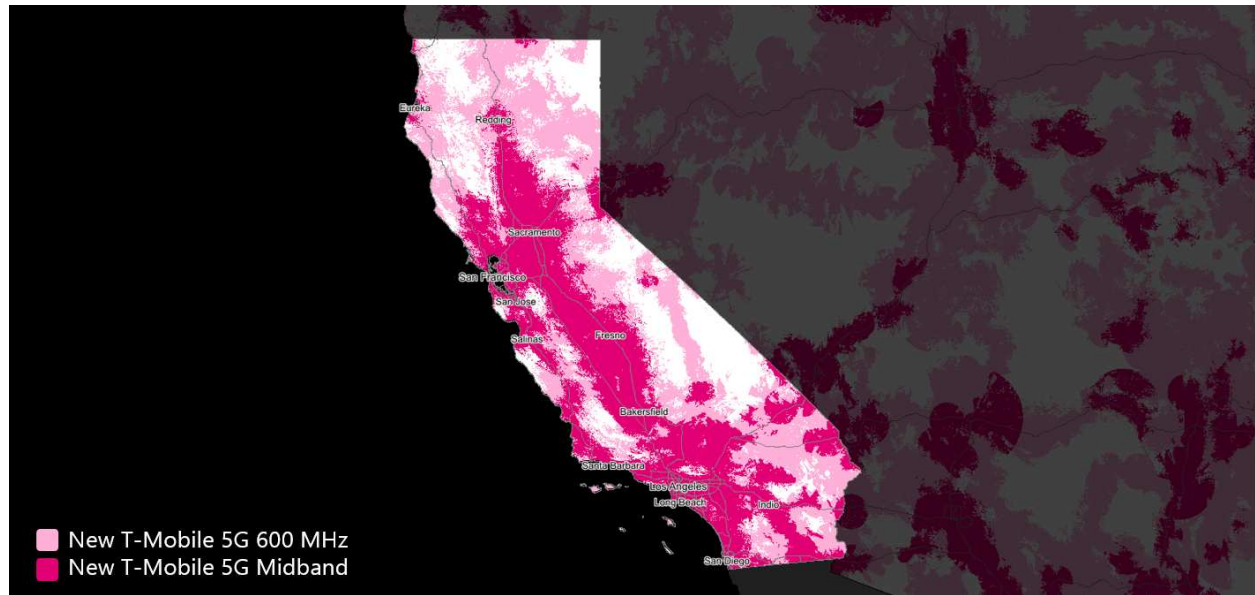
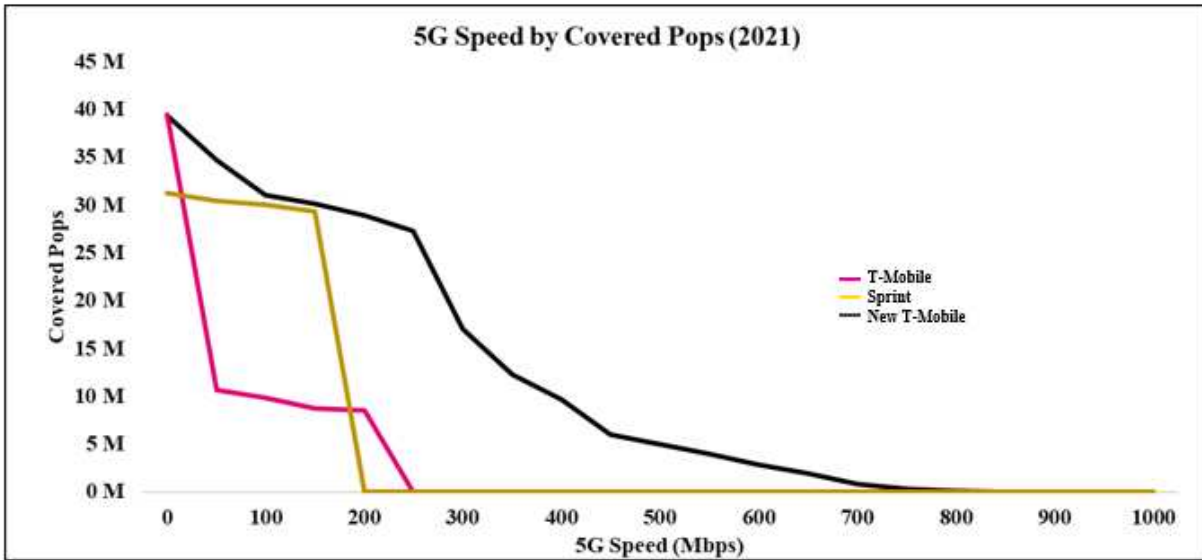


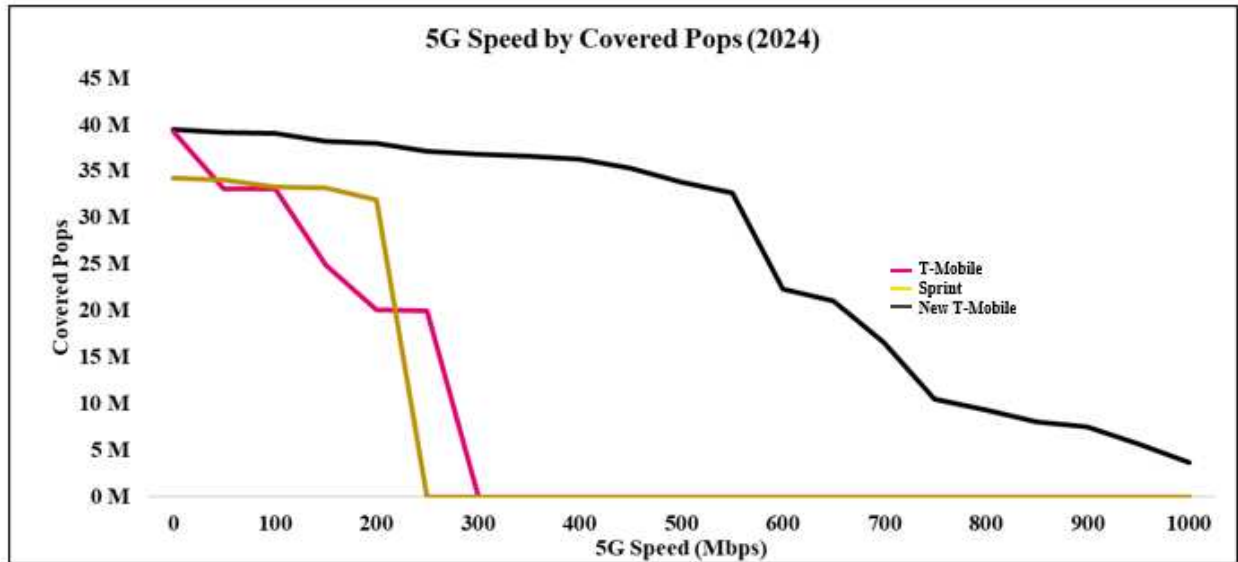
Figure 3: New T-Mobile Projected 5G Coverage in California in 2021

~~[BHC-AEO]~~

The impact of this broader 5G mid-band deployment is even more striking once we consider the speeds that will be available to millions of Californians as a result of the merger. By 2021 in California, New T-Mobile will deliver speeds greater than ~~[BHC-AEO]~~ 150 Mbps to 76 percent of the population and greater than 300 Mbps to 43 percent of the population. By 2024, Californians will receive from New T-Mobile data rates greater than 150 Mbps to 97 percent of the population and greater than 300 Mbps to 93 percent of the population.~~[BHC-AEO]~~ At these data rates, New T-Mobile will be competitive not only with mobile wireless providers but also with fixed wired providers, bringing a choice to many consumers in California that have none today.



California Covered Pops by Speed				% California Pops		
2021	T-Mobile	Sprint	New T-Mobile	T-Mobile	Sprint	New T-Mobile
Pops with > 100 Mbps	9.8 M	30.1 M	31.0 M	25%	76%	79%
Pops with > 150 Mbps	8.8 M	29.3 M	30.1 M	22%	74%	76%
Pops with > 300 Mbps			17.0 M			43%
Pops with > 500 Mbps			5.0 M			13%



California Covered Pops by Speed				% California Pops		
2024	T-Mobile	Sprint	New T-Mobile	T-Mobile	Sprint	New T-Mobile
Pops with > 100 Mbps	33.1 M	33.3 M	39.1 M	84%	84%	99%
Pops with > 150 Mbps	24.9 M	33.2 M	38.2 M	63%	84%	97%
Pops with > 300 Mbps			36.8 M			93%
Pops with > 500 Mbps			33.8 M			83%

[EHC-AEO]

Q: Would the standalone T-Mobile or Sprint networks be able to provide the same benefits as the New T-Mobile network to California consumers absent the merger?

A: No, not even close. The transaction will enable New T-Mobile to build a network with distinct advantages over the standalone 5G network planned by T-Mobile. On a standalone basis, T-Mobile does not have enough, or the right combination of, spectrum or cell site resources to deliver the enormous gains in capacity that New T-Mobile will provide in the near term. By having the option to use cell sites from either company, the transaction will allow the merged entity to have almost immediate access to more cell sites than either company would have absent the merger.

The merger also will enable the combined company to dedicate more spectrum to 5G much sooner than either company could do individually, while also allowing New T-Mobile to more efficiently utilize existing spectrum assets for continued and unimpaired LTE services.

1 New T-Mobile will be able to move more spectrum to 5G than either standalone company
2 because it will: (1) increase 5G device penetration levels, and (2) therefore reduce the number of
3 customers still relying upon LTE for service. New T-Mobile will be able to drive 5G-capable
4 device penetration rates up by 10 percent, year over year. A more rapid transition to new 5G
5 devices will enable New T-Mobile to refarm more spectrum from LTE to 5G and simultaneously
6 ease LTE demand for spectrum, ensuring that the user experience for remaining LTE customers
7 in California will not suffer during the refarming process.

8 In sum, New T-Mobile's deployment of T-Mobile's and Sprint's combined spectrum
9 portfolios, together with the addition of many more radios across the combined network than
10 either party would install on its own, will create a massive increase in capacity that would not be
11 possible but for the transaction. At a fundamental level, the multiplicative effects associated
12 with more cell sites, more spectrum per cell site, and higher spectral efficiencies will result in
13 dramatic increases in capacity, throughput, and coverage.

14
15 **Q: What other specific benefits can California consumers expect from the New T-**
16 **Mobile network?**

17 A: As explained in the testimony of Mike Sievert, the New T-Mobile 5G network produces
18 massive capacity at lower costs. As Mr. Sievert states, Californians will pay less for more; get
19 choice and competition for in-home broadband, get improved and new rural service; as well as
20 improved and expanded enterprise and IoT services and job increases.

21 Contrary to what Cal PA contends, an accelerated move to 5G, such as that envisioned by
22 the New T-Mobile network build-out, is a permanent benefit, and not merely a means to
23 facilitate the transition to 5G technology. Getting to a better 5G network faster increases
24 Californians' benefits exponentially, as they continually reap the cascading rewards resulting
25 from being on the cutting edge of this crucially important technology. Simply put, the benefit
26 from getting to 5G faster will last forever. Once deployed, super high-speeds will enable
27 California consumers and businesses to deploy innovative applications. New T-Mobile's 5G
28 network will provide a nationwide footprint and robust capacity to enable Californians to benefit
29 from the full spectrum of possible 5G services and applications.

1 **Q: T-Mobile and Sprint have recently announced a spectrum leasing arrangement and**
2 **a roaming agreement. Why don't those arrangements provide the same benefits as the**
3 **merger as Cal PA seems to suggest (Reed Testimony at pp. 13-14)?**

4 **A:** Although Mr. Draper also addresses this in his testimony, Sprint's roaming agreement
5 with T-Mobile certainly helps Sprint deal with some of its network limitation issues here in
6 California (and elsewhere), but it does not even begin to provide benefits comparable to those
7 that will be created by the merger. First, the customer experience cannot be guaranteed for a
8 roaming subscriber. This is because the Applicants' networks may or may not support the
9 features that are on the home network and these handoffs (from one network to another) may not
10 always occur seamlessly. Second, a roaming agreement would not achieve the network
11 efficiencies of the merger. Most importantly, it would not achieve the multiplicative effect from
12 combining the spectrum and sites of the Applicants and increasing the amount of spectrum
13 deployed per site. In addition, a roaming agreement does not allow for carrier aggregation or
14 core network efficiencies, and does not offer the prospect of improved spectral efficiency
15 because of the continued inability to refarm spectrum to new technology (like 5G) due to the
16 need to avoid disruption of prior technology service (like LTE). Third, the roaming agreement
17 does not achieve the non-network efficiencies of a transaction like the proposed merger (e.g.,
18 lower dealer commissions and equipment cost savings, which require increased scale).
19 Furthermore, the roaming agreement limits the amount of traffic Sprint can put on the T-Mobile
20 network based on congestion. The roaming agreement includes LTE data only (i.e., no voice,
21 VoLTE or 5G). Moreover, because the standalone companies are both limited in their spectrum
22 resources for 5G, the roaming agreement between the two entities does not allow for an
23 expansion of coverage and capacity. It also does not deliver the synergies that the transaction
24 will provide, which allows for additional investment in more capacity and coverage.

25 Similarly, the spectrum lease does not provide the same incentive and ability to make the
26 investments necessary to replicate New T-Mobile's network. Absent the merger synergies, the
27 complementary assets of the combined firm, and deprived of the long-term benefits gleaned from
28 building a world-leading network, standalone T-Mobile would lack the ability and incentive to
29 make the necessary investments to build out a network comparable to New T-Mobile's due to the
30 short-term nature of such lease agreements. A spectrum swap is insufficient for similar reasons.

1 T-Mobile does not have sufficient low-band spectrum to swap it against the required amount of
2 mid-band spectrum. Moreover, swapping spectrum would not achieve the benefits of the
3 merger, which depend on combining T-Mobile's low-band to provide coverage and Sprint's mid-
4 band spectrum to provide capacity. 5G and LTE require large, continuous blocks of spectrum to
5 operate efficiently. In sum, no alternative arrangement can replicate the benefits that the merger
6 will produce.

IX. RURAL BENEFITS

Q: Cal PA and CWA both express doubt that consumers in California rural areas will experience these benefits resulting from the merger (Reed Testimony at pp. 17-18; Afflerbach/Dehaven Testimony at pp. 32-33). Will rural customers benefit from the merger?

A: Absolutely. Nationally, New T-Mobile will leverage its spectrum resources and merger synergies, again mostly resulting from combining the two networks into one, to deliver the following broadband benefits to consumers living in small towns and rural communities:

- **Coverage:** increasing outdoor wireless coverage to reach 59.4 million rural residents, or 95.8 percent of the estimated 62 million rural residents, and indoor wireless coverage to reach 31 million rural residents;
- **Quality:** improving signal quality and reliability and increasing network capacity to enable data intensive services and improve the overall consumer experience;
- **Speeds:** delivering mobile broadband service with download speeds of at least 10 Mbps or greater to 45.9 million rural residents over two million square miles, accounting for 74 percent of rural residents nationwide; and
- **In-Home Service:** providing fixed in-home broadband service of at least 25/3 Mbps to 52.2 million rural residents over 2.4 million square miles, approximately 84.2 percent of rural residents nationwide.

Q: Does this apply to rural California as well?

A: Without a doubt. For example, with respect to the national benefits noted above, the California impact is notable.²

- **Outdoor 2024 Coverage:** Of the 59.4 million covered rural residents, T-Mobile estimates approximately [BHC-AEO] [REDACTED] [EHC-AEO] will be covered.
- **Indoor Coverage:** Of the 31 million covered rural residents, T-Mobile estimates approximately [BHC-AEO] [REDACTED] [EHC-AEO] will be covered.

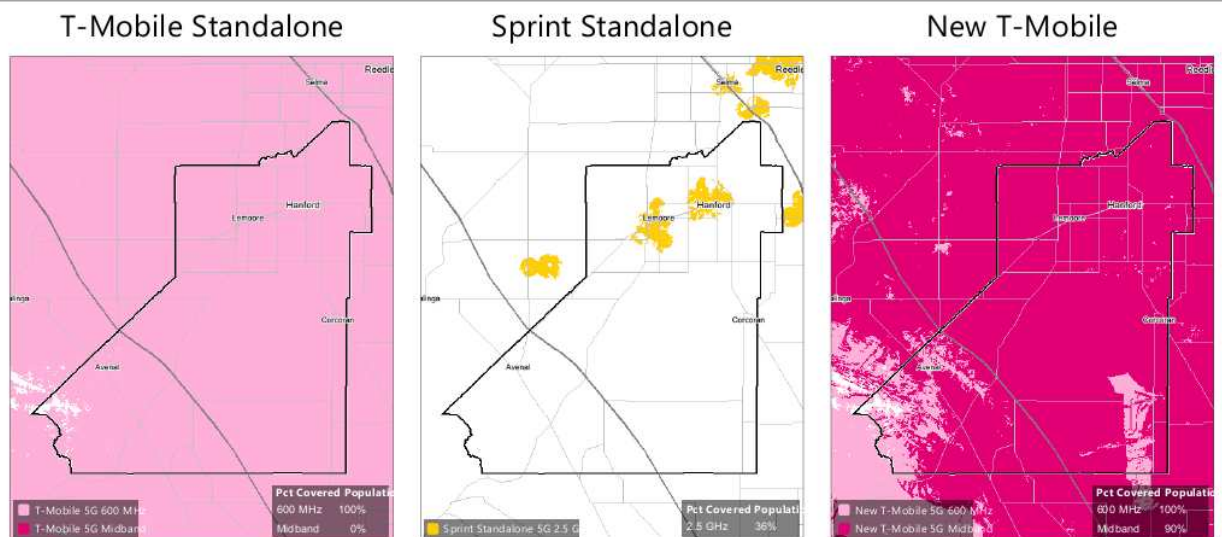
² These figures use a rural California population of 2.02 million.

- **Quality:** improving signal quality and reliability and increasing network capacity to enable data intensive services and improve the overall consumer experience;
- **Speed:** Of the 45.9 million rural residents, T-Mobile estimates approximately [BHC-AEO] [REDACTED] [EHC-AEO] will be covered.
- **In-Home Service:** Of the 52.2 million rural residents with projected fixed broadband of at least 25/3 Mbps in 2024, T-Mobile estimates approximately [BHC-AEO] [REDACTED] [EHC-AEO] will be covered.

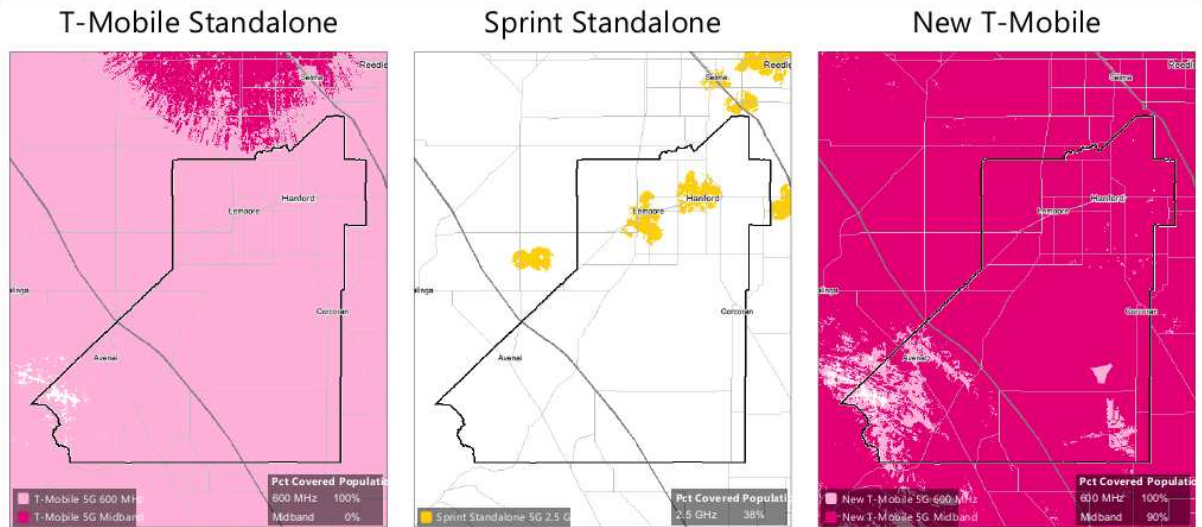
In addition, the massive expansion of depth of coverage and network speed is well-illustrated in the county specific maps we prepared (and provided to the various parties through discovery) and which are otherwise included with my testimony as Attachment D. I am including the maps of Kings County, a primarily rural area, below to highlight the point I am making here:

[BHC-AEO]

Projected 2021 5G Coverage: Kings County (06031)



Projected 2024 5G Coverage: Kings County (06031)



~~{EHC-AEO}~~

New T-Mobile will benefit rural Californians immensely. The broad geographic reach of New T-Mobile's 5G network will facilitate the use of advanced applications that are critically needed in small towns and rural communities. For example, New T-Mobile's 5G network will transmit high-resolution video and audio to distant physicians, enabling rural residents to access higher-quality medical care, and to get it faster and without having to travel hundreds of miles. The network also will support information-enabled agriculture processes that allow farmers in rural areas to monitor crops, climates, livestock, equipment, and commodities markets.³ Further, 5G will offer enhancements in energy efficiency leading to longer battery life and the capability to connect a much greater number of devices. More specifically, 5G could potentially offer:

- A tenfold increase in connection density from approximately 100,000 connections per square kilometer to 1,000,000 connections per square kilometer;
- A tenfold improvement in latency;
- A tenfold improvement in the typical user experience data rate from 10 Mbps to 100 Mbps (or more);

³ Dusty Weis, *How Smart Farms Are Making the Case for Rural Broadband*, AEM (Oct. 19, 2017), <https://www.aem.org/news/october-2017/how-smart-farms-are-making-the-case-for-rural-broadband/>.

- A twentyfold increase in peak downlink data rates;
- A tenfold increase in peak downlink data rates;
- A tenfold improvement in network energy efficiency;
- Three times greater spectral efficiency; and
- Longer battery life (up to 10 years for some IoT devices).

As a result 5G will also provide the ability to connect a massive number of Internet of Things (“IoT”) devices and sensors to monitor, among other things, the electric grid to instantly detect surges and outages so that repair crews can be immediately deployed to where they are needed; industrial processes to create more efficiencies within factories and notify maintenance crews before a machine fails; or biometric data to alert doctors when a patient’s diagnostic readings are approaching critical levels so that action can be taken before larger issues develop. The complementary spectrum and network assets brought together in the merged company will provide the high-speed broadband needed to support these types of beneficial applications and bring them to rural areas and small towns that would otherwise go without them.

Rural markets in California will particularly benefit from the New T-Mobile’s roll-out of 5G. As noted in my testimony above, New T-Mobile will bring ~~[BHC-AEO]~~ 100 Mbps speeds and even 300 Mbps 5G ~~[EHC-AEO]~~ to most of the state’s population by 2021. And by 2024, T-Mobile will bring 100 Mbps to ~~[BHC-AEO]~~ 99 ~~[EHC-AEO]~~ percent and 300 Mbps to more than ~~[BHC-AEO]~~ 90 ~~[EHC-AEO]~~ percent of the state’s population. This is a dramatic bridging of the longstanding digital divide and provides high-speed connectivity to people and places who are disconnected today.

Q: CWA argues New T-Mobile’s technical claims about 5G capabilities depend on mmWave spectrum, which is not useful or available in rural areas (Afflerbach/Dehaven Testimony at p. 28) . How do you respond to that?

A: New T-Mobile’s rural 5G deployment does not depend on mmWave and we have never asserted otherwise. As I stated previously, mmWave spectrum is best utilized in dense urban markets where there are extreme capacity demands. As previously discussed, New T-Mobile’s

1 rural deployment depends on T-Mobile and Sprint's complementary low- and mid-band
2 spectrum.

3
4 **Q: Cal PA argues that standalone T-Mobile already has adequate spectrum to serve**
5 **rural areas and increased deployment will depend on capital investment, not new spectrum**
6 **(Reed Testimony at pp. 17-18; Selwyn Testimony at p. 156). Is this true?**

7 **A:** No. Although it is true that T-Mobile has spectrum holdings in rural areas, it lacks the
8 spectrum diversity necessary, specifically Sprint's 2.5 GHz, to provide the capacity to
9 complement T-Mobile's coverage layer. The scale benefits, reduced costs, and increased
10 capitalization described above help the business model for building out to rural areas, but
11 without the complimentary spectrum achieved as a result of the merger, the network realities of
12 supplying service to rural areas would prevent providing service on par with what's envisioned
13 with New T-Mobile's network.

14
15 **Q: So how will the New T-Mobile be able to service rural areas?**

16 **A:** As I described in detail above, the combined network, built with the 600 MHz band as the
17 foundational coverage layer and the 2.5 GHz band as the primary capacity layer, will result in a
18 huge increase in capacity. In addition, the breadth of the new cell site infrastructure, with macro
19 cell sites blanketing California, will allow New T-Mobile to provide reliable signal strength
20 levels to more areas than either standalone company. The data throughput improvements will be
21 experienced by underserved consumers in rural areas. The improvement in rural coverage for
22 New T-Mobile is substantial. New T-Mobile's increase in coverage is due largely to the
23 enhanced signal strength enabled by the combined spectrum portfolios of T-Mobile and Sprint as
24 well as the increased cell site density of New T-Mobile.

25 In addition to bringing new, quality mobile services to rural areas, the complementary
26 spectrum assets of T-Mobile and Sprint will allow 5G deployment to deliver higher speeds and
27 additional capacity on a wide-scale basis for fixed services. As a result, New T-Mobile will
28 provide rural California with a true in-home, high-speed wireless alternative to existing fiber and
29 cable offerings. These service improvements and New T-Mobile's targeted efforts to obtain new
30 subscribers will allow the combined company to expand services more broadly into rural

1 communities, as it will be able to spread the costs of expansion across an increased customer
2 base. Moreover, New T-Mobile's increased scale will enable it to obtain better pricing for
3 infrastructure and may allow more bang for the buck to purchase equipment that T-Mobile would
4 not otherwise be able to as a standalone company. The important rural benefits for Californians
5 are described in greater detail in Mr. Sievert's testimony.

6 I would note that as recognized by Cal PA, Sprint standalone does not have any rural
7 broadband buildout plans of its own which only highlights the benefits this will bring to those
8 consumers who might not have access to 5G even on a standalone basis.

9
10 **Q: CWA argues New T-Mobile's rural build out depends in large part upon Sprint's**
11 **mid-band spectrum, but will only have marginal utility in rural areas with limited coverage**
12 **(Afflerbach/Dehaven Testimony at pp. 13-15). Is this true?**

13 **A:** No it is not. Mid-band spectrum (from 1 to 6 GHz) provides a lot of utility for New T-
14 Mobile's 5G network. As I stated previously, mid-band provides high capacity with some
15 reduction in coverage capabilities as compared to sub-1 GHz spectrum bands. Because there is
16 more spectrum in the mid-band, there is more capacity that can be delivered from a single cell
17 site, and it is well-suited for urban and suburban markets where consumer demand for more
18 capacity is highest. Because the propagation in the mid-band is more limited (operating radii of
19 approximately up to 4 miles around cell sites) the band is not optimized for rural area coverage,
20 as it requires more capital expenditures to cover those geographies. However, when coupled
21 with T-Mobile's low-band spectrum, and the scale to spread the costs of expansion to new areas
22 via new cell sites across more subscribers, Sprint's mid-band spectrum serves a key role in New
23 T-Mobile's rural build-out.

24
25 **Q: CWA goes on to question New T-Mobile's capacity and coverage estimates for rural**
26 **areas (Afflerbach/Dehaven Testimony at p. 21). How do you respond to that?**

27 **A:** As I have previously described, New T-Mobile will aggressively deploy 2.5 GHz (and
28 other mid-band) spectrum throughout California. Nationally, by 2021, New T-Mobile will cover
29 65 million more of the population with mid-band spectrum—expanding to 85 million more of the
30 population by 2024. Additionally, New T-Mobile would be able to deploy all available 2.5 GHz

1 spectrum for 5G by 2022—whereas standalone Sprint would still have 60 megahertz of 2.5 GHz
2 spectrum reserved for LTE in 2024 and beyond. This would be true in California as well. All
3 2.5 GHz spectrum would be available for 5G services (that otherwise would have 60 megahertz
4 reserved for LTE) and mid-band spectrum would be deployed on more cell sites throughout the
5 state, including rural areas. As a result, 71% of Californians will have access to mid-band
6 spectrum for 5G in 2021 (compared to only 26% for standalone T-Mobile) and 99% of
7 Californians will have access to mid-band spectrum for 5G in 2024 (compared to 82% for
8 standalone T-Mobile).

1 X. CUSTOMER MIGRATION

2
3 **Q: Cal PA raises some concerns regarding how Sprint customers will be migrated to**
4 **New T-Mobile (Reed Testimony at p. 13). Can you please generally describe New T-**
5 **Mobile's network integration and migration plans?**

6 **A:** New T-Mobile's network and customer migration will be timely and efficient. We plan
7 an aggressive technology migration program for the combined company that will allow for a
8 smooth and rapid expansion of capacity and enable customers to quickly experience the benefits
9 of the transaction. The combination will be accomplished through a network and customer
10 migration. This migration plan involves: (1) accommodating Sprint's existing LTE customers in
11 California on the existing T-Mobile network as rapidly as possible after closing, and (2) utilizing
12 the freed up spectrum resources for 5G as soon as practical thereafter.

13 This is not our first large scale migration; as described in greater detail below and in Mr.
14 Keys' testimony, we migrated 9 million customers from the MetroPCS network to T-Mobile's
15 network in 2013-14, and did it very successfully—besting our own projections and schedules,
16 achieving greater synergies than expected, avoiding customer disruptions, surpassing expert
17 predictions, improving service for customers and, ultimately, sparking rapid growth for
18 MetroPCS customer base. We expect to utilize a similar approach for migrating Sprint
19 customers, including many of the same tools and team members. Based on our experience
20 migrating MetroPCS customers onto the T-Mobile network, I am confident this migration
21 process will be successful.

22
23 **Q: Cal PA also expresses concerns about how Sprint customers with incompatible**
24 **devices will be migrated onto New T-Mobile's network (Reed Testimony at p. 13). Please**
25 **explain how the New T-Mobile will ensure that California consumers are efficiently**
26 **migrated to the new network.**

27 **A:** Cal PA raises an important issue, but its concern is misplaced as we have a detailed plan
28 for migrating all Sprint customers, including those with incompatible devices. Sprint customers
29 who have handsets compatible with T-Mobile's network or upgrade to T-Mobile-compatible
30 handsets, will gain access to New T-Mobile's nationwide network, improved coverage quality,

1 higher performing devices,⁴ access to VoLTE capabilities if compatible,⁵ and a broader choice of
2 handsets. The remaining Sprint customers will eventually require handset change outs. The
3 majority of these will be accomplished through the natural upgrade cycle, but New T-Mobile
4 (similar to how the MetroPCS transition was handled) will offer promotions to expedite upgrades
5 to compatible devices. T-Mobile expects that all Sprint customers are likely to be completely
6 migrated within three years. By undertaking this rapid migration, New T-Mobile will drive
7 synergies to our existing LTE network and free up valuable spectrum for 5G use in a more rapid
8 fashion than either company could accomplish on its own. Even so, the transition from the 800
9 MHz CDMA network will begin no earlier than January 1, 2021, and T-Mobile will not
10 terminate the CDMA network in any market without migrating users from the network first.

11 Additionally, a built-in LTE feature known as Multi-Operator Core Network (“MOCN”)
12 will allow us to unify the T-Mobile and Sprint radio access networks (“RANs”) almost
13 immediately and allow the existing customers with compatible devices to seamlessly access the
14 best of both networks during integration. As Sprint customers are migrated off of the Sprint
15 core, we will remove this requirement and collapse to a single New T-Mobile core network.
16

17 **Q: What about prepaid customers; how will they be migrated to the New T-Mobile**
18 **network?**

19 **A:** Prepaid customers ride over the same network as all other T-Mobile customers, and their
20 migration will be identical to other customers. Similarly, Sprint prepaid customers will be
21 migrated in exactly the same fashion and on the same timeframe as Sprint postpaid customers.

⁴ Sprint’s existing voice services are provided using CDMA technology. CDMA does not allow a voice and data connection at the same time—so a Sprint customer on the CDMA network must choose between these services.

⁵ VoLTE is an acronym for Voice over LTE networks. VoLTE is a standards-based technology that is required to allow for the delivery of voice calls over the LTE network. Sprint began to deploy VoLTE on its network on a standalone basis in 2018. When moving Sprint customers to the New T-Mobile network, VoLTE-capable devices of existing Sprint customers can immediately be updated through an over-the-air software upgrade. While Sprint will began deploying VoLTE in 2018, our experience is that this effort may take some time to roll out throughout the network. T-Mobile already has VoLTE available on its network and Sprint devices that are capable through a software update to use the New T-Mobile network and are compatible with VoLTE will be able to rapidly have access to VoLTE and HD Voice capabilities.

1 **Q: How will you deal Sprint customers who do not have compatible devices and don't**
2 **want to change phones; won't they be left behind?**

3 **A:** Absolutely not. Although there may be some Sprint customers on legacy plans with
4 older devices that may not be inclined to upgrade their phones, we believe that the advantages of
5 New T-Mobile's network will really limit the number of customers who do not want to switch.
6 In addition, as I noted above, we intend to offer a set of promotions to facilitate that process
7 where necessary. That could include providing discounted or even free devices for those last few
8 customers; this proved to be very successful in the Metro merger for those last few customers
9 who wanted to hold on to their older devices.

10
11 **Q: Above you mentioned the MetroPCS customer migration; can you summarize how**
12 **that customer migration worked, and why you think it is an indicator of success for the**
13 **migration of Sprint customers to the New T-Mobile?**

14 **A:** Although Mr. Keys also discusses this in his testimony, based on our experience
15 migrating MetroPCS customers onto the T-Mobile network, I am confident this migration
16 process will be successful. We projected that the entire migration of approximately 9 million
17 MetroPCS subscribers, utilizing a market-by-market transition, would be completed in 24
18 months. In reality, we fully completed this process within 26 months after the deal closed, with
19 the majority of markets completed well ahead of schedule. In addition, MetroPCS customers
20 were using incompatible technology (CDMA) that required handset changes for all existing
21 subscribers to access to T-Mobile network. Through this process, 70 percent of MetroPCS
22 subscribers migrated to HSPA+ or LTE within 15 months and this enabled a more accelerated
23 refarm of the MetroPCS spectrum to LTE (from CDMA). And, importantly, we utilized the
24 MOCN technique described above to combine the two RANs on Day One without any adverse
25 effect to MetroPCS subscribers.

26 We expect to utilize a similar approach for migrating Sprint customers, including many
27 of the same tools and team members. The two companies both have spectrum assets in the PCS
28 band which will greatly aid the integration of Sprint's existing customers onto our new network.
29 A substantial portion of the Sprint customer base can have their existing devices updated through
30 over-the-air software to allow almost immediate access to the New T-Mobile network. Further,

1 we integrated the sites retained from MetroPCS much in the same way we will do here with the
2 retained sites from Sprint and T-Mobile, on a market-by-market basis. Finally, the success of the
3 MetroPCS migration provides a good indication of what will occur in the New T-Mobile
4 migration plan. And for the best example you need look no further than California, as one of the
5 biggest success stories of the MetroPCS migration occurred in Los Angeles. During that
6 transition 1.43 million MetroPCS subscribers were seamlessly migrated onto the T-Mobile
7 network. For this merger, 1.46 million Sprint subscribers will need to be migrated. I understand
8 the concern about customer experience during this process, but with T-Mobile's strong track
9 record, particularly in California, these concerns are misplaced.

10
11 **Q: Will legacy Sprint customers who have not yet migrated to the New T-Mobile**
12 **network see their service diminish during the network integration period?**

13 **A:** No. As I just detailed, the same approach utilized to migrate MetroPCS customers will
14 be used to migrate Sprint customers. Most importantly for assessing the potential impact on
15 Sprint customers, the customer experience for both MetroPCS and T-Mobile subscribers was
16 maintained (and in many cases improved) during that prior transaction's transition process. In
17 fact, MetroPCS's customer base *doubled* over the 4.5 years following the close of the
18 transaction, customer churn was reduced, and speed and quality was greatly improved for
19 subscribers. As will be the case in the Sprint customer migration, MetroPCS sites were not
20 decommissioned until subscribers could be fully accommodated on the T-Mobile network. The
21 integration playbook for New T-Mobile will be similar and utilize the expertise gained from the
22 MetroPCS transition. In contrast to other less successful transitions, this process will be built
23 upon a proven methodology that delivered cost savings ahead of schedule, with synergies better
24 than expected and without any customer disruption.

**XI. EMERGENCY RESPONSE, NETWORK RESILIENCY AND SUPPORT FOR
FIRST RESPONDERS**

A. Emergency Response

Q: Cal PA recognizes that both T-Mobile and Sprint have “robust emergency plans” (Reed Testimony at p. 36). Can you elaborate?

A: Yes. T-Mobile is fully committed to safeguarding the interests of its customers, employees, the public, and other stakeholders, including first responders, in the event of an emergency or other significant business disruption. As a result, T-Mobile maintains an enterprise-wide Business Continuity Program that is designed to provide general guidance and maximum flexibility in order to provide effective, and individually tailored, responses to a wide variety of potentially disruptive events such as earthquakes, wildfires and the like. T-Mobile's Business Continuity Program promotes active involvement by all lines of business and is regularly refined to maintain its effectiveness and ensure the flexibility needed to effectively address emergency situations throughout the country—each of which presents unique challenges—and ensure overall business continuity. T-Mobile draws from industry best practices and governmental guidance to shape its Business Continuity Program. T-Mobile additionally participates in the annual certification program at CTIA, the premiere U.S. trade association for wireless services providers.

Our systems seem to be working very well, although we are always looking for ways to improve our ability to help first responders and customers impacted by these events. For example, in the case of the recent Camp and Woolsey wildfires, the T-Mobile emergency response teams worked closely with local governments, first responders, and community organizations to quickly restore service that was disrupted by the fires and to otherwise assist impacted consumers. Among other things, T-Mobile used a variety of tools to expedite restoration of service, including the use of Cells on Light Trucks (“COLTs”), Cells on Wheels (“COWs”), generators, and microwave or satellite backhaul. T-Mobile also provided “pre-lit” devices at no cost to affected communities and customers at evacuation centers, T-Mobile stores, and various other locations in and near the areas of the fire. T-Mobile also provided car, wall, and portable chargers and distributed N95 masks to address air quality. In addition, T-Mobile

1 made WiFi available at various locations, including evacuation centers and shelters, and
2 provided impacted consumers with service and billing relief including making unlimited calls
3 and texts available to customer who did not already have that access, removing equipment
4 installment plan charges for devices lost in the fire, and granting payment extensions. Payment
5 fee waivers were automatically applied for affected area codes and collection holds were placed
6 on all impacted accounts. Further, T-Mobile provided regular updates to the California Public
7 Utilities Commission, the California Office of Emergency Services, and the California Utilities
8 Emergency Association regarding the status of its network and its efforts to restore service.

9 T-Mobile notes that it has leveraged its relationships with national vendors to meet the
10 needs of impacted communities and local governments as well as to support its own recovery
11 efforts. T-Mobile maintains backup and alternate power sources at mission-critical locations,
12 and has information processing and telecommunications backup sites that provide redundancy
13 important to protecting key business information and services. Emergency preparedness will of
14 course remain a priority for New T-Mobile.

15
16 **Q: How does T-Mobile ensure that it can get its network backup and running as soon**
17 **as possible after an emergency?**

18 **A:** Not all emergencies result in network outages, but where they do T-Mobile has built
19 robust resiliency measures into its network, including maintaining backup and alternate power
20 sources at mission-critical cell sites and all switch locations, and has leveraged its relationships
21 with national vendors to effectively respond. As noted above, T-Mobile retains a variety of tools
22 to expedite restoration of service when outages occur, including COLTs, COWs, portable
23 generators, and alternate backhaul options via microwave or satellite. For example, T-Mobile
24 retains approximately [BHC-AEO] [REDACTED] [EHC-AEO] portable generators in the state of
25 California, and approximately [BHC-AEO] [REDACTED] [EHC-AEO] additional portable generators that
26 can be delivered to California within 24-48 hours. Further, T-Mobile has entered into contracts
27 with both local and national vendors that operate in California, including portable generator
28 rental companies to meet the needs of impacted communities and local governments, as well as
29 to support its own recovery efforts. T-Mobile also maintains information processing and
30 telecommunications backup sites that provide redundancy that is important to protecting key

1 business information and services. These resiliency and recovery measures will become part of
2 New T-Mobile through the merger.

3
4 **Q: Cal PA notes that Sprint's existing fleet of portable generators, COLTs, and COWs**
5 **provide critical public safety benefits, and suggests that New T-Mobile will decommission**
6 **Sprint's Equipment in a way that will harm public safety (Reed Testimony at pp. 36-38).**
7 **Do you have any comment on the issue of portable generators?**

8 **A:** As I discuss in my prior response, T-Mobile retains a significant number of portable
9 generators in California, and even more generators that can be delivered to California on short
10 notice. New T-Mobile recognizes the value in Sprint's existing fleet of portable generators and
11 commits to maintaining those portable generators located in California. This should only
12 enhance the continued resilience and functionality of New T-Mobile's network during
13 emergencies, like during California's recent wildfires. New T-Mobile also commits to retaining
14 the Sprint inventory of COLTs and COWS to support the legacy Sprint network until the
15 network integration is complete. Importantly, however, since COLTs/COWs are technology
16 specific (CMDA/GSM) Sprint's COLTs/COWs will not be useable to support the New T-Mobile
17 network once the two networks are integrated.

18
19 **Q: Cal PA also asserts that the decommissioning of some Sprint cell sites following the**
20 **merger will negatively impact network resiliency. Can you comment?**

21 **A:** Cal PA is mistaken. Integrating the Sprint and T-Mobile networks into the New T-
22 Mobile network would involve decommissioning a number of Sprint cell sites where they are
23 redundant and unnecessary. These generally will be sites that are either collocated with existing
24 T-Mobile sites (*i.e.*, on the same tower or rooftop) or located very close to an existing T-Mobile
25 site with extensively overlapping coverage. As such, they are unnecessary to provide or
26 maintain service, and would not be constructed by an operator in the ordinary course. For this
27 reason, decommissioning these sites will not affect the resiliency of the New T-Mobile network
28 or the reliability of service provided to consumers and first responders. On the other hand,
29 eliminating these unnecessary sites is critical to realizing the projected network synergies from

1 the transaction, which are essential to making possible the nearly \$40 billion investment in a 5G
2 network and services, which does benefit the network's resiliency.

3
4 **B. Permanent Backup Power and NORS Reports**

5
6 **Q: Cal PA seems to suggest that your Network Outage Reporting System ("NORS")**
7 **reports indicate an issue with your backup power capabilities (Reed Testimony at pp. 37-**
8 **38). Is that correct?**

9 **A:** No, it is not correct. All switches have permanent generator backup. Battery backups are
10 also part of the standard T-Mobile configuration for macro cell sites. Thus, essentially all of T-
11 Mobile's approximately [BHC - AEO] [REDACTED] [EHC - AEO] macro cell sites in California have
12 such battery backups. In some case, sites also are equipped with permanent fuel-powered
13 generators. For clarity, the permanent backup power at sites differs from the portable generators
14 described above which can be developed to different cell sites on an as needed basis in case of
15 emergencies. In general, the only cell sites that do not have backup power are in locations where
16 the local authorities restrict the provisioning of backup power or where other physical limitations
17 (e.g., a weight or size restriction) prevents the permanent installation of a backup power
18 source. Even in those limited instances, T-Mobile continually evaluates new technologies that
19 may enable the installation of backup power where it was previously unavailable, for example,
20 Lithium Ion batteries can help address sites that have restrictions due to weight limits. I would
21 note that T-Mobile has generator backup at all of its California mobile switching centers as well.

22
23 **Q: You also mentioned that you have permanent generators at all of your mobile**
24 **switching centers. Can you elaborate?**

25 **A:** Yes. T-Mobile has permanent generator backup at all of its California mobile switching
26 centers:
27

1 [BHC-AEO]

[REDACTED]

2 [REDACTED]
3 [REDACTED]
4 [REDACTED]

5 [REDACTED]
6 [REDACTED]
7 [REDACTED]

8 [REDACTED]
9 [REDACTED]
10 [REDACTED] [EHC-AEO]

11

12 **Q: How long is your battery backup at macro sites designed to last?**

13 **A:** T-Mobile's backup battery can power a macro cell site for [BHC-AEO] [REDACTED]
14 [REDACTED] [EHC-AEO], depending on the type and/or quantity of batteries at the site. When the
15 normal supply of power is re-established to the site, the backup battery will automatically

1 recharge. In the case of longer power outages, as described above, T-Mobile deploys portable
2 generators as soon as practicably possible, subject to the conditions of the site. Further, T-
3 Mobile has a program of regularly scheduled maintenance under which backup batteries are
4 tested and replaced where needed, as they have a lifespan of [BHC-AEO] [REDACTED]
5 [EHC-AEO], depending on the type of battery at the site. In a situation where there is a power
6 outage to a particular site, the redundancy in the system often allows us to continue providing
7 service by redirecting traffic to other sites that are not impacted.
8

9 **Q: Does battery backup ensure the ability to provide service in the case of a broader**
10 **disruption that impacts the backhaul provider?**

11 **A:** No it does not. To oversimplify, a cell site requires both (a) power to operate the
12 antennas and equipment on a particular site and (b) backhaul. Backhaul, a service T-Mobile
13 obtains from other providers, also requires power. A cell site will not be functional if it does not
14 have backhaul. So, for example, in the case of a major disaster – like a fire or an earthquake –
15 where backhaul is interrupted, we may experience an outage even though we have power (either
16 commercial or backup) to a particular site. Moreover, even if backhaul is up and operating, a
17 customer may not be able to complete a call to a landline number if the landline providers switch
18 or lines are out of service due to the major disaster.
19

20 **Q: Can you explain what seems to be the source of the misunderstanding of the use of**
21 **backup power on the on the part of Cal PA?**

22 **A:** Although I have not had any conversations with Cal PA on this subject, I suspect that its
23 confusion results from a misunderstanding of how NORS reports are prepared or how backup
24 power is used by different companies. For example, Cal PA seems to rely on what is referred to
25 as the “Direct Cause” on the FCC’s NORS reporting forms to support its assertion that there is
26 some issue with our backup or network resiliency. However, that is incorrect. The FCC
27 provides a list of dropdown options to populate that part of the form and it is our practice and
28 policy to use “Power Failure (Commercial and/or Backup)” when the FCC outage threshold is
29 met and the initial alarm related to that outage involved a loss of commercial power. That
30 dropdown choice in no way indicates that backup power was the sole cause nor does it provide

1 information about the overall situation that resulted in the reported outage. It does not tell you
2 whether there was a backhaul issue or, for example, whether a site was destroyed in the course of
3 a natural disaster. It only tells you that our system first identified an interruption to commercial
4 power with respect to identifying that reportable outage.

5
6 **Q: Can you provide an example?**

7 **A:** Yes. In the recent and tragic Camp and Woolsey Fires, we submitted the attached NORS
8 reports. (See Attachment E.) As you can see, they indicate that the Direct Cause of the outage
9 was “Power Failure (Commercial and/or Backup)”. However, the reports also indicate that the
10 Root Cause was “Environment (External) – Fire” and in the description they provide “Wildfires
11 affected power to the sites.” The reportable outages that resulted from these fires were not
12 simply a matter of backup power; it was a broader issue with the entire power and
13 telecommunications ecosystem. Finally, T-Mobile’s ability to restore service quickly even in the
14 face of those disasters only confirms the robustness of our emergency response plans, as noted
15 by Cal PA in their testimony, as well as our backup capabilities.

16
17 **Q: Have there been any changes to the NORS reporting requirements that seem**
18 **important to understand here?**

19 **A:** Yes. In May 2018, the FCC changed the way carriers are to calculate when the 900,000
20 user minute threshold is met. In brief, the changes require carriers to use essentially an average
21 customers/site to determine impacted customers for any outage. Thus, if a carrier had an average
22 of 500 customers/site and service to 90 sites in a particular area was interrupted for 30 minutes,
23 the threshold would be met (i.e., 500 customers/site (x) 90 sites (x) 30 minutes = 900,000). This
24 has increased the number of reportable outages under the FCCs rules since the implementation of
25 the new rules; it does not mean that there is an issue with the resiliency of our network.

26
27 **C. Support for First Responders**

28
29 **Q: Cal PA also suggests that New T-Mobile should construct a dedicated and separate**
30 **public safety network for first responders (Reed Testimony at p. 39). Can you comment?**

1 **A:** Leaving aside the fact that such a network would be both practically and financially
2 untenable, it is also wholly unnecessary. AT&T has already constructed dedicated first
3 responder networks—indeed the State of California has entered into a contract with AT&T to
4 ensure California-based first responders, statewide, can have access to AT&T’s dedicated public
5 safety network. For background, in 2017, FirstNet, a congressionally mandated independent
6 authority, awarded a 25-year agreement to AT&T to build a nationwide first responder network.
7 As part of that agreement, AT&T was awarded the right to deploy significant public safety
8 spectrum resources in the 700 MHz Band. Neither T-Mobile nor Sprint has been awarded
9 comparable spectrum, or state- or nationwide government contracts, to construct a separate first
10 responder network. However, as I noted above, T-Mobile has a robust emergency response
11 program; one which even drew praise from Cal PA in its testimony. Moreover, T-Mobile, like
12 other wireless providers are continuously enhancing their practices and procedures to better meet
13 the needs of public safety. I am not aware of any justification for such a proposal.
14

15 **Q: What plans does New T-Mobile have to make sure that first responders receive the**
16 **best service?**

17 **A:** T-Mobile is grateful for the service of first responders, and acknowledges the importance
18 of specially serving first responders to ensure they can get their jobs done. To that end, New T-
19 Mobile will offer first responders specialized government account plans that take into account
20 the unique data and communications needs of first responders during an emergency event,
21 including unlimited talk and text, unlimited high-speed data, and plans that are not subject to
22 data prioritization. The company will also develop an outreach program for current and new first
23 responder customers to inform them about specialized first responder plans available for
24 government accounts. Furthermore, New T-Mobile recognizes that its public safety customers
25 may have unique issues and needs that cannot be addressed in the same way as a typical
26 customer. Therefore, T-Mobile provides first responder customers with government accounts
27 support through the government Team of Experts (TEX), a team-based approach to customer
28 care with expertise in serving government customers, including first responders with government
29 accounts.

1 Additionally, New T-Mobile acknowledges that not all public safety agencies will be
2 subscribed to first responder government account plans. If such a first responder does not have
3 such an account contacts New T-Mobile during an emergency, New T-Mobile will offer them
4 unlimited data options with no de-prioritization to address any additional high-speed data needs
5 during an emergency. Through these commitments, New T-Mobile is dedicated to providing the
6 best quality service to first responders so that they can focus at the task on hand.

7
8 **Q: Does this conclude your rebuttal testimony?**

9 **A: Yes, it does.**

ATTACHMENT A

—PUBLIC VERSION—
(ENTIRE ATTACHMENT SUBMITTED UNDER SEAL)

ATTACHMENT B

**—PUBLIC VERSION—
(ENTIRE ATTACHMENT SUBMITTED UNDER SEAL)**

ATTACHMENT C

—PUBLIC VERSION—
(ENTIRE ATTACHMENT SUBMITTED UNDER SEAL)

ATTACHMENT D

~~PUBLIC VERSION~~
~~(ENTIRE ATTACHMENT SUBMITTED UNDER SEAL)~~

California – Projected 2021 & 2024 5G County Level Coverage

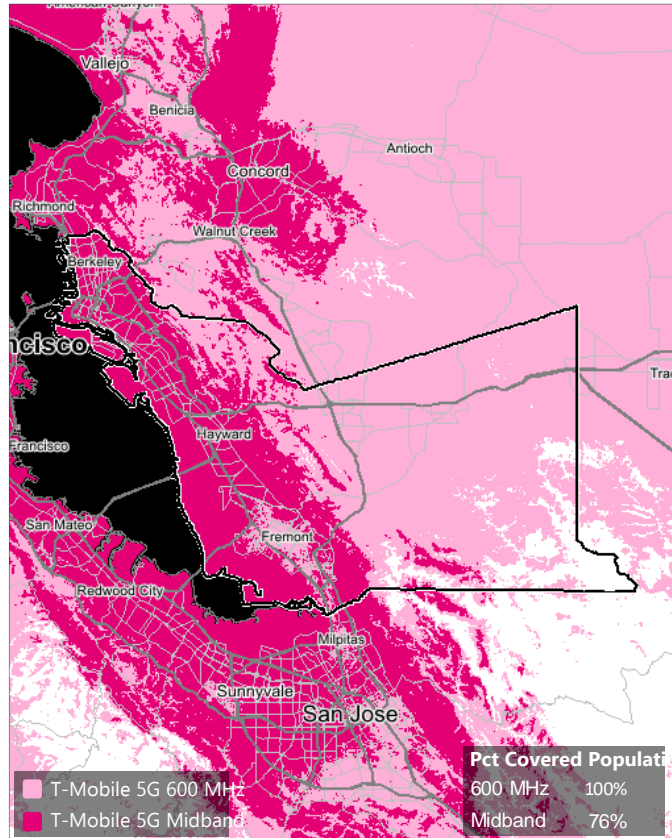


Radio Network Engineering & Development

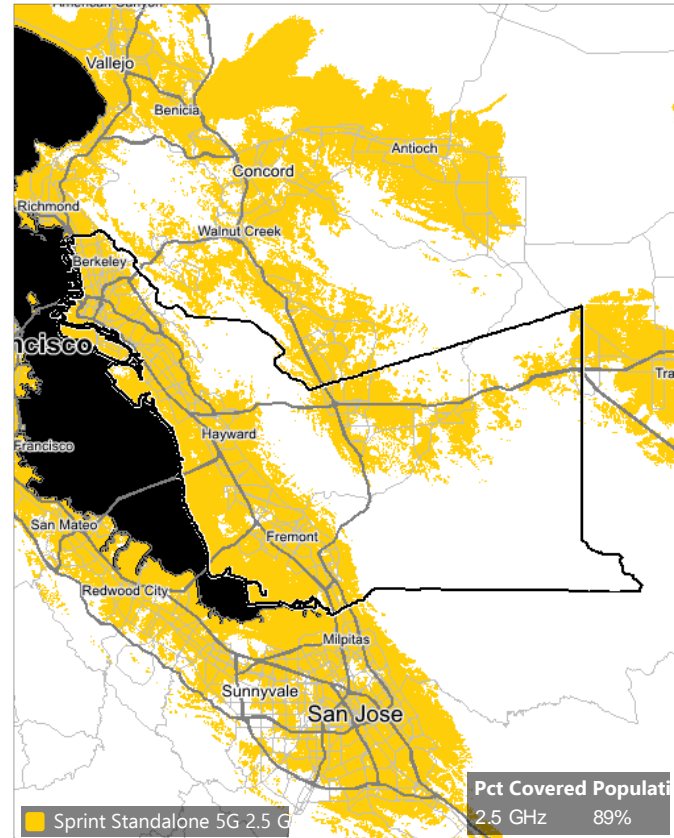
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Projected 2021 5G Coverage: Alameda County (06001)

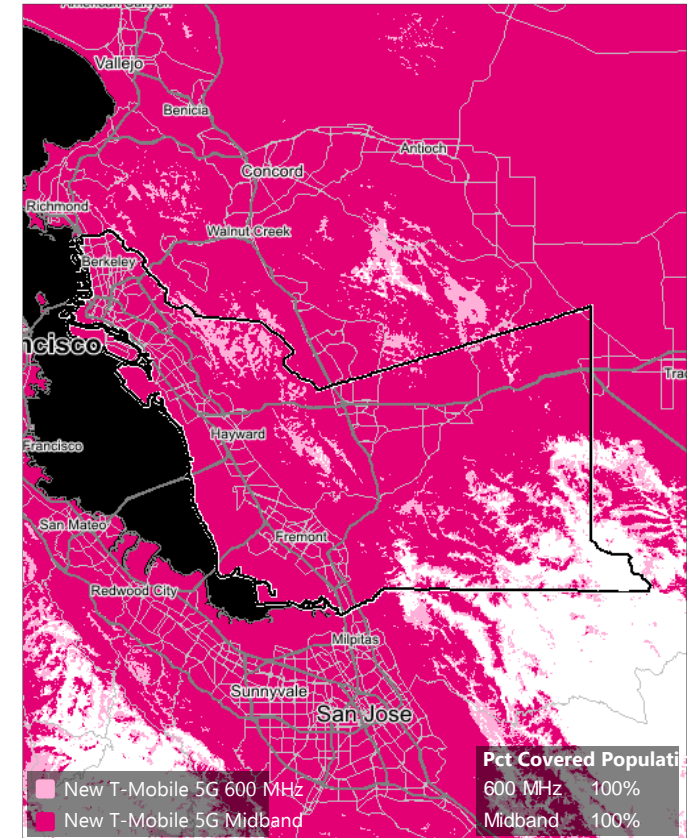
T-Mobile Standalone



Sprint Standalone

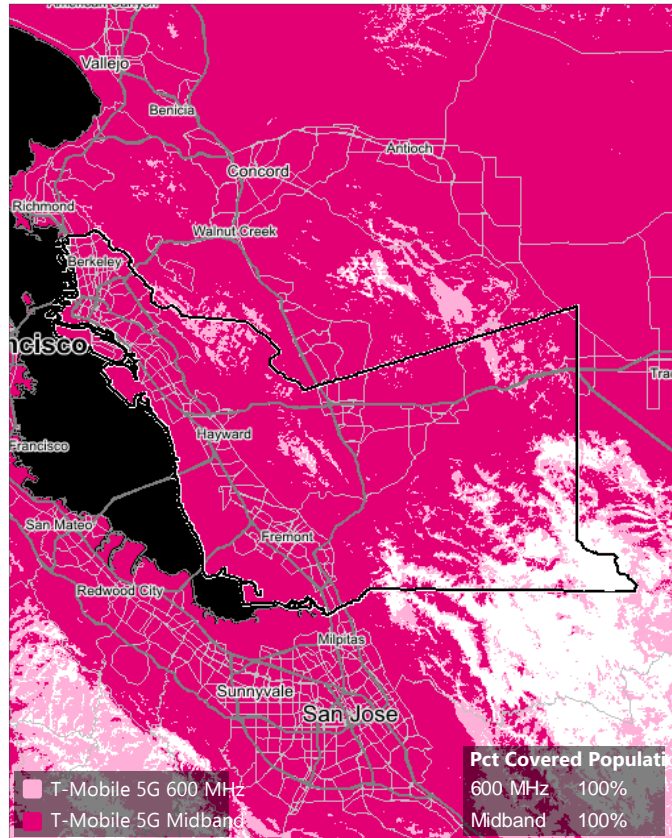


New T-Mobile

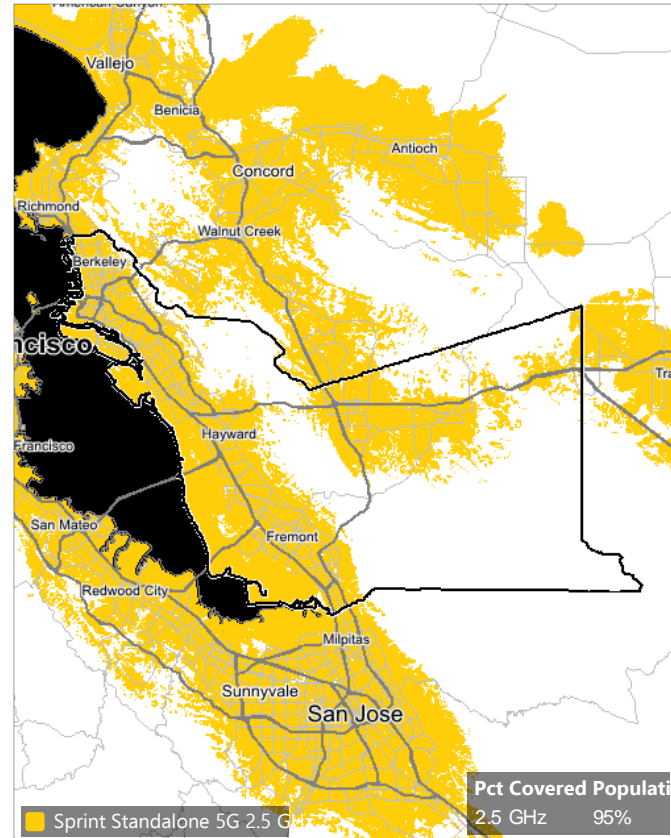


Projected 2024 5G Coverage: Alameda County (06001)

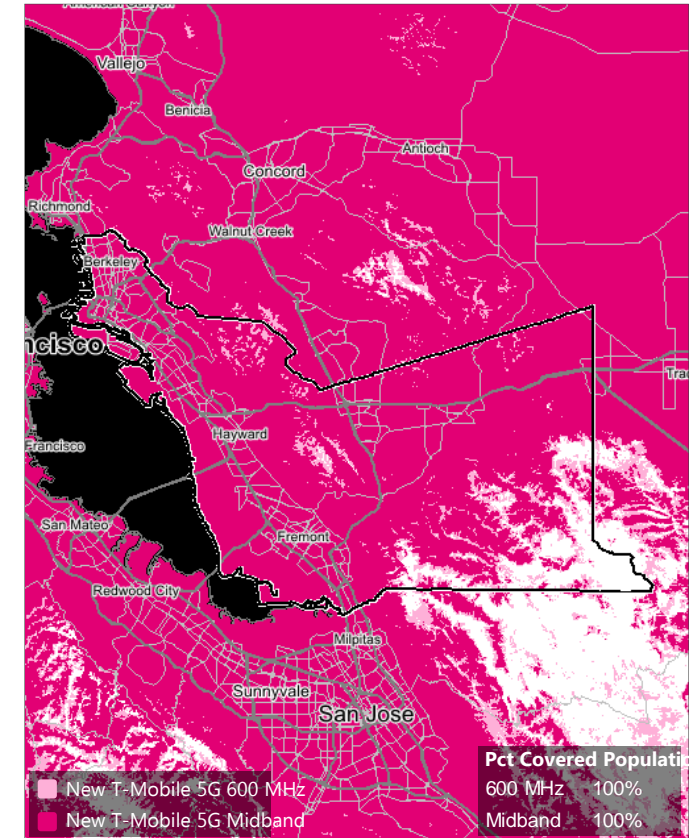
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Sprint Standalone

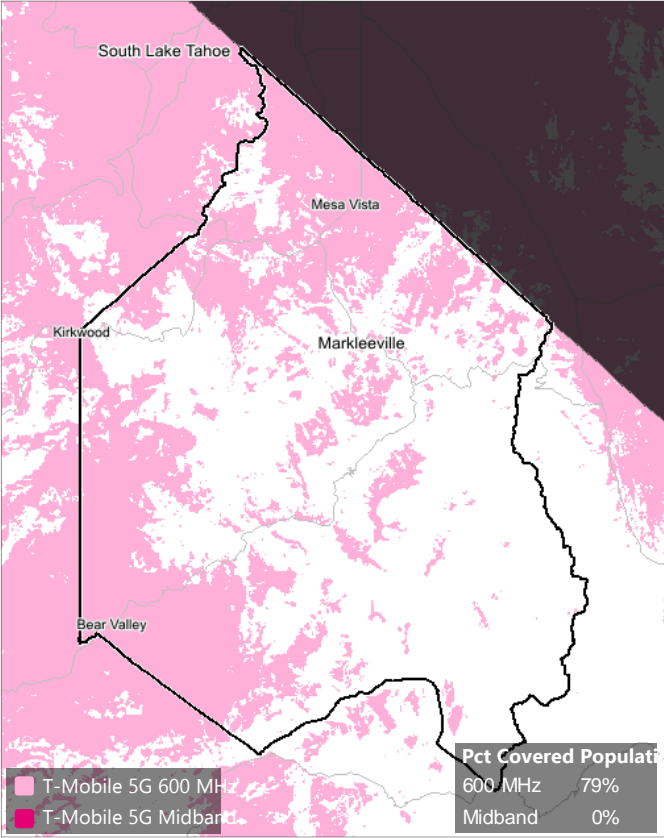


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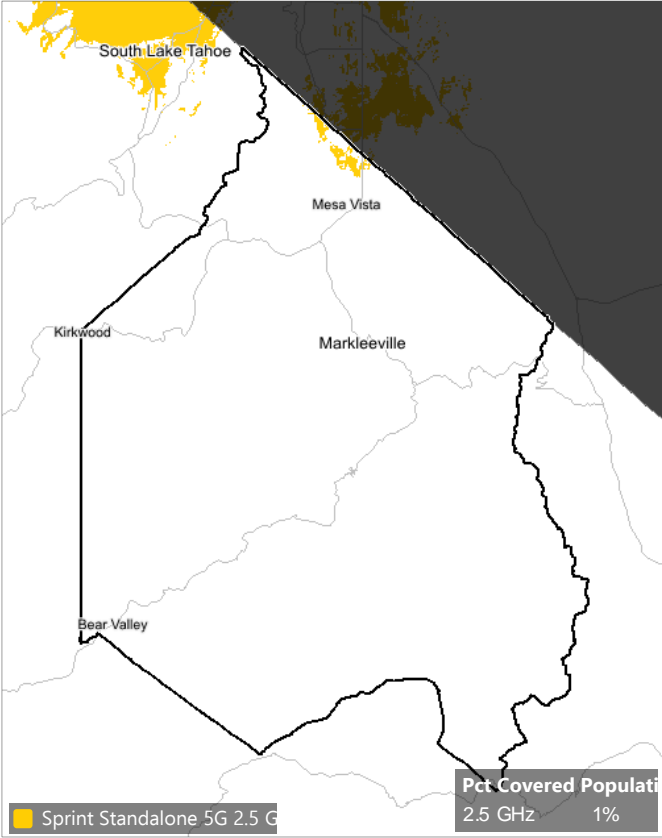


Projected 2021 5G Coverage: Alpine County (06003)

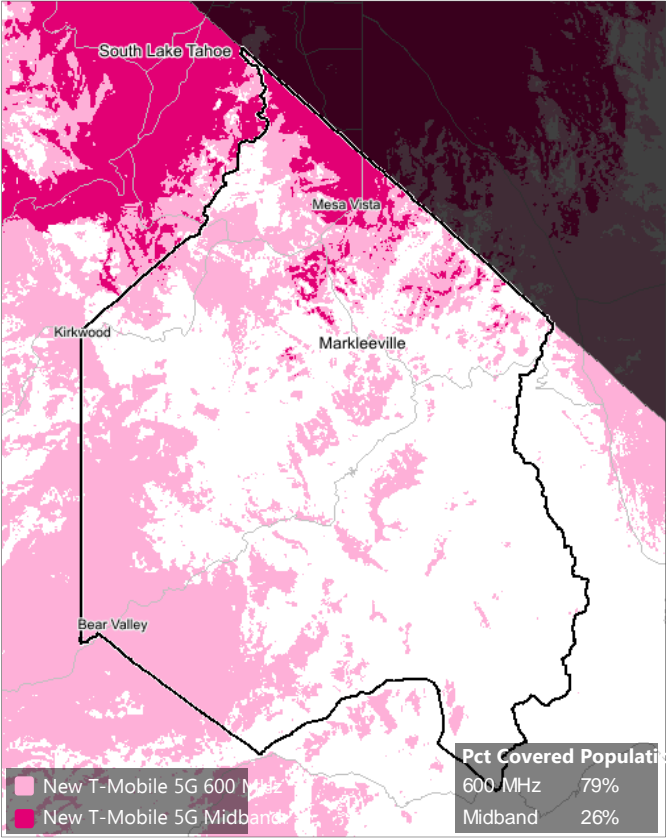
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Sprint Standalone

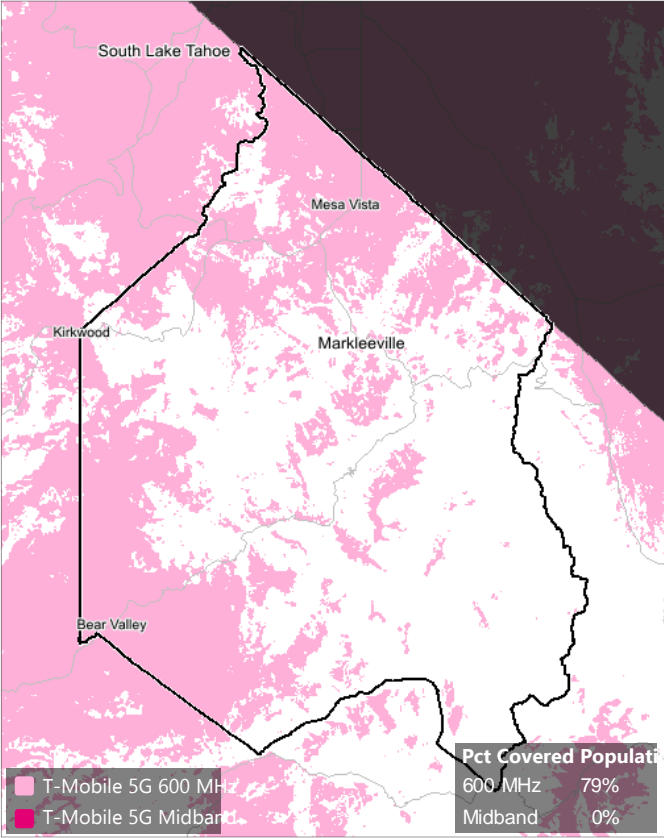


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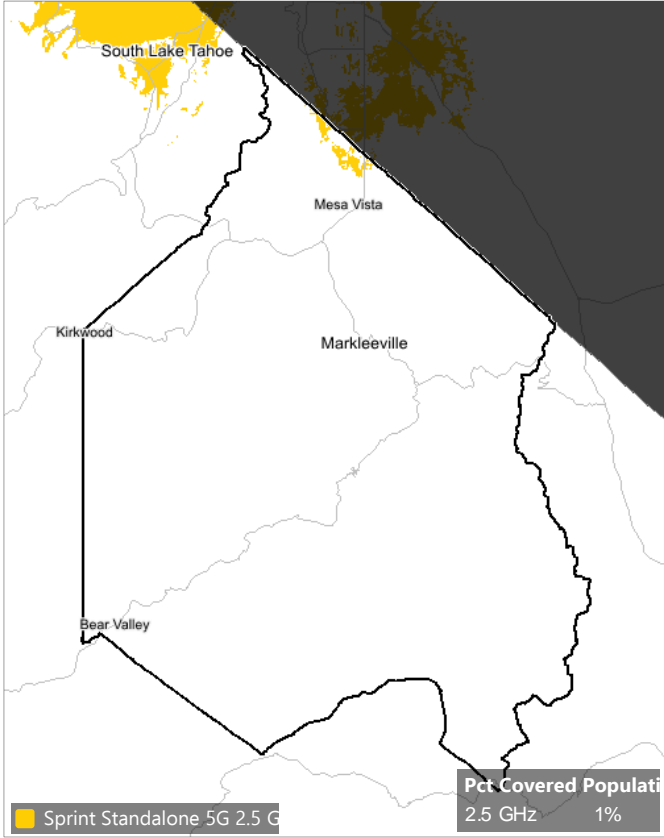


Projected 2024 5G Coverage: Alpine County (06003)

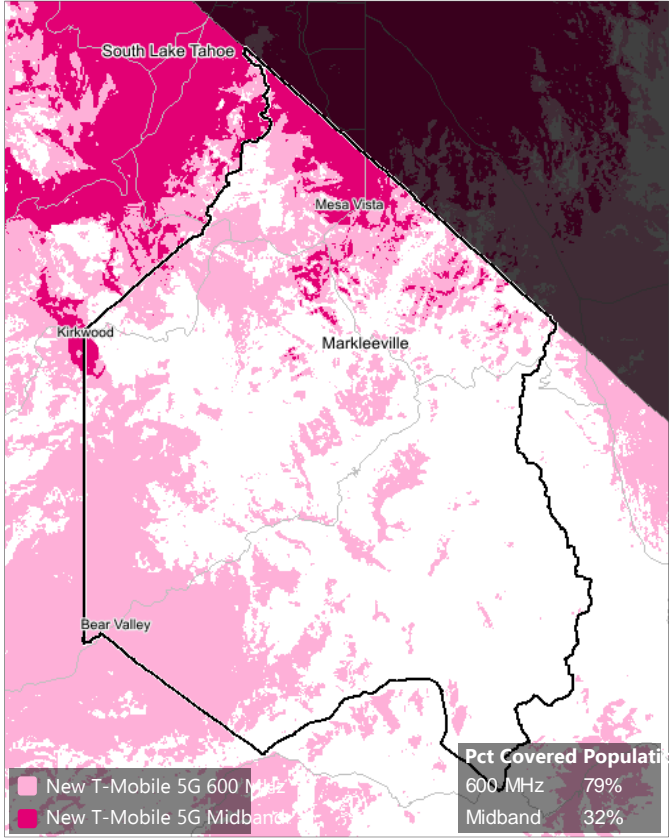
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Sprint Standalone

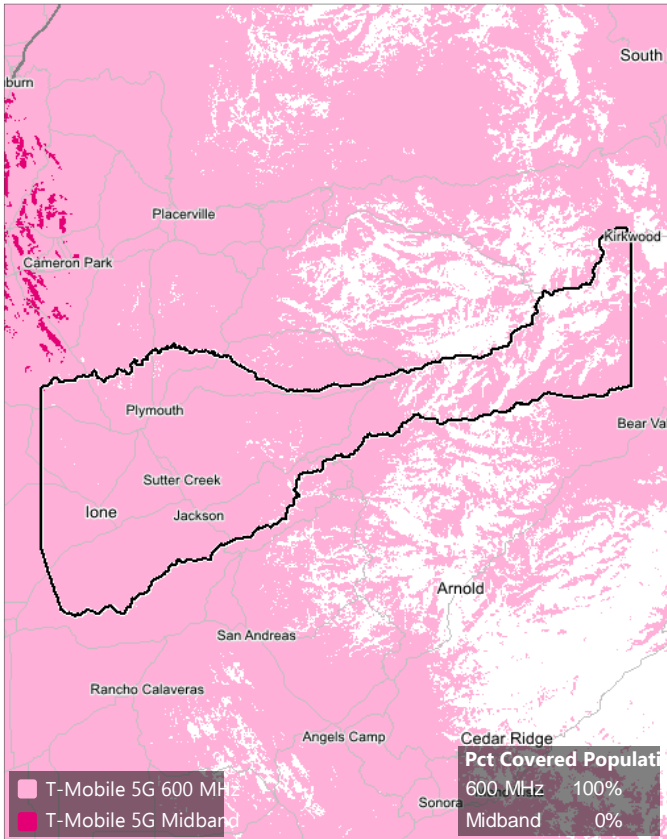


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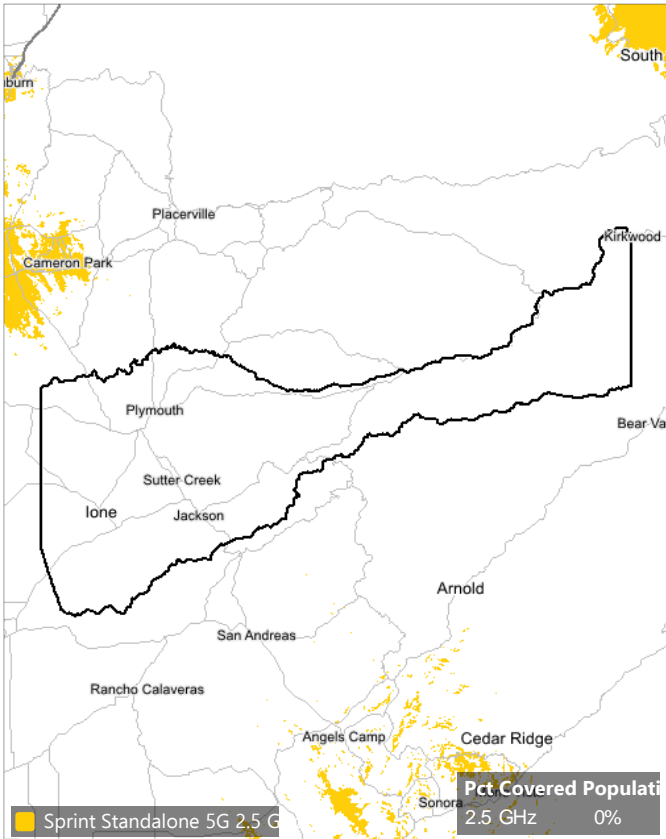


Projected 2021 5G Coverage: Amador County (06005)

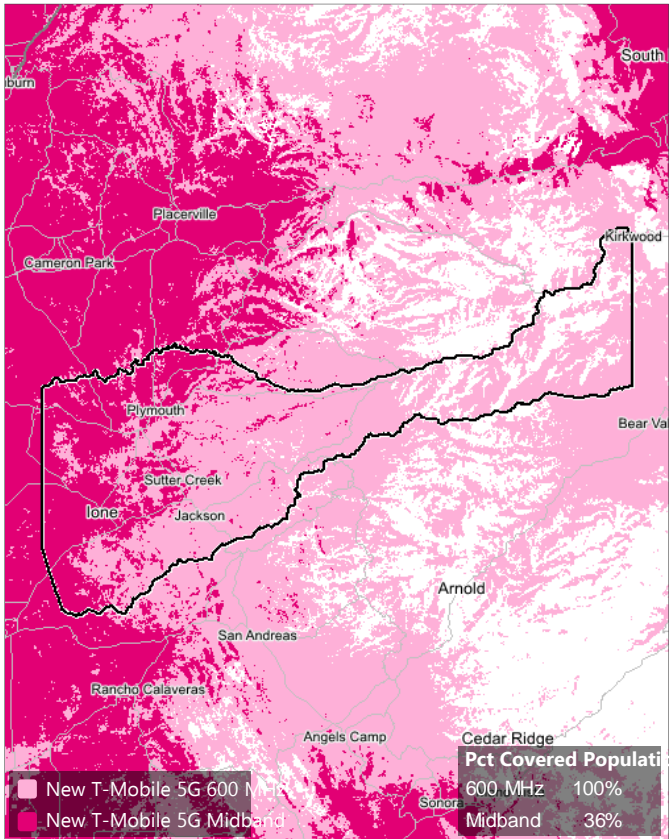
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Sprint Standalone

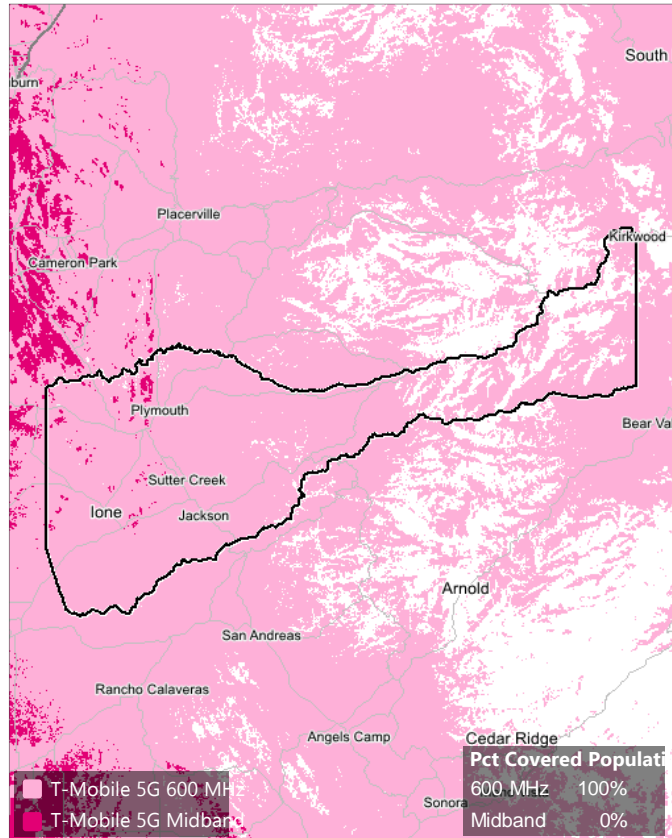


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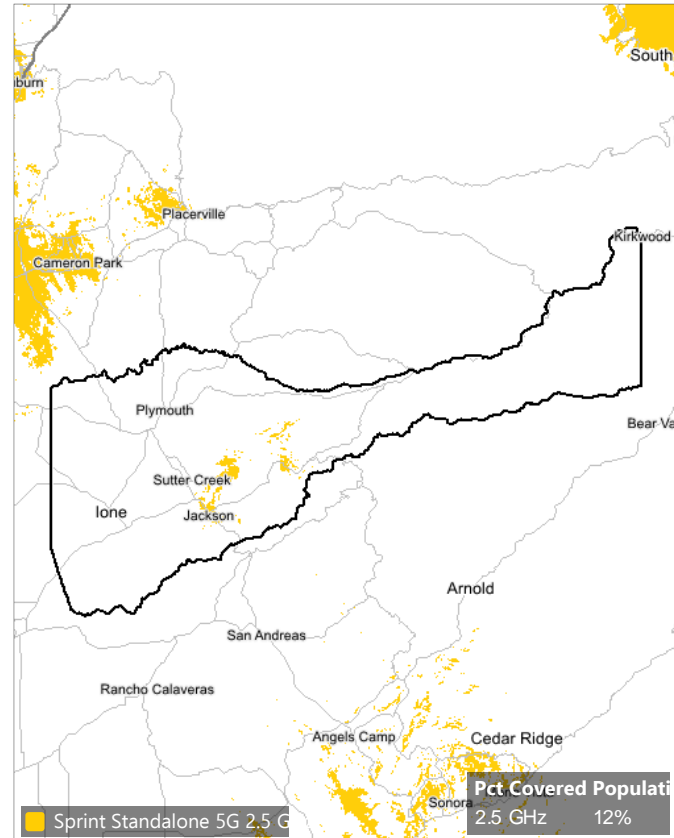


Projected 2024 5G Coverage: Amador County (06005)

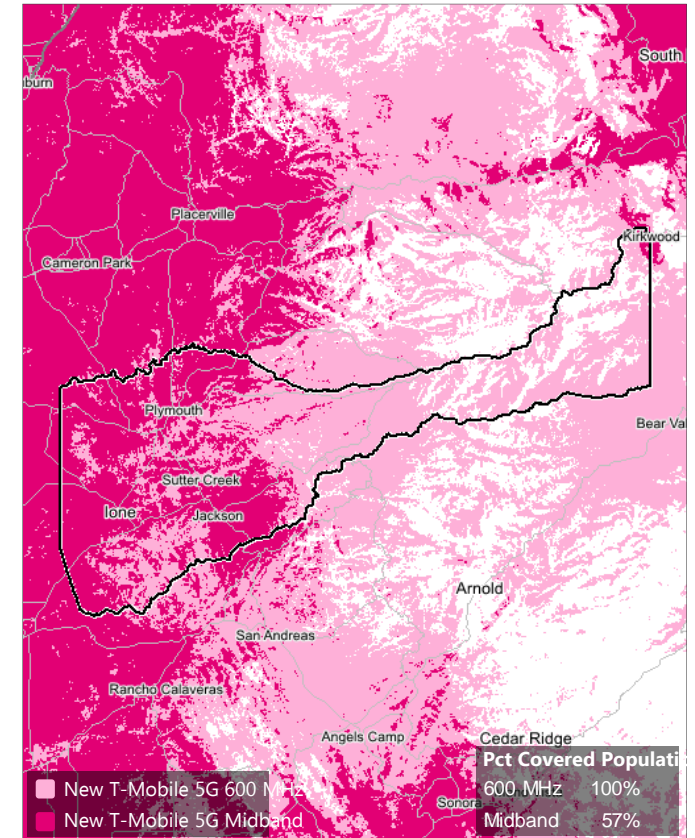
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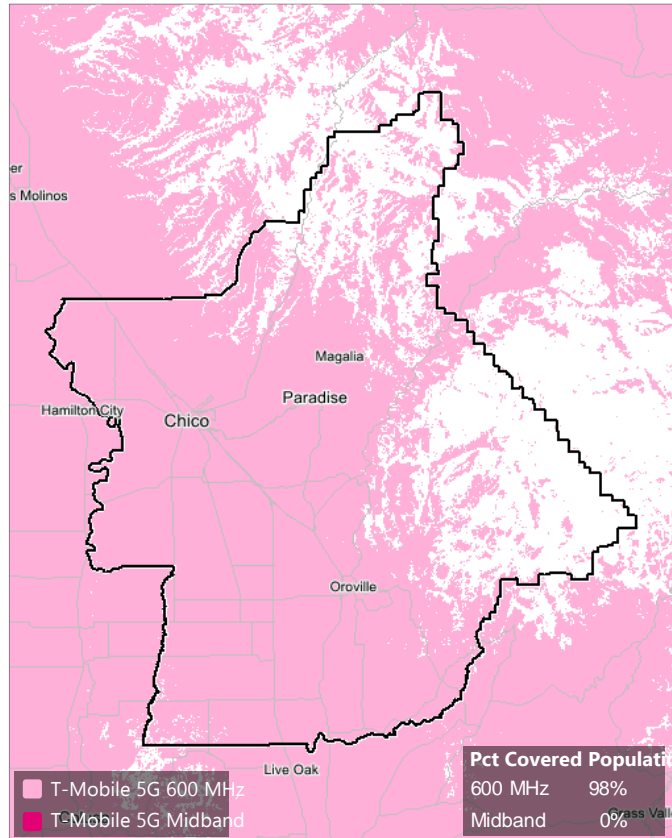


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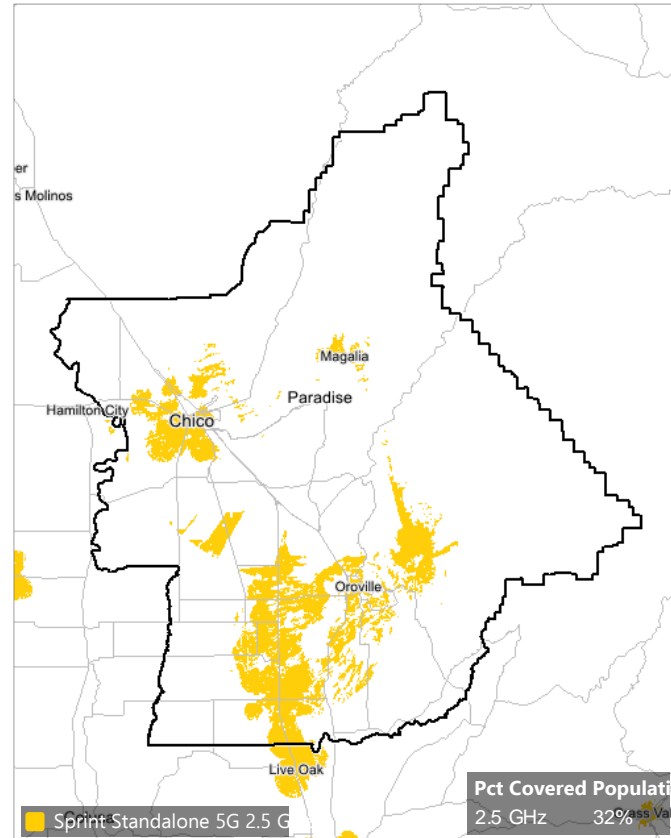


Projected 2021 5G Coverage: Butte County (06007)

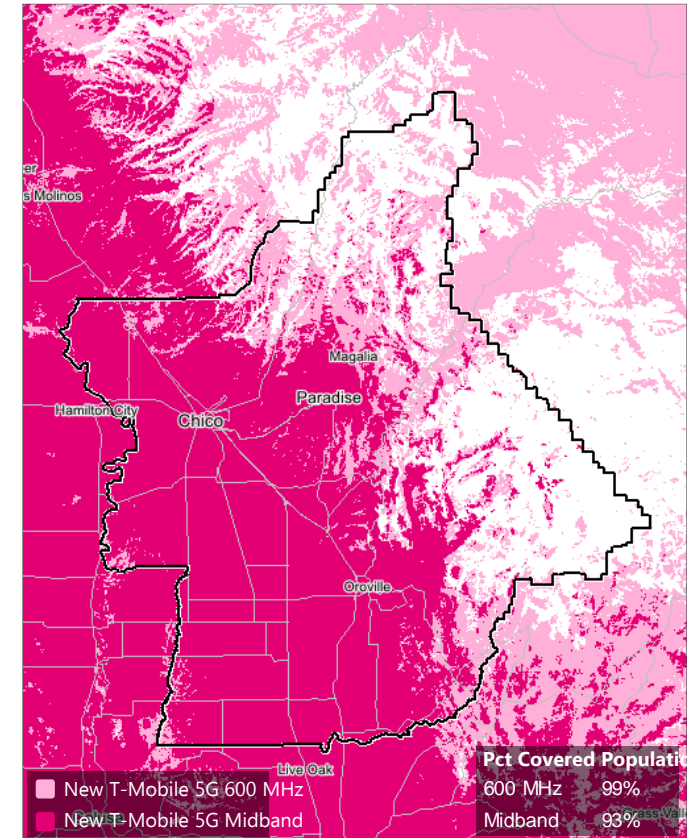
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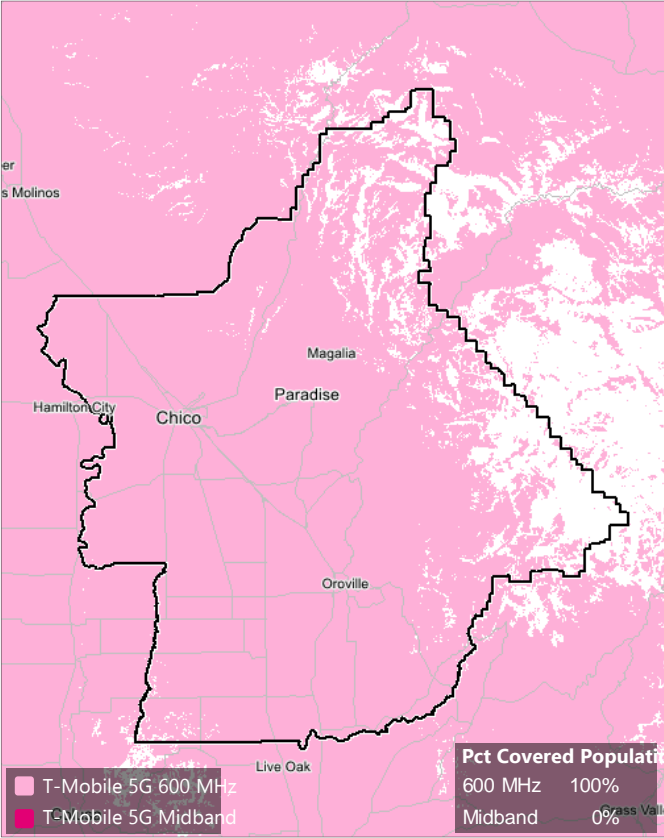


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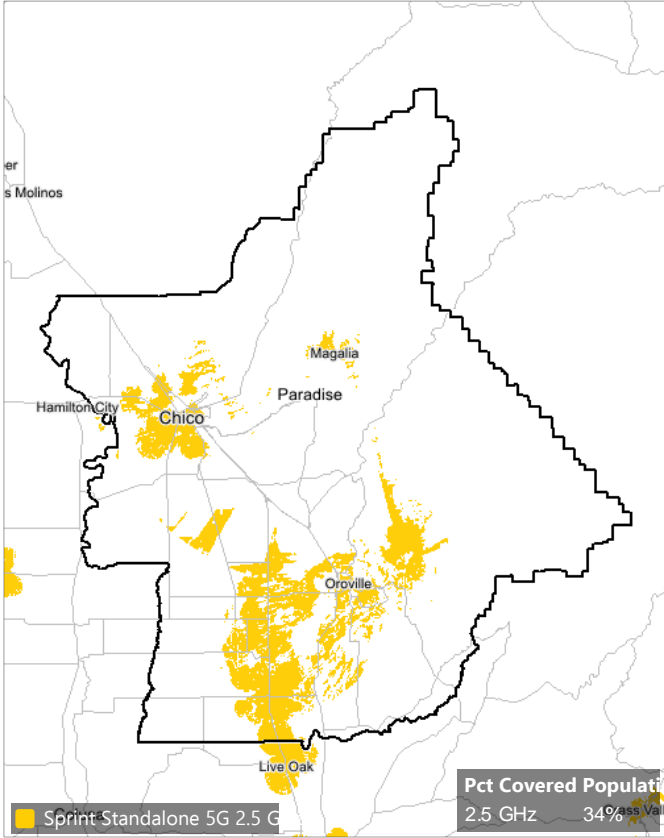


Projected 2024 5G Coverage: Butte County (06007)

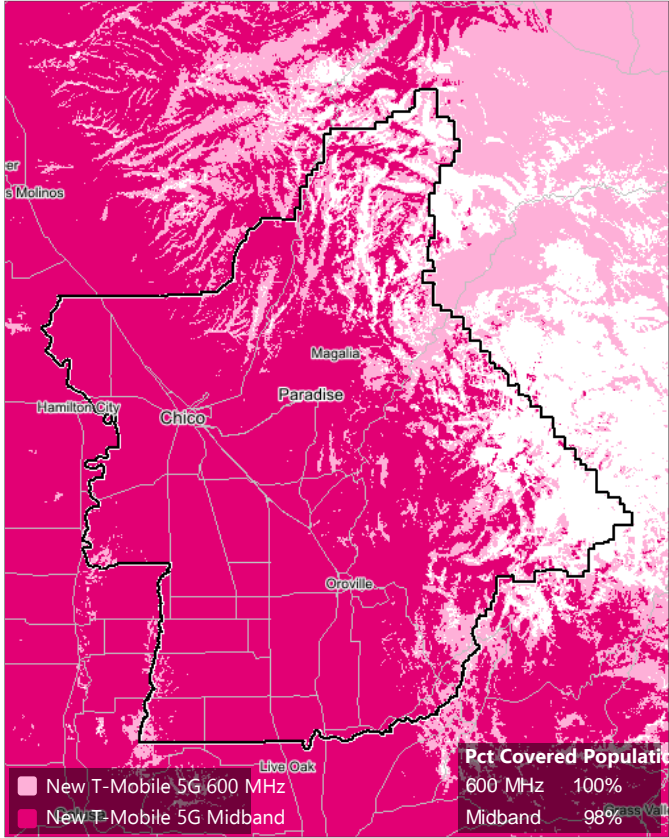
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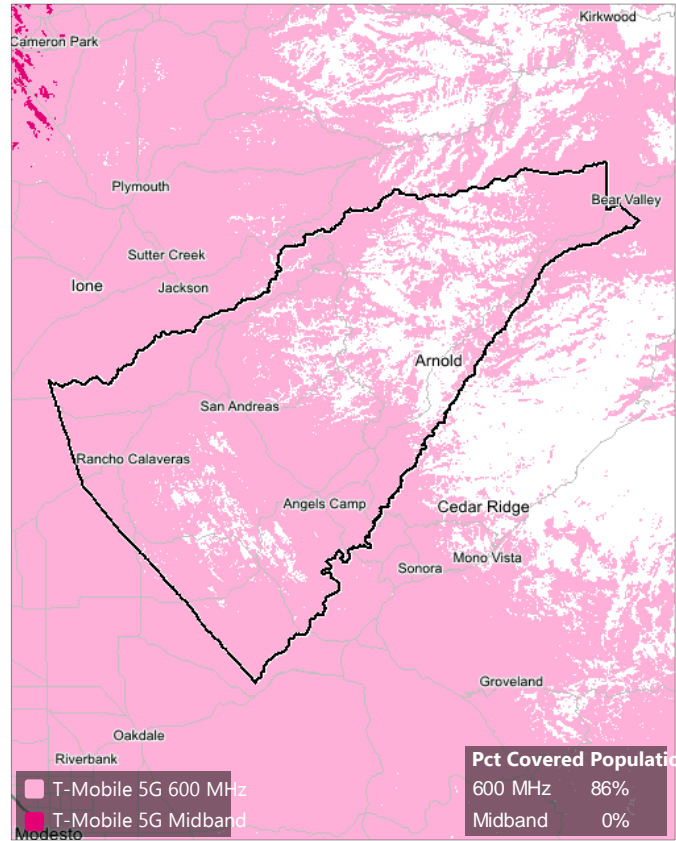


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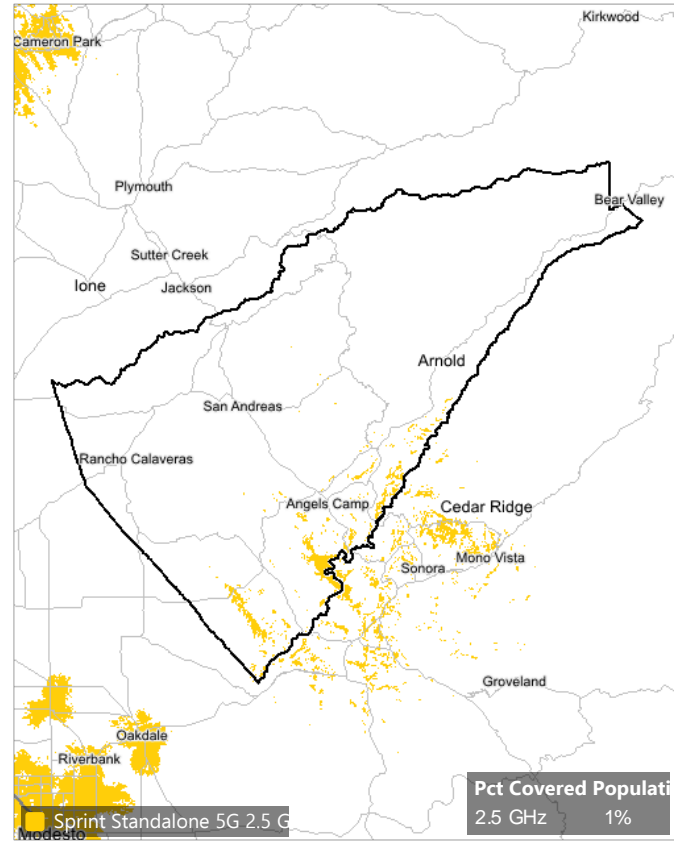


Projected 2021 5G Coverage: Calaveras County (06009)

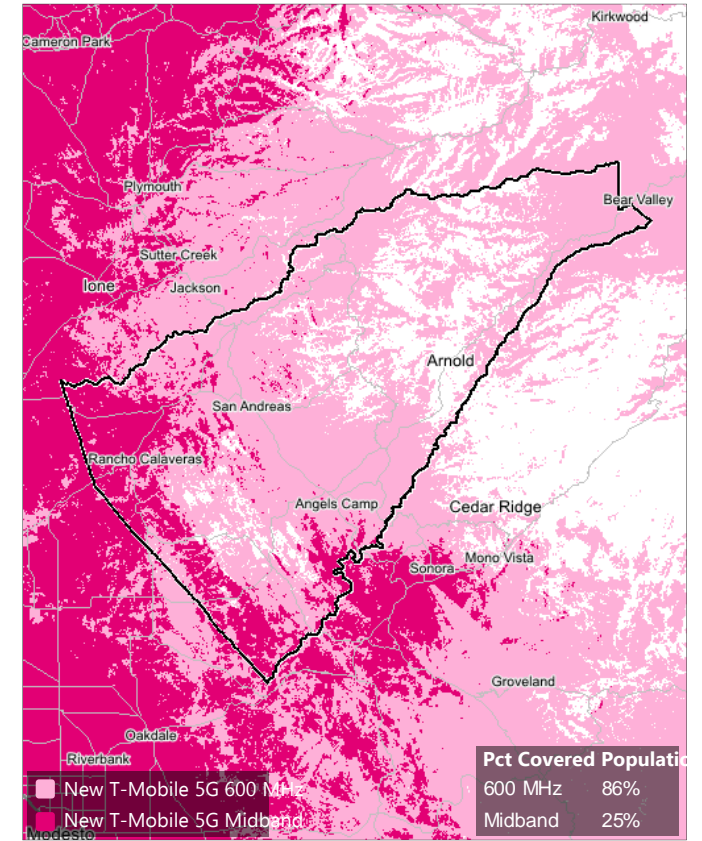
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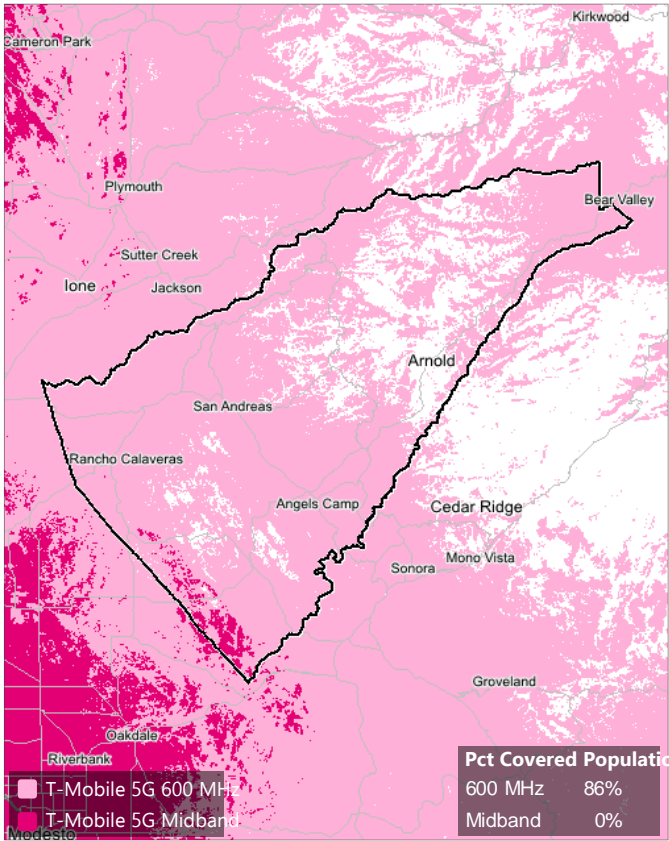


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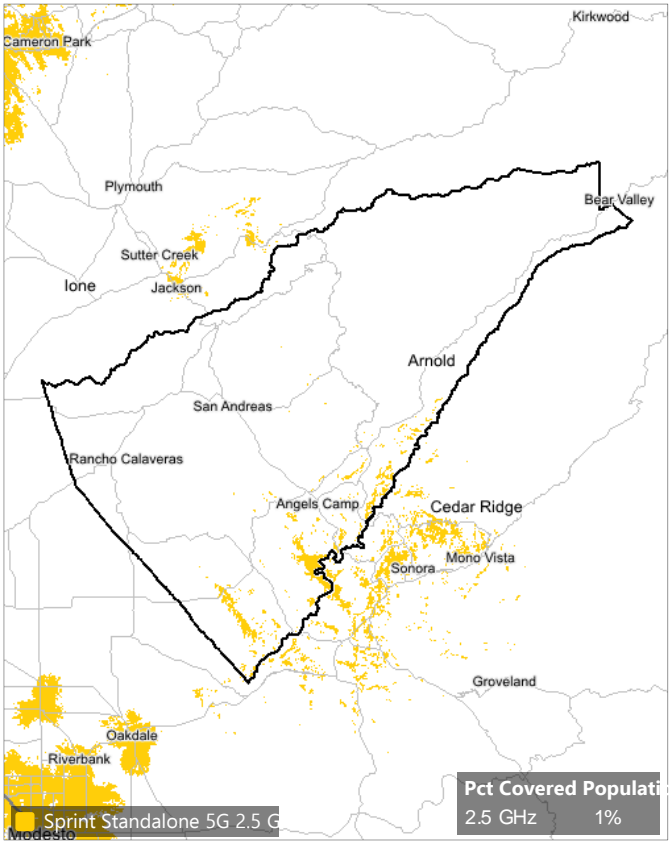


Projected 2024 5G Coverage: Calaveras County (06009)

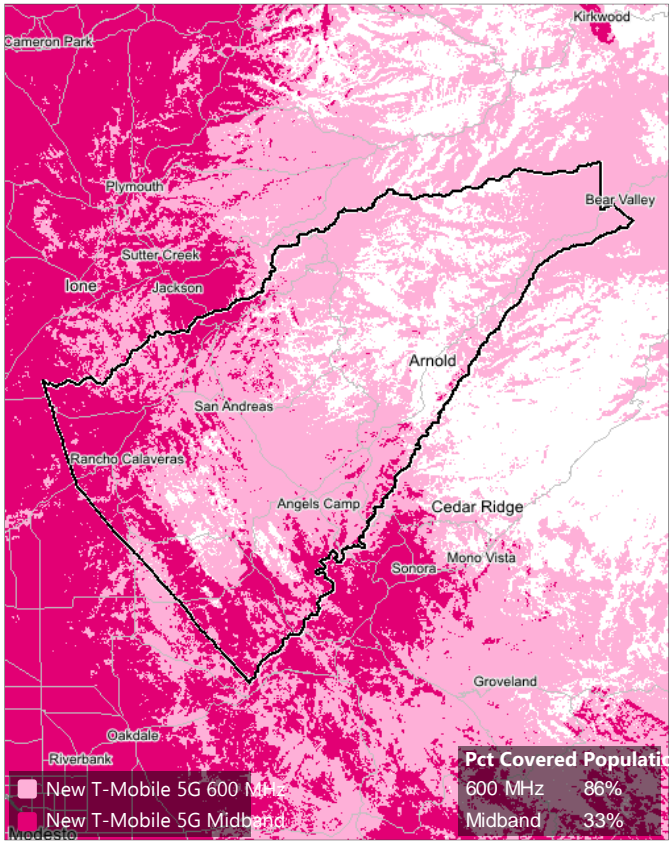
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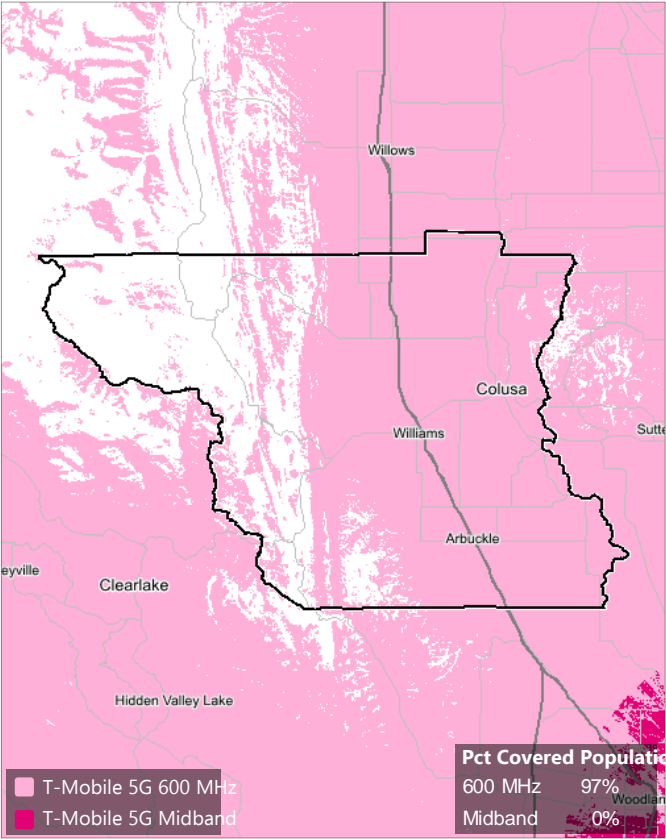


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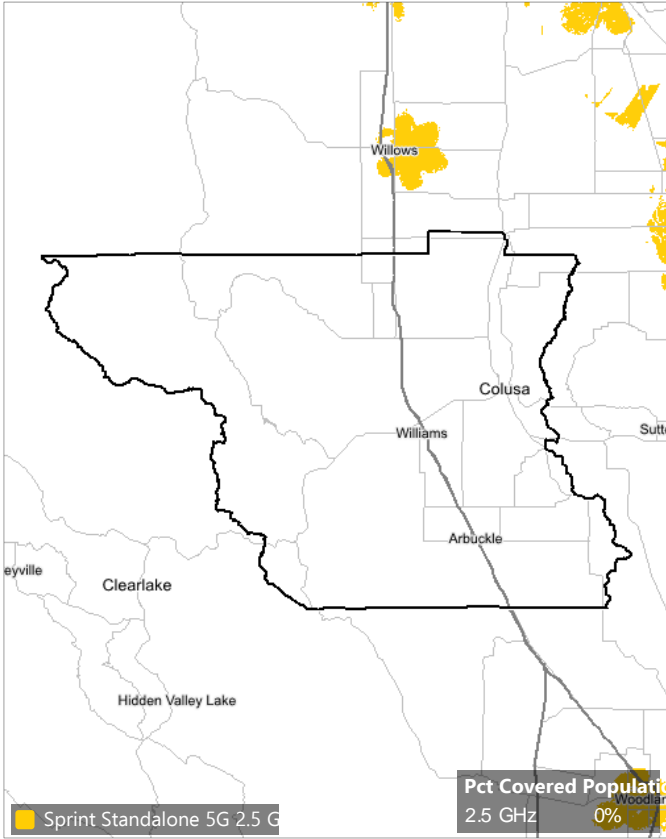


Projected 2021 5G Coverage: Colusa County (06011)

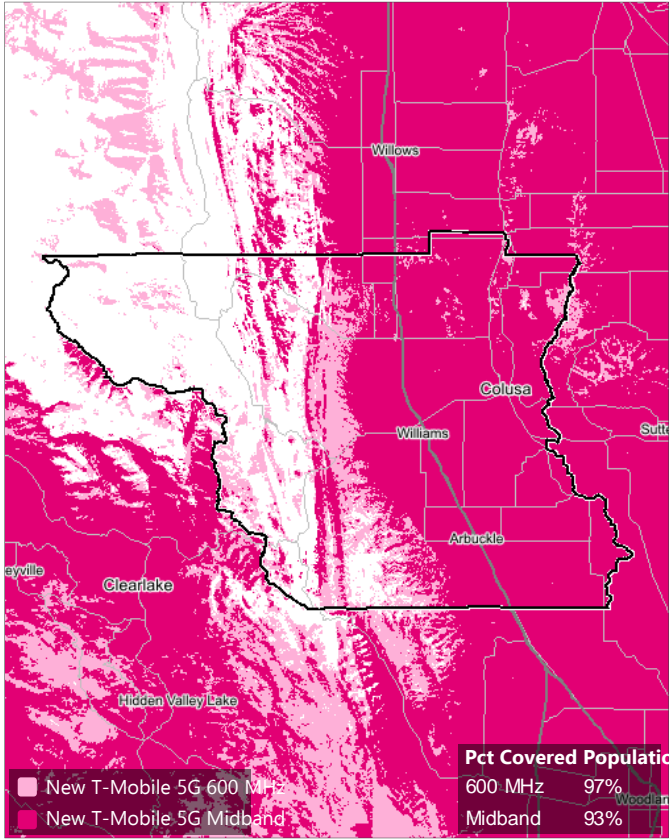
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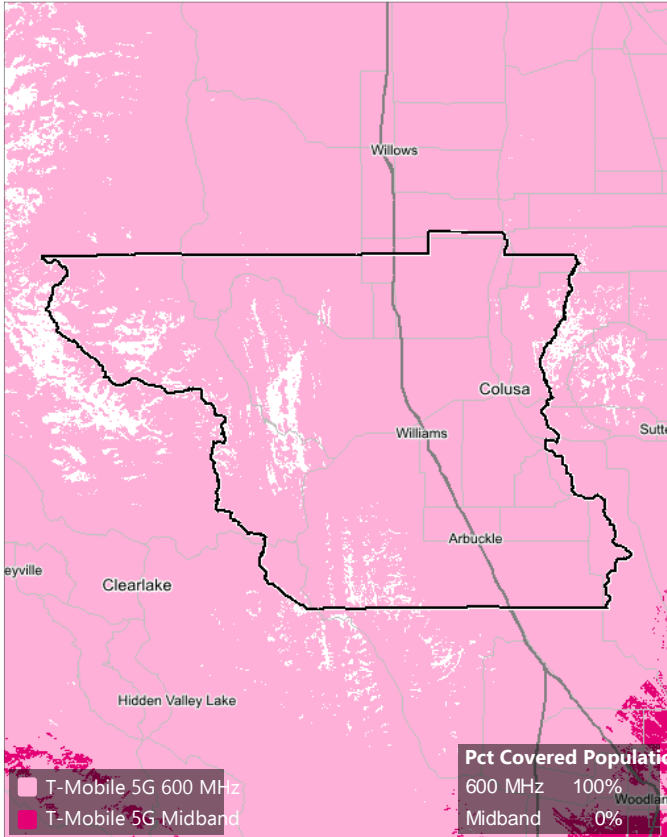


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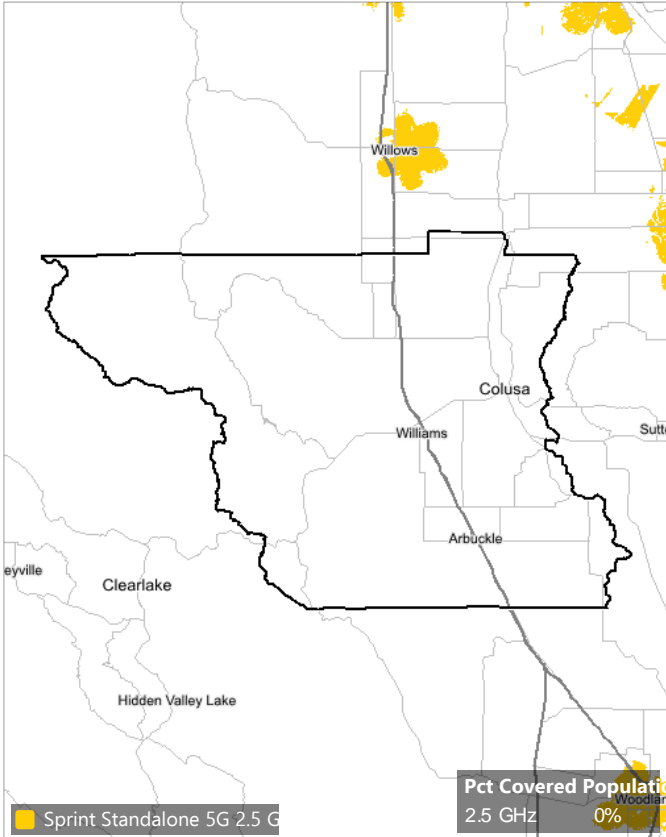


Projected 2024 5G Coverage: Colusa County (06011)

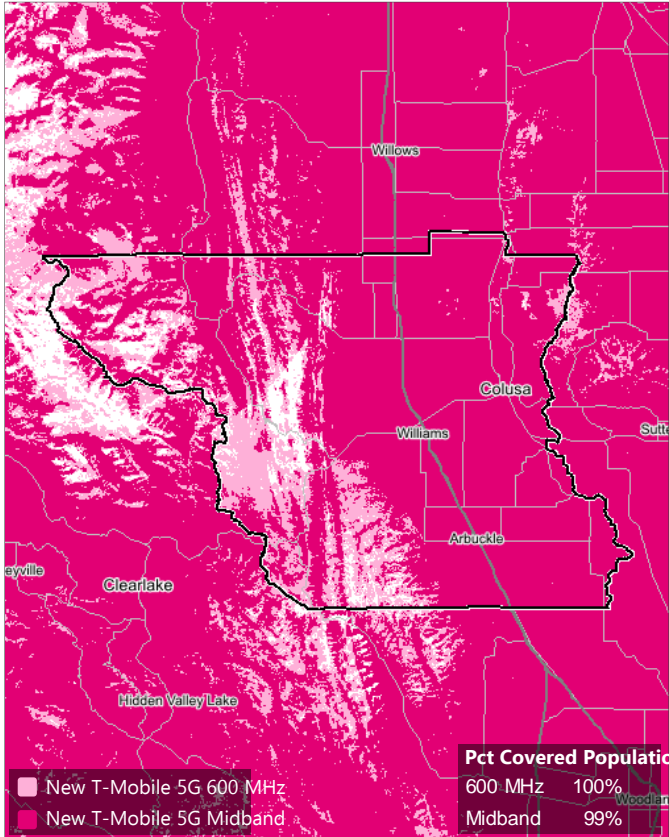
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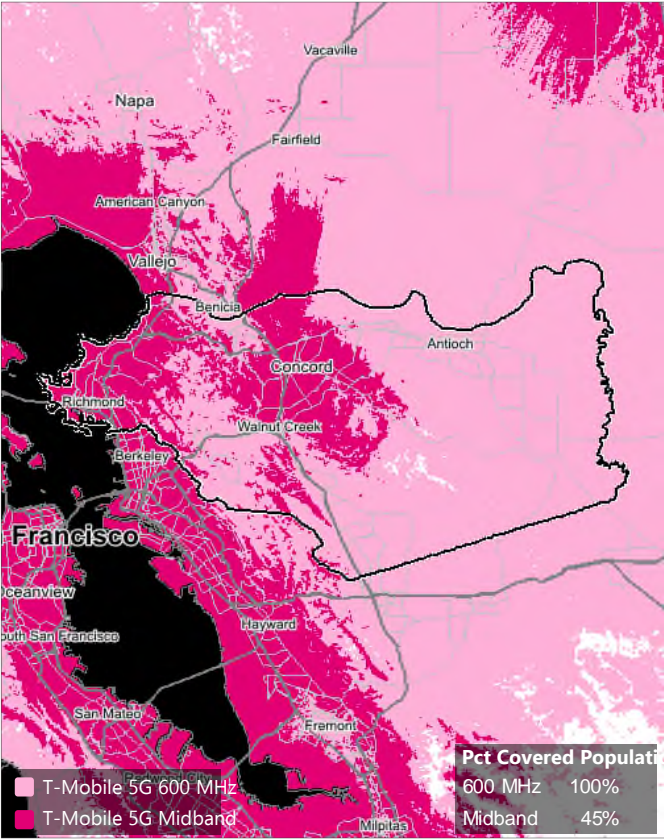


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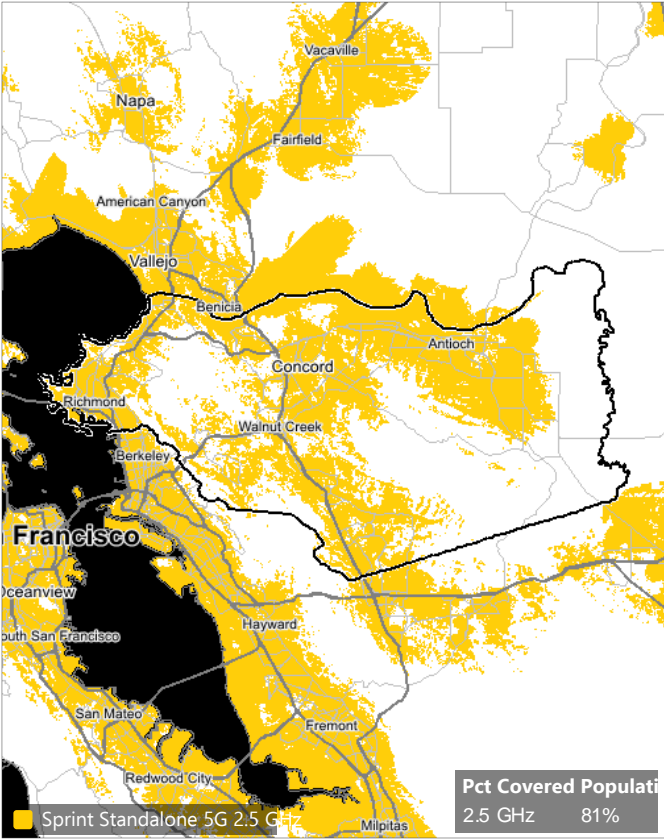


Projected 2021 5G Coverage: Contra Costa County (06013)

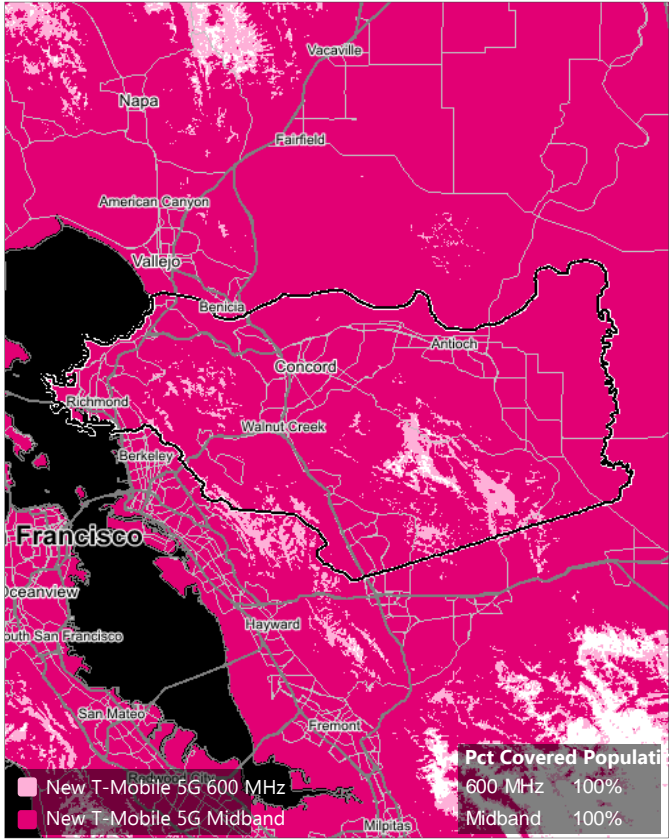
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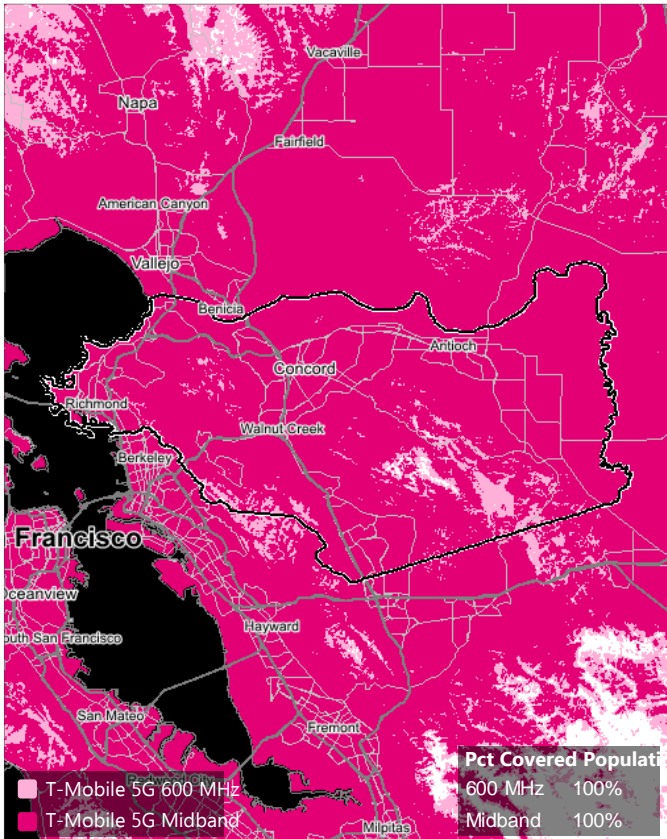


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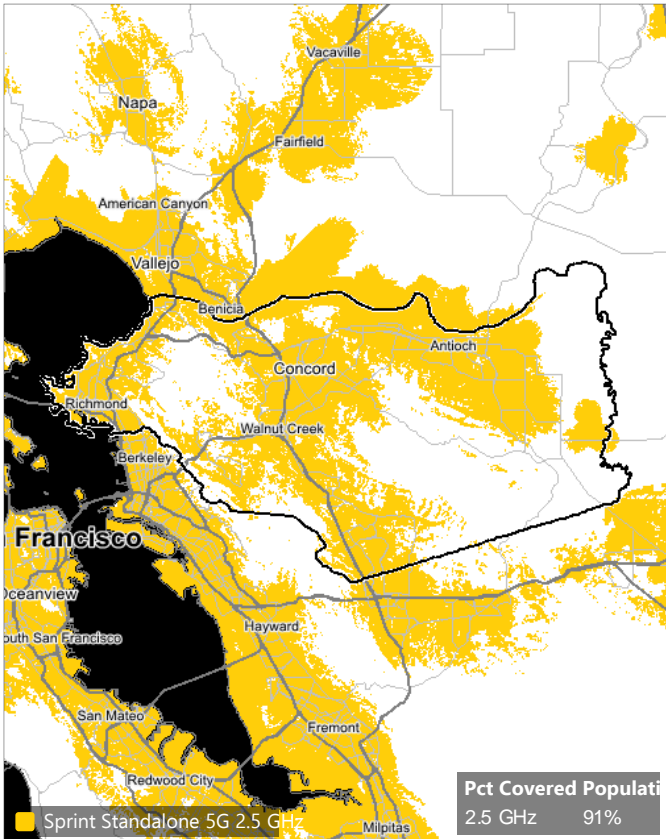


Projected 2024 5G Coverage: Contra Costa County (06013)

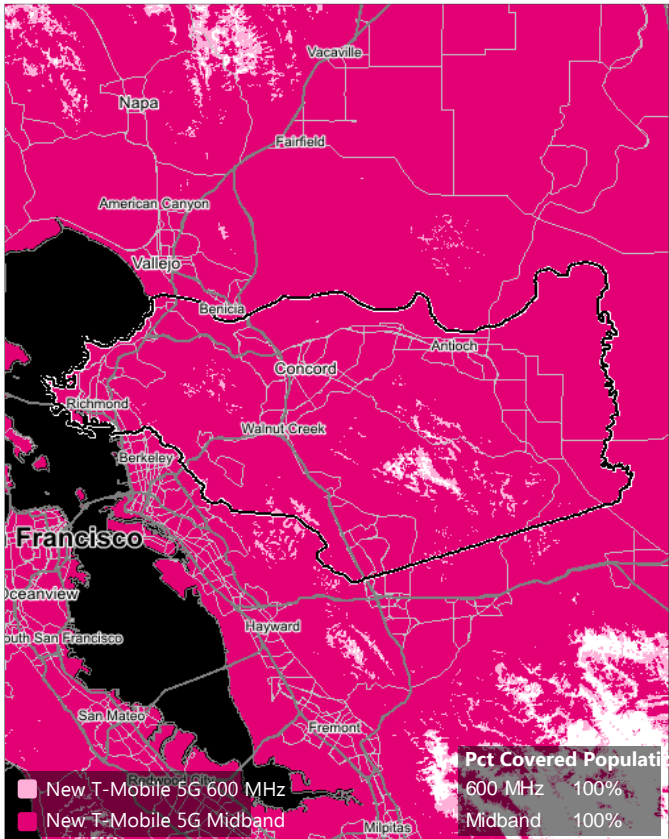
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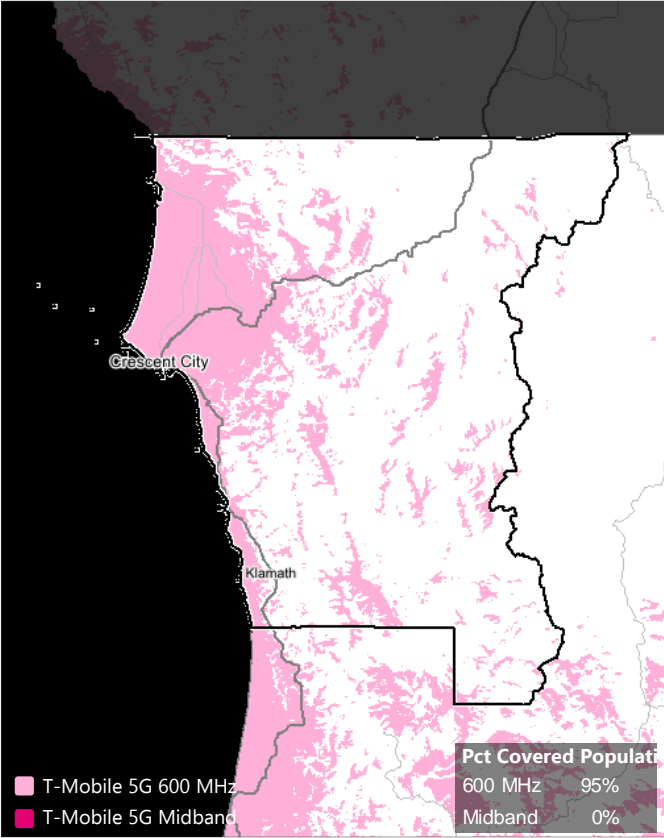


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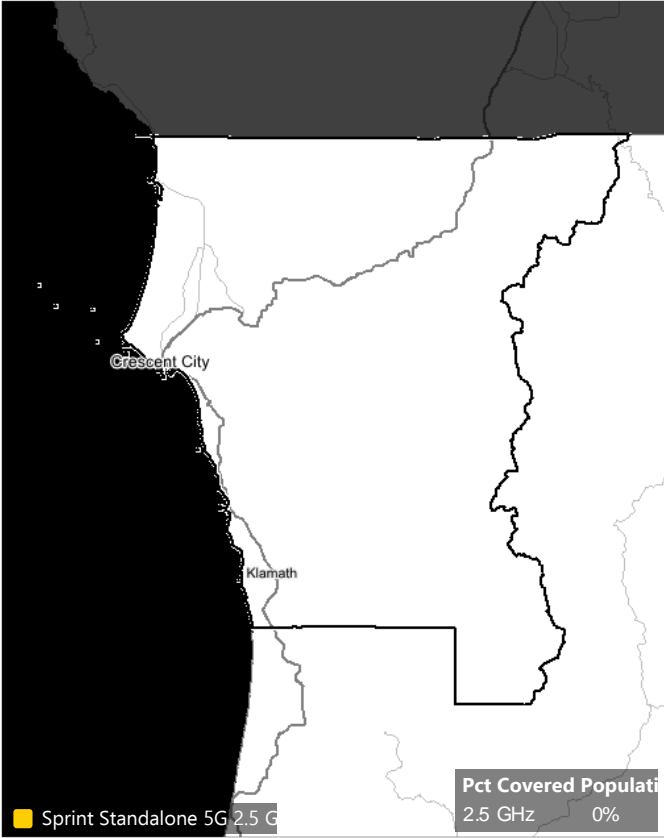


Projected 2021 5G Coverage: Del Norte County (06015)

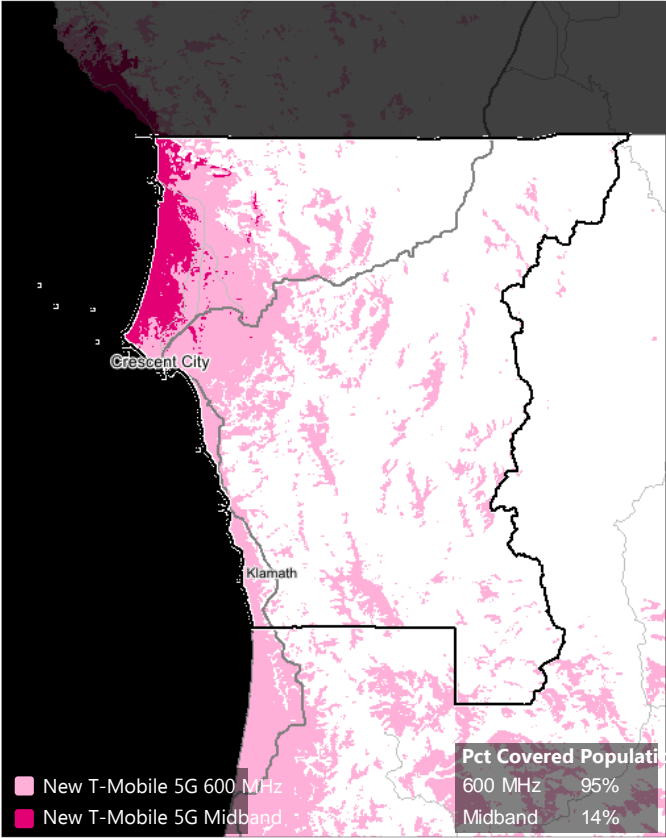
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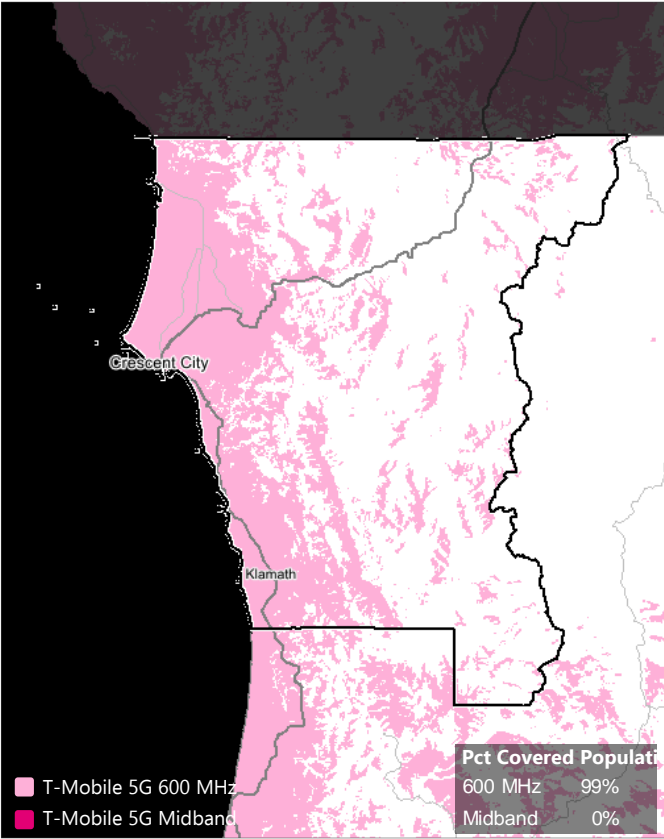


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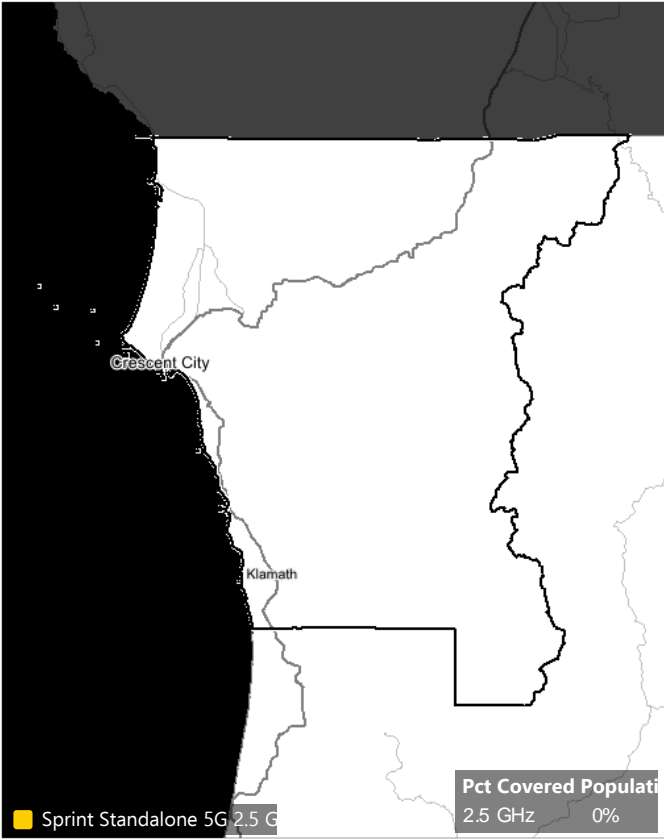


Projected 2024 5G Coverage: Del Norte County (06015)

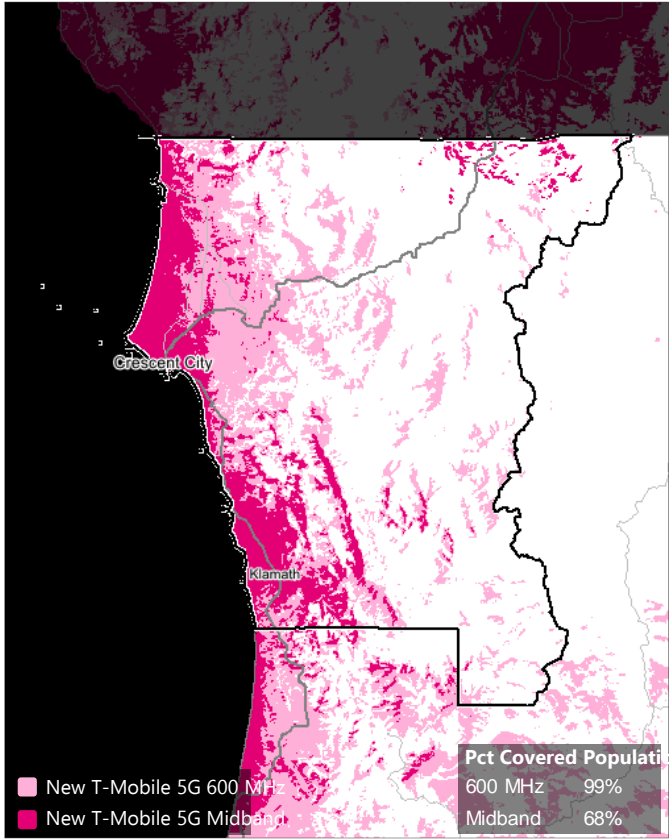
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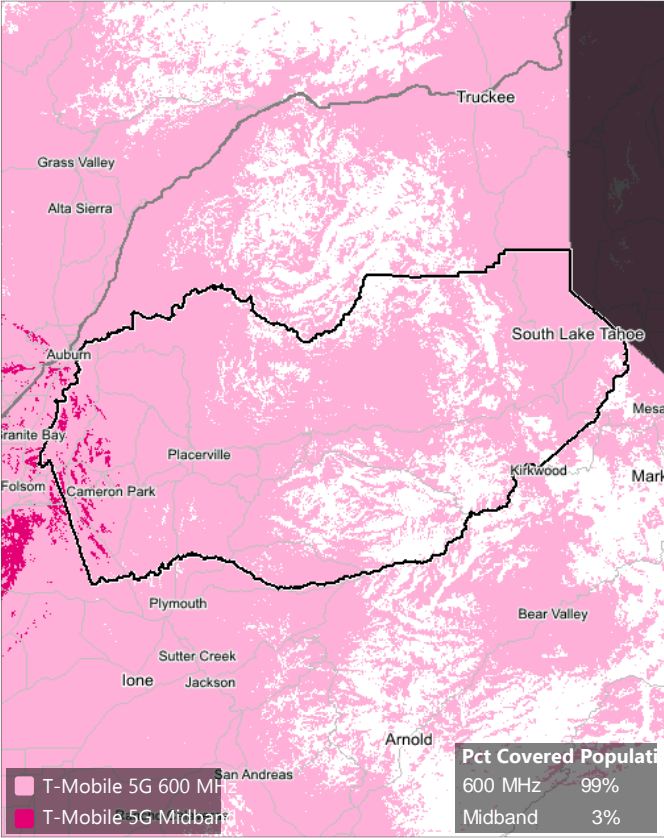


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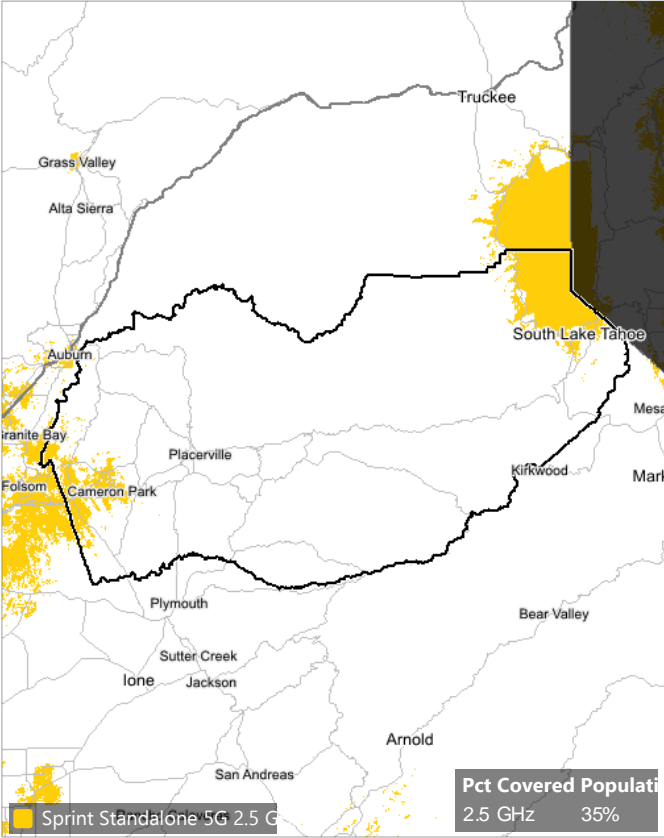


Projected 2021 5G Coverage: El Dorado County (06017)

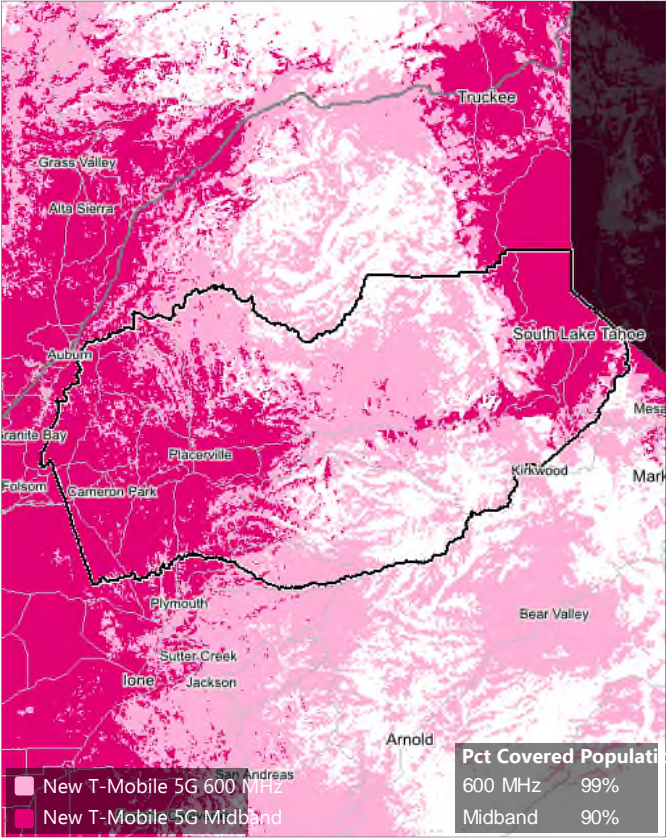
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Sprint Standalone

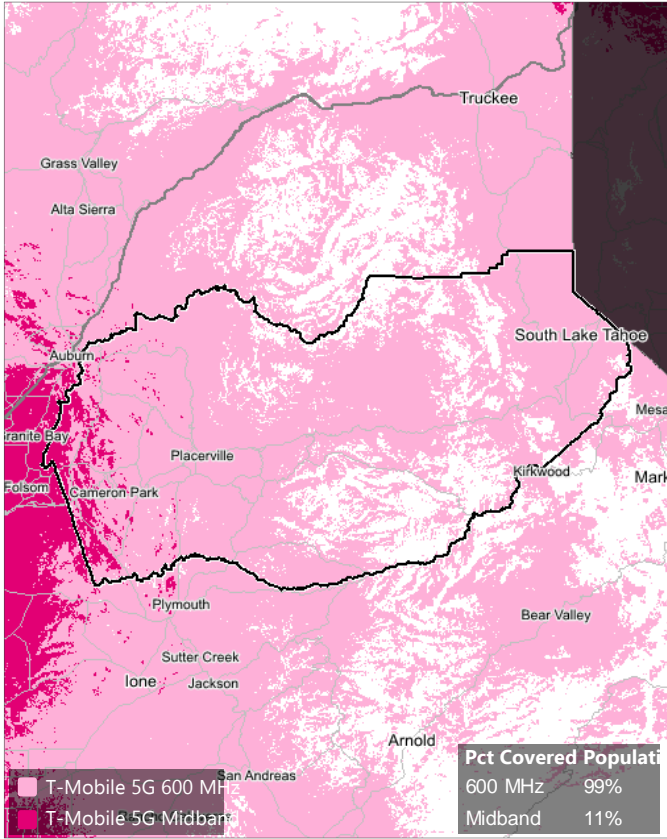


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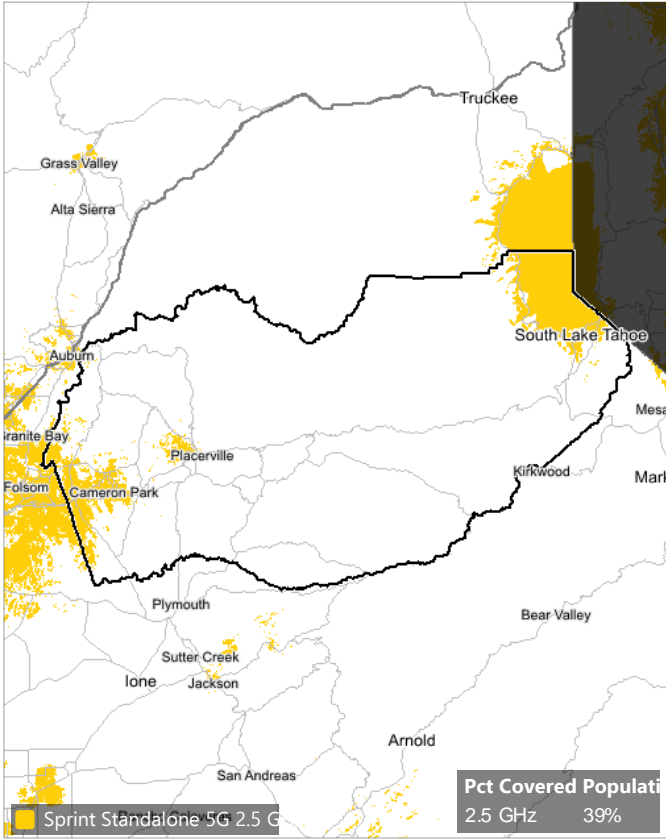


Projected 2024 5G Coverage: El Dorado County (06017)

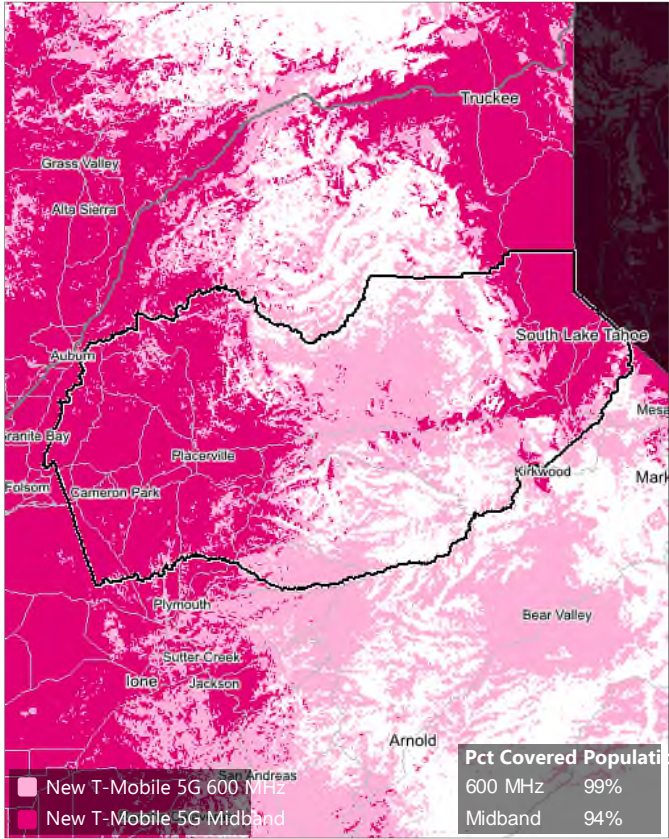
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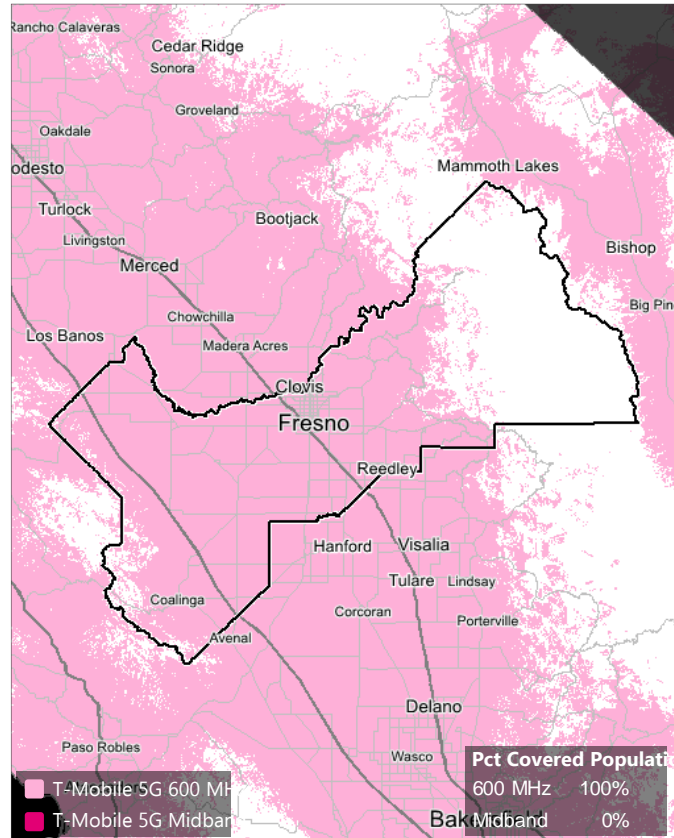


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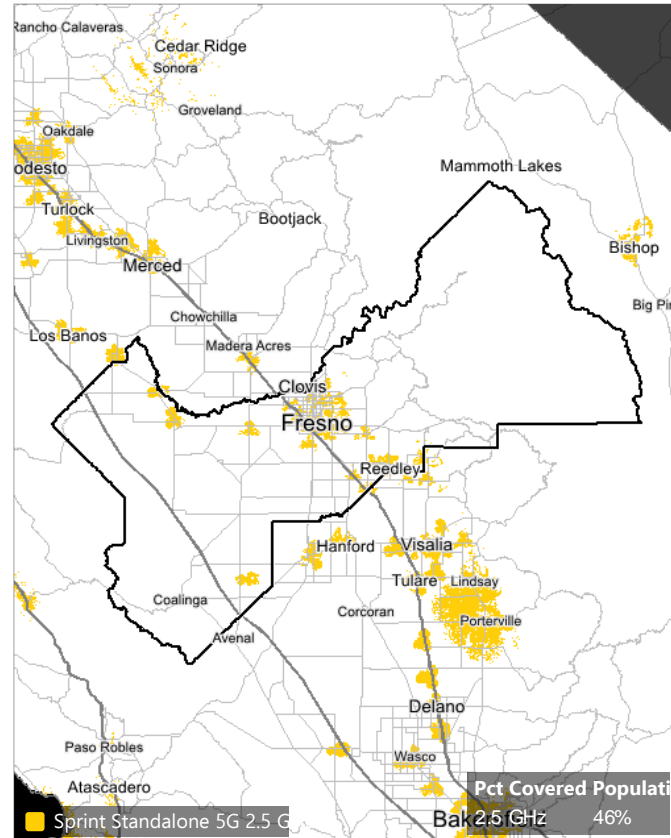


Projected 2021 5G Coverage: Fresno County (06019)

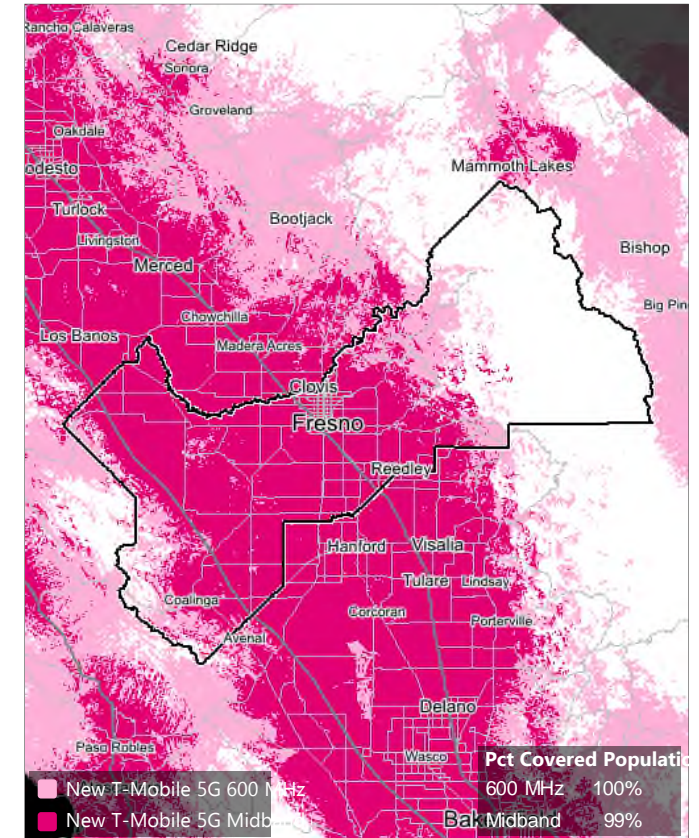
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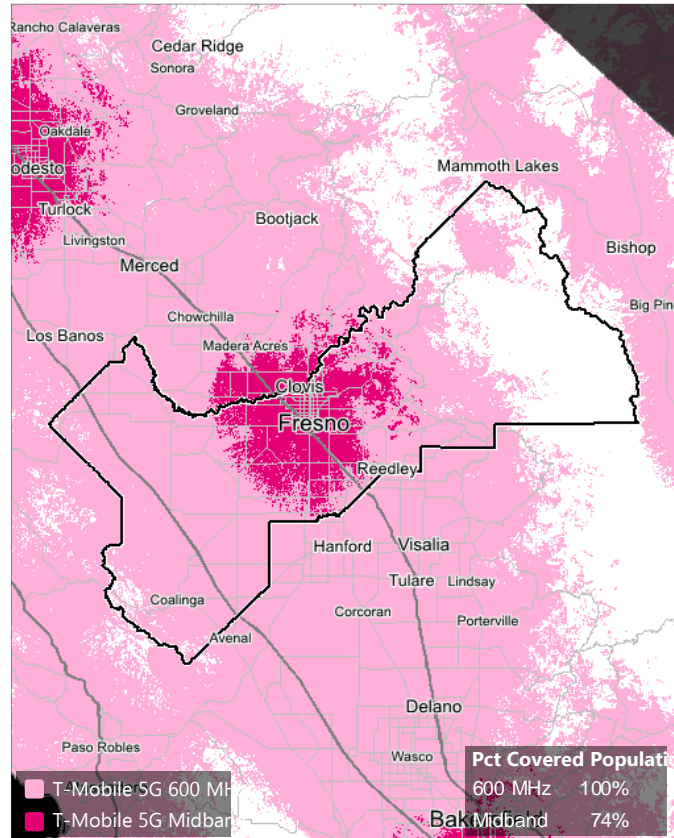


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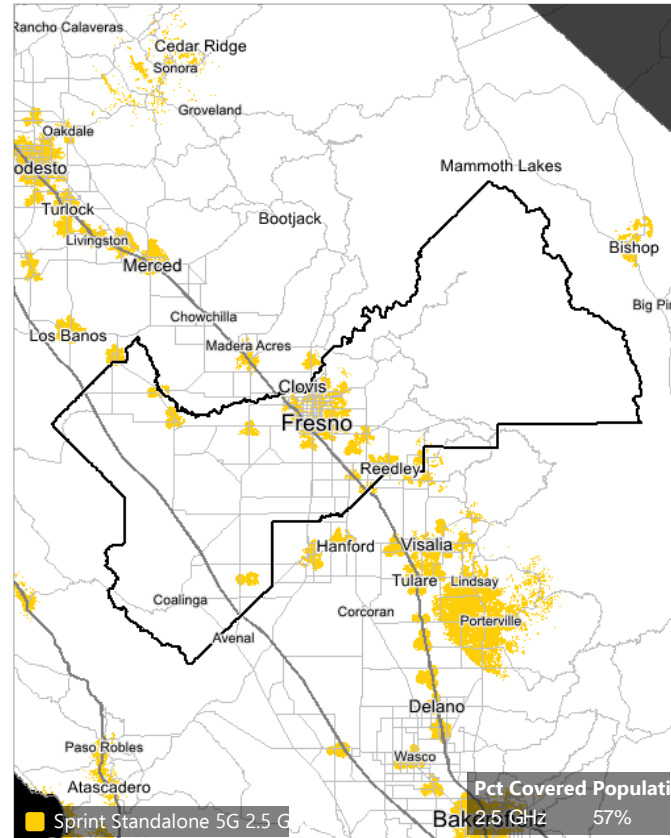


Projected 2024 5G Coverage: Fresno County (06019)

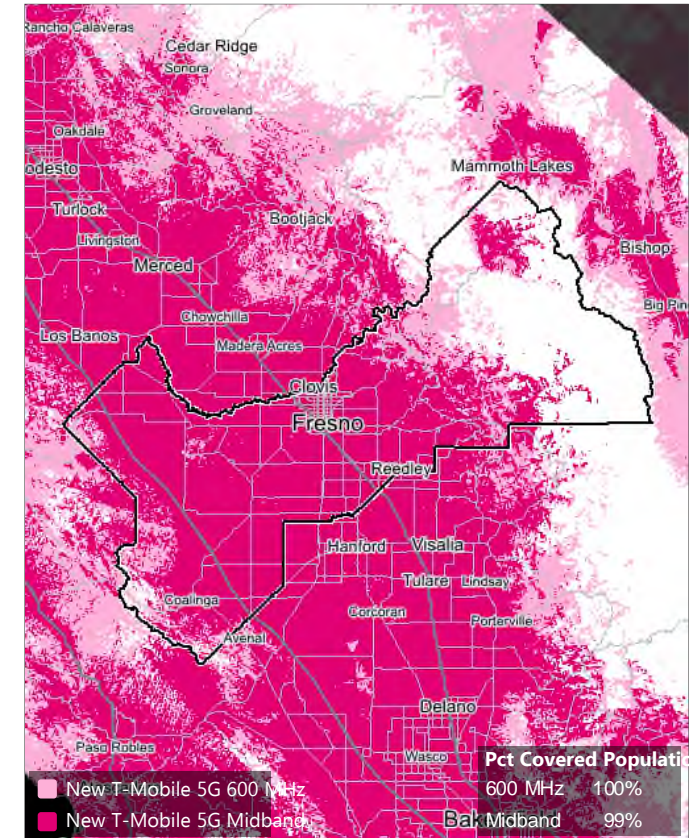
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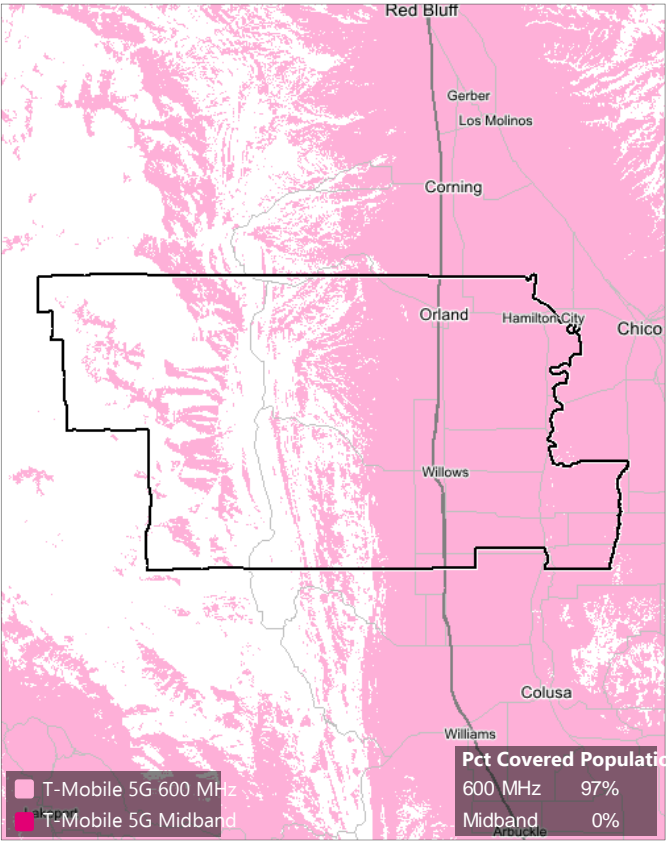


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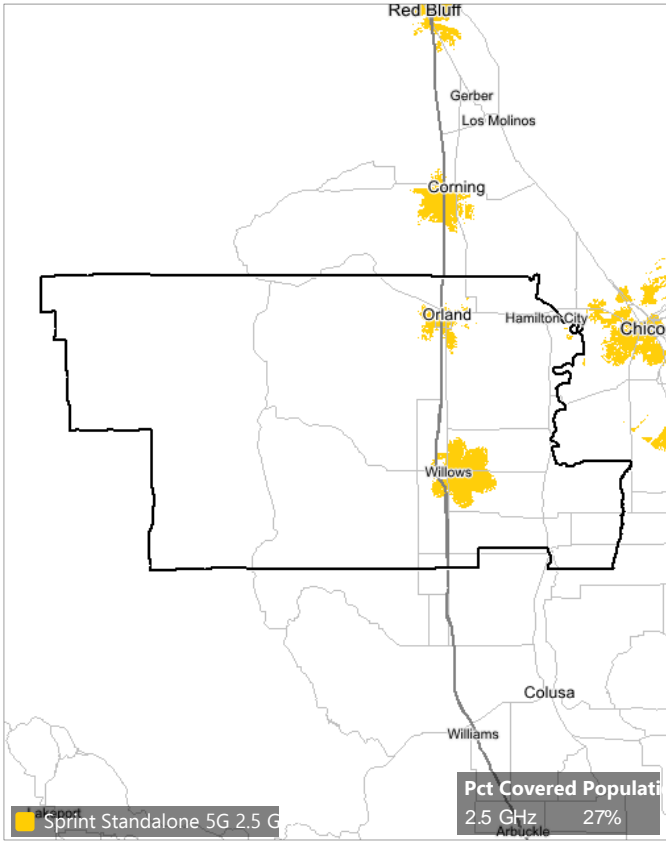


Projected 2021 5G Coverage: Glenn County (06021)

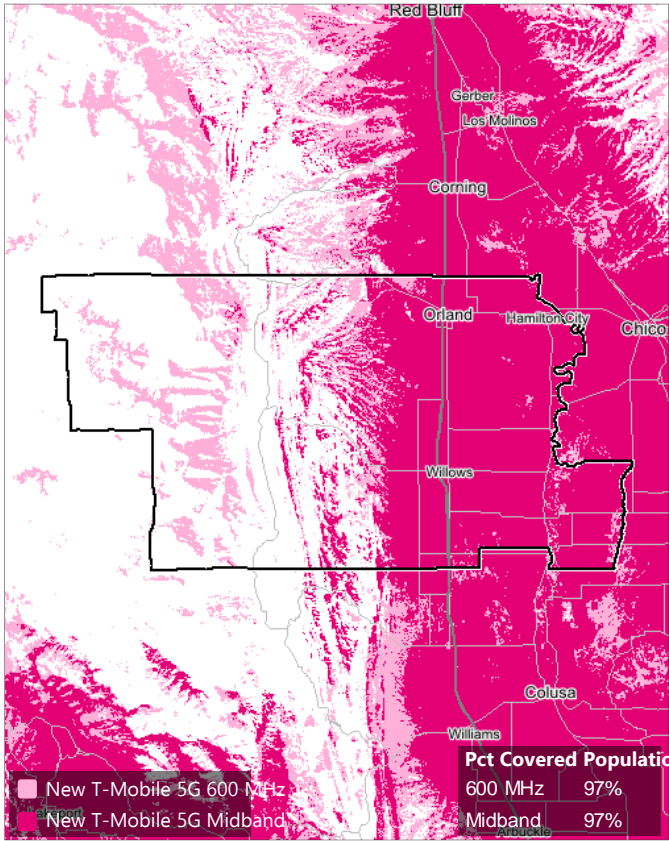
T-Mobile Standalone



Sprint Standalone

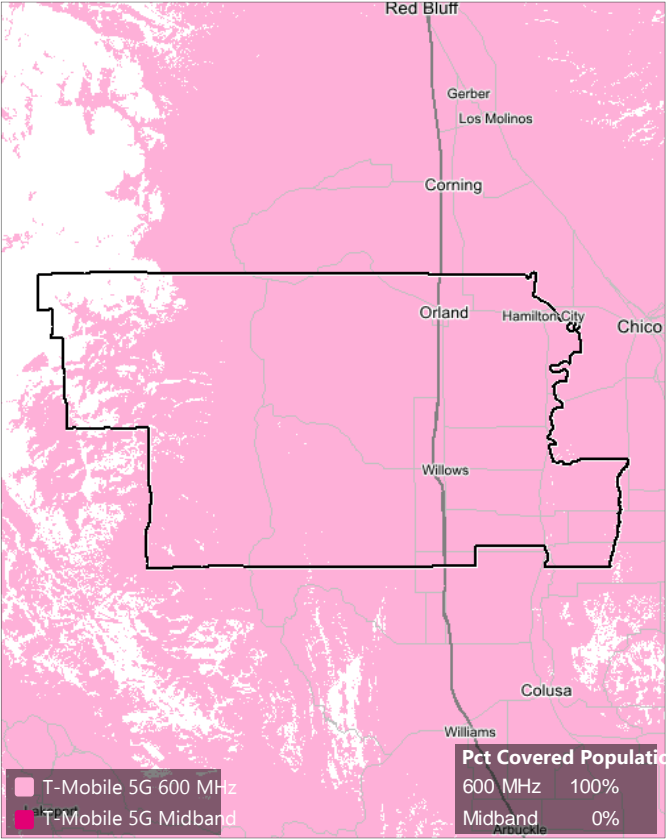


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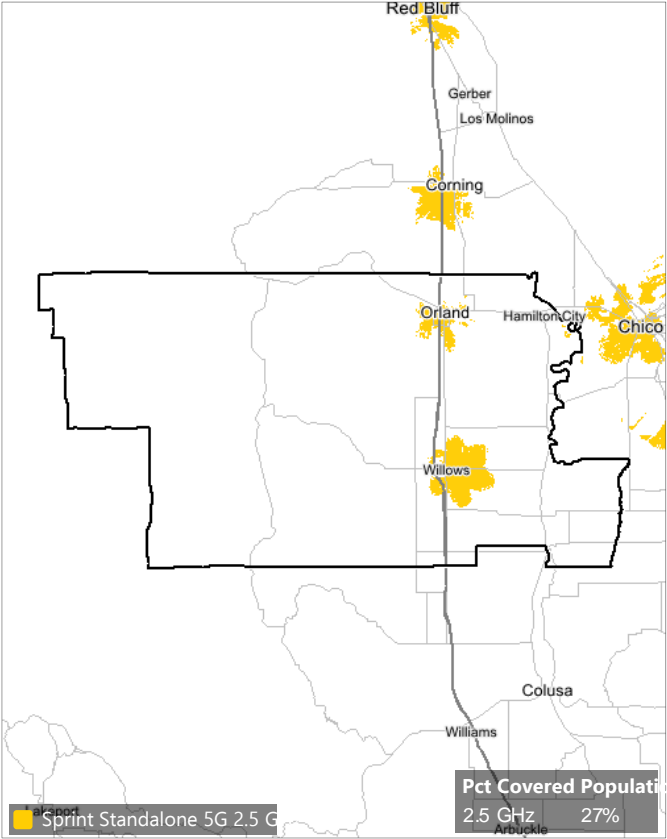


Projected 2024 5G Coverage: Glenn County (06021)

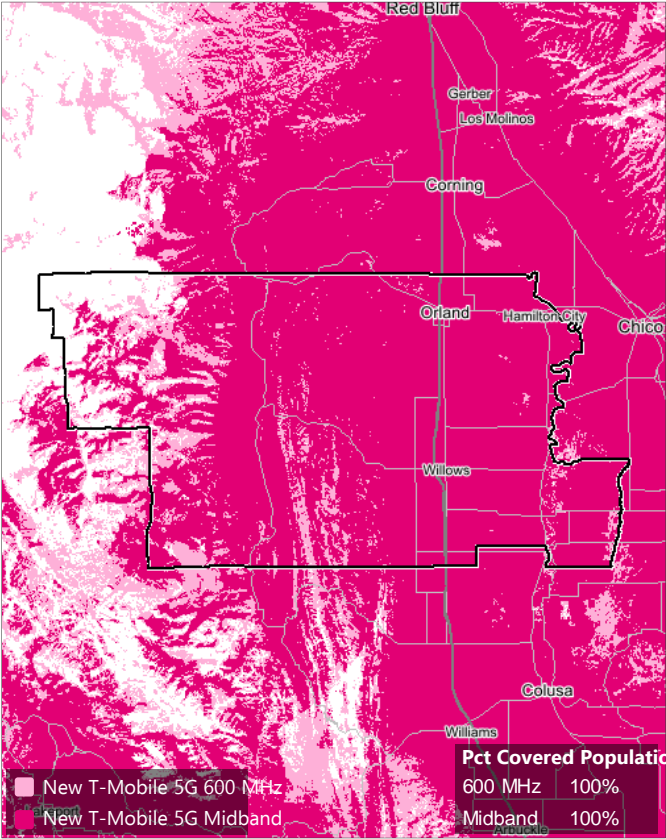
T-Mobile Standalone



Sprint Standalone

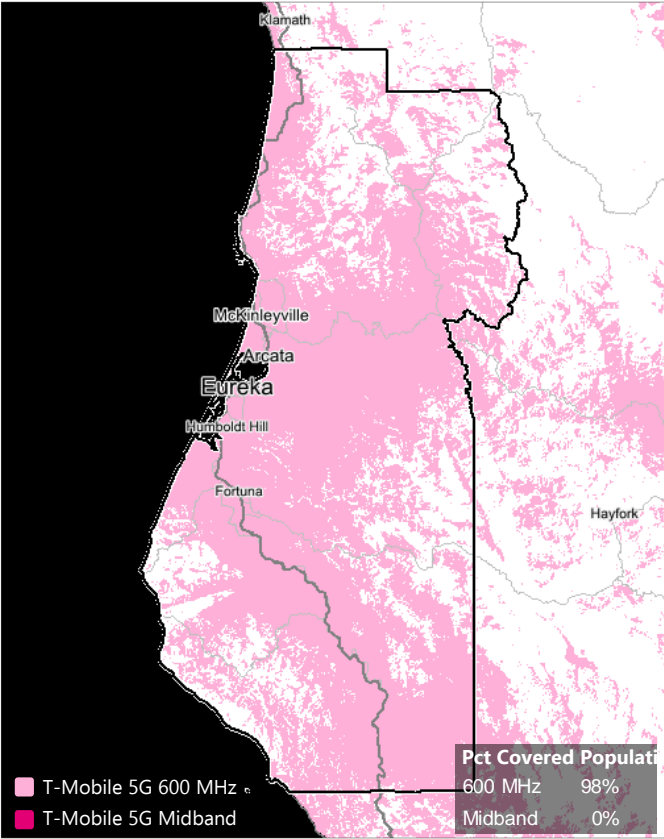


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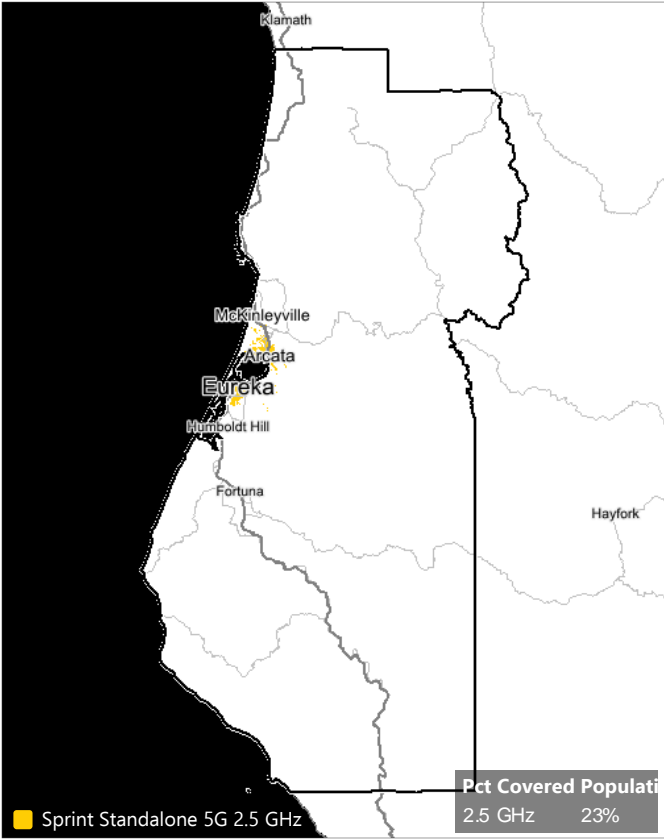


Projected 2021 5G Coverage: Humboldt County (06023)

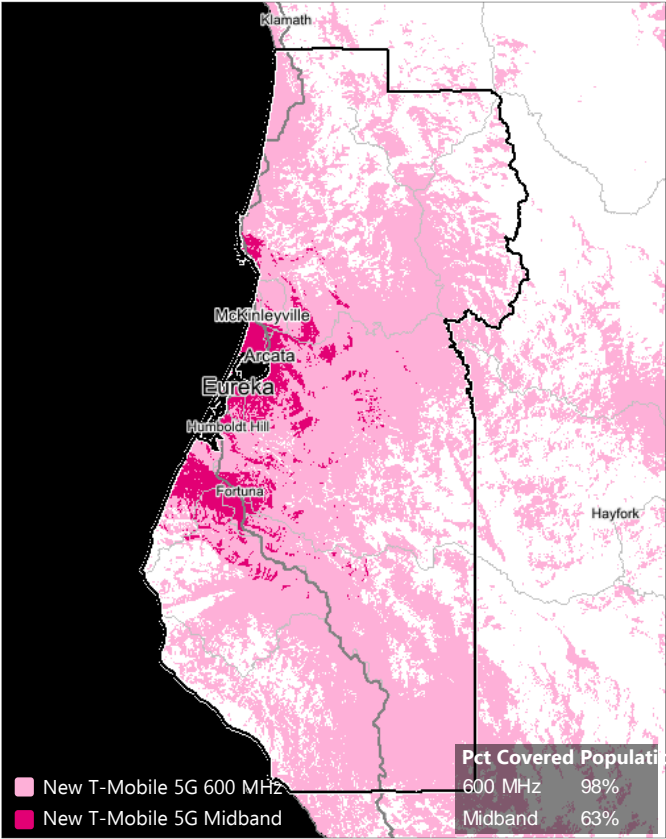
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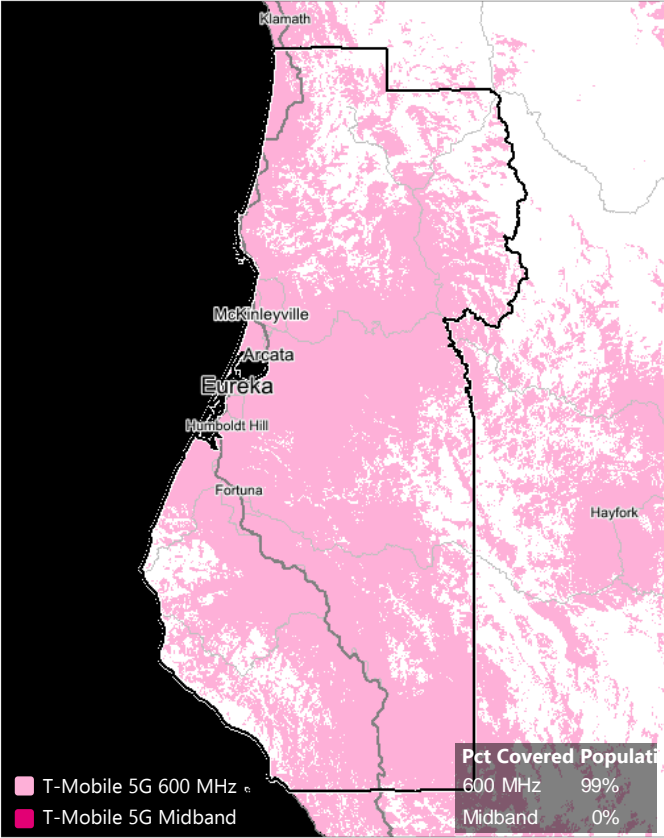


New T-Mobile

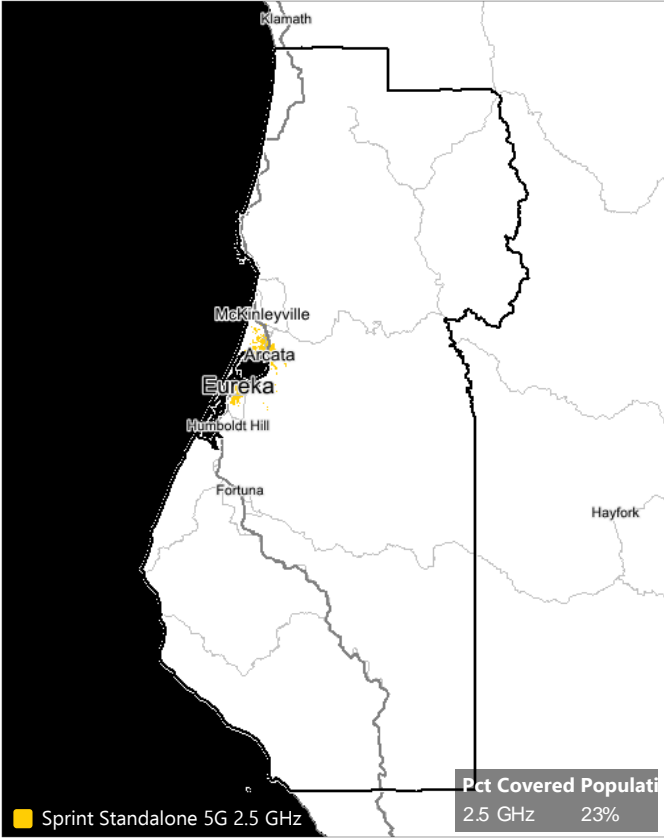


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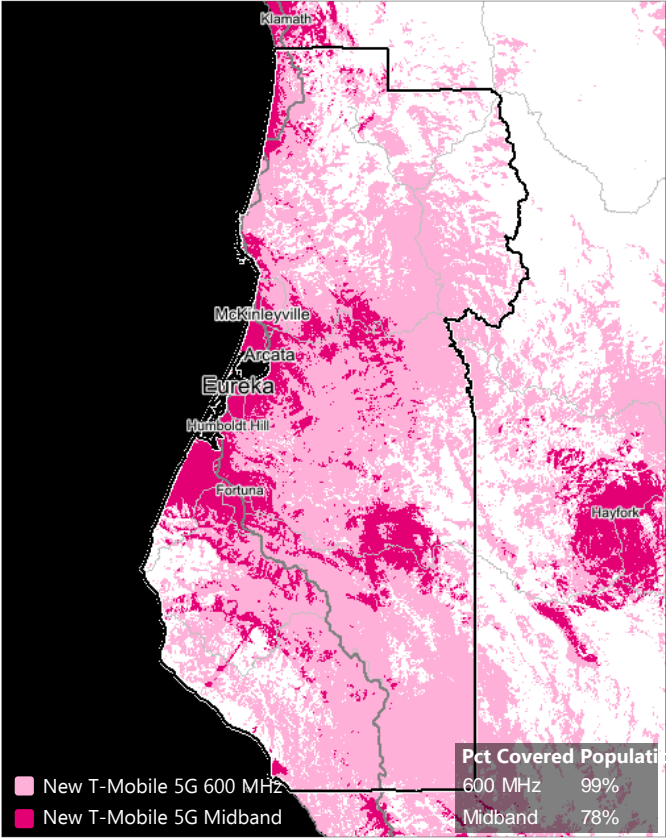
T-Mobile Standalone



Sprint Standalone

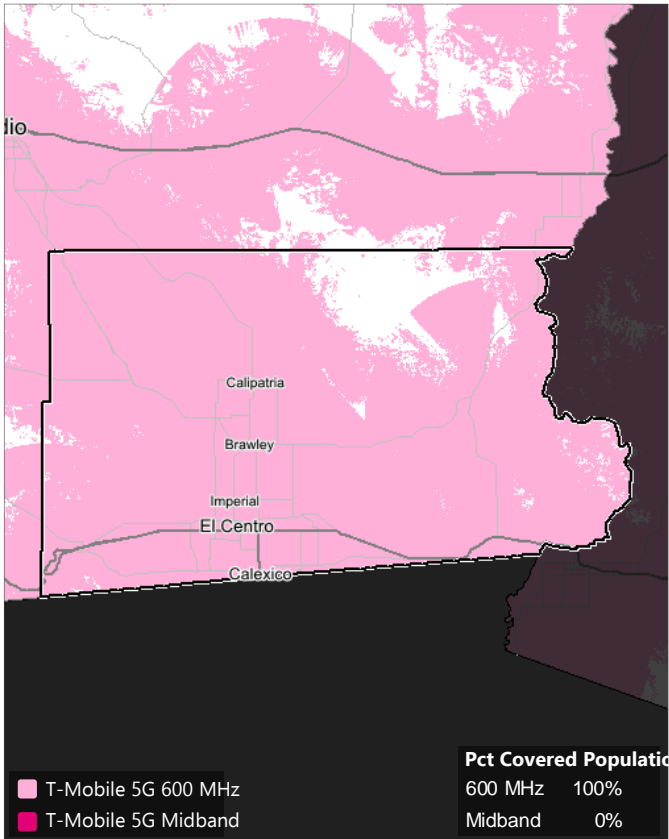


New T-Mobile

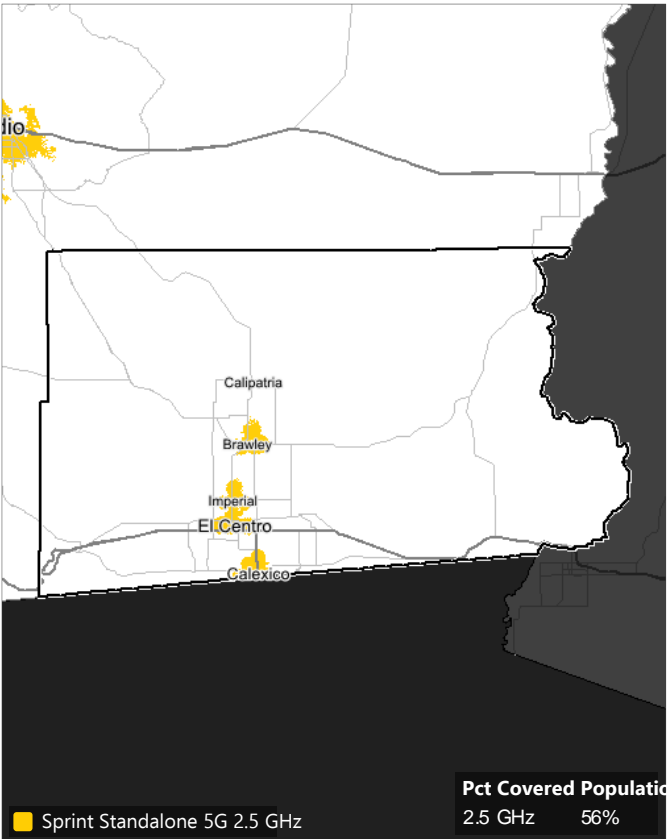


Projected 2021 5G Coverage: Imperial County (06025)

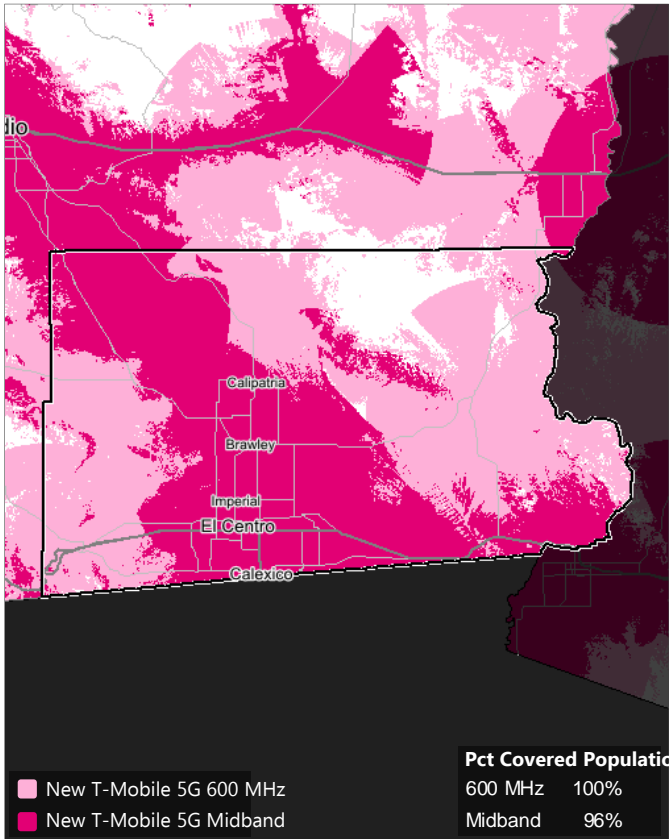
T-Mobile Standalone



Sprint Standalone

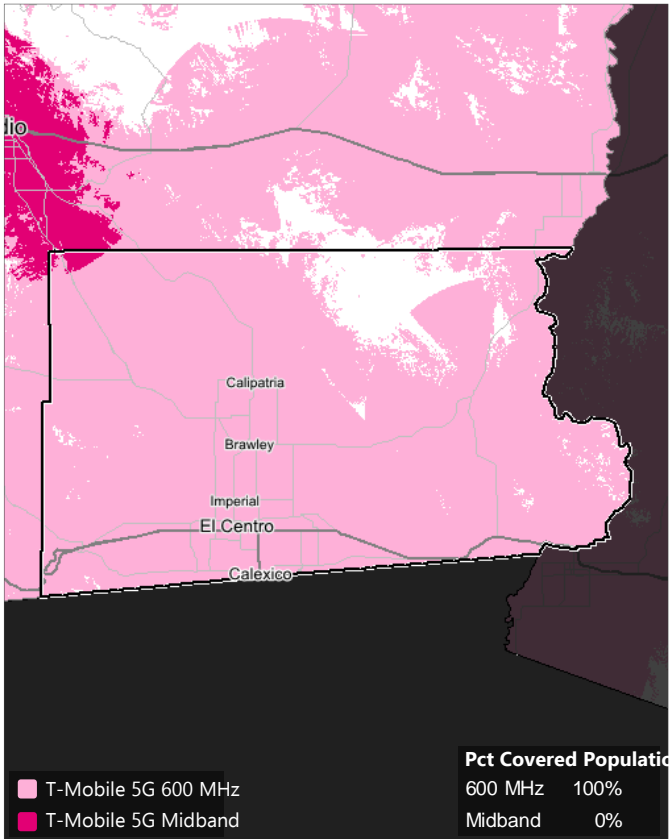


New T-Mobile

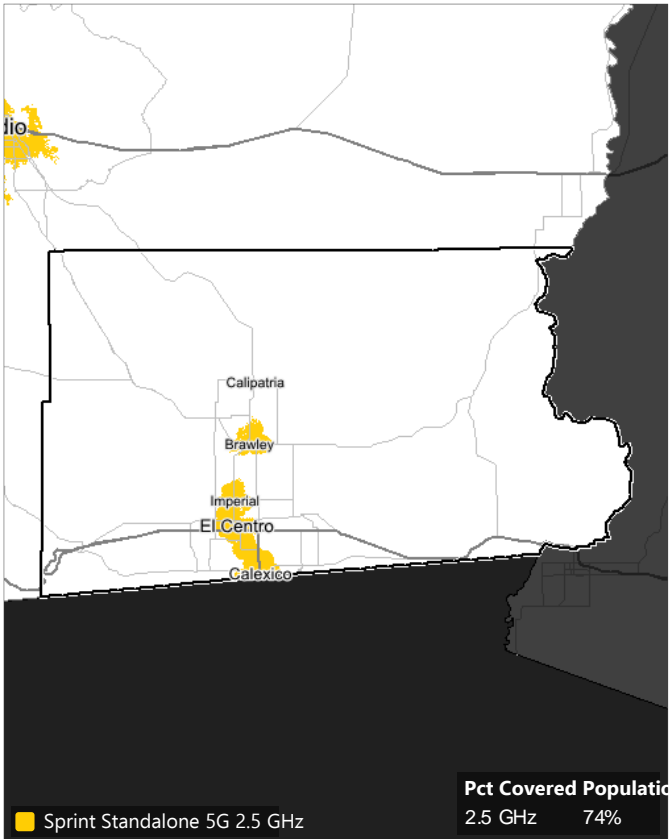


Projected 2024 5G Coverage: Imperial County (06025)

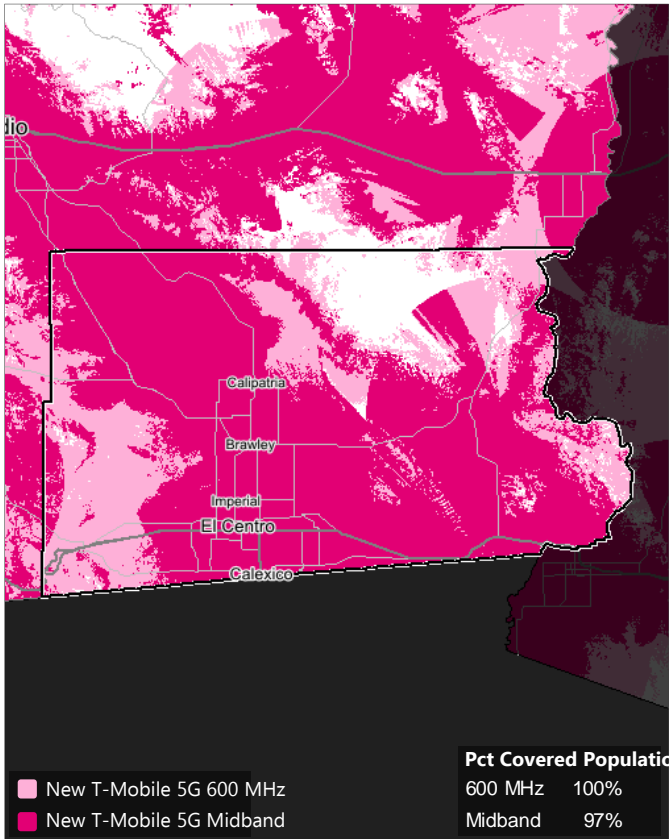
T-Mobile Standalone



Sprint Standalone

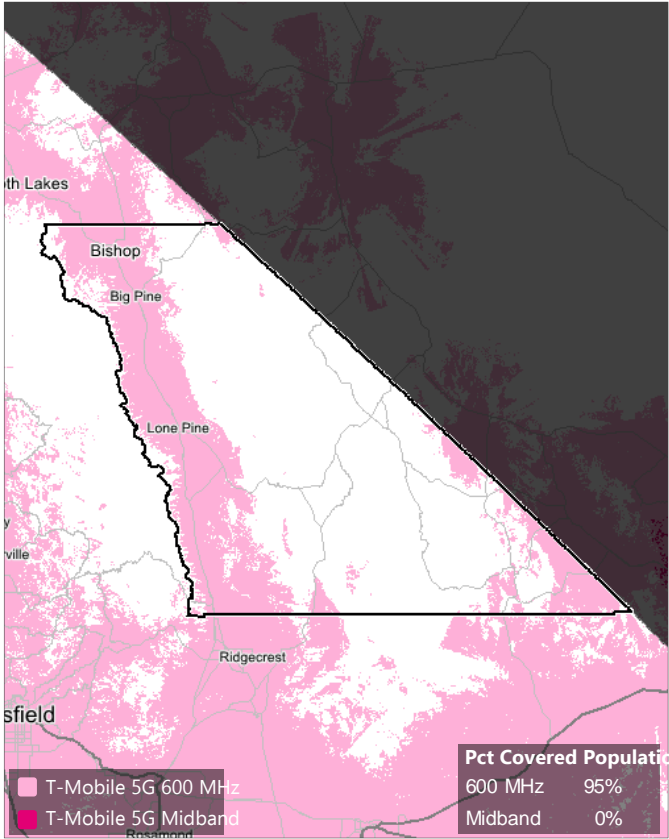


New T-Mobile

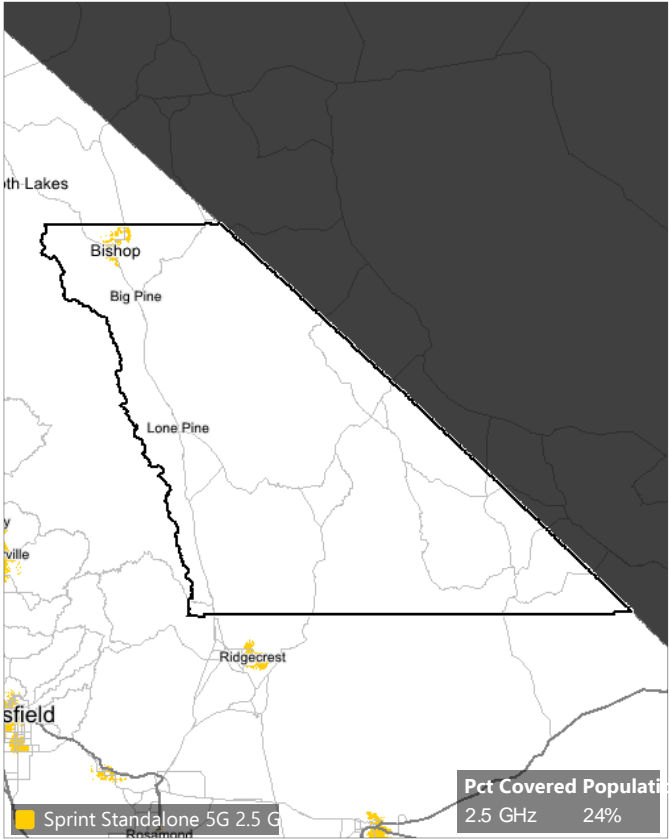


Projected 2021 5G Coverage: Inyo County (06027)

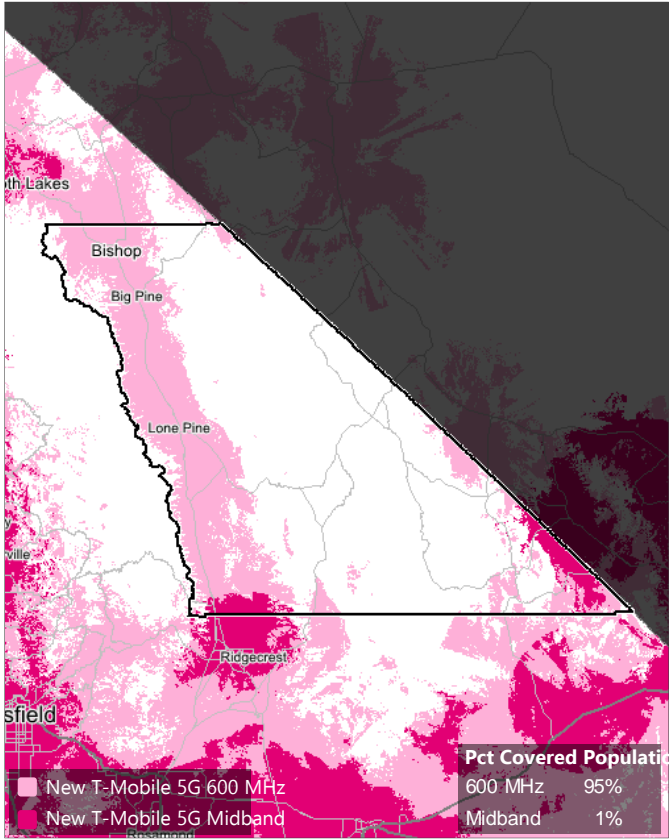
T-Mobile Standalone



Sprint Standalone

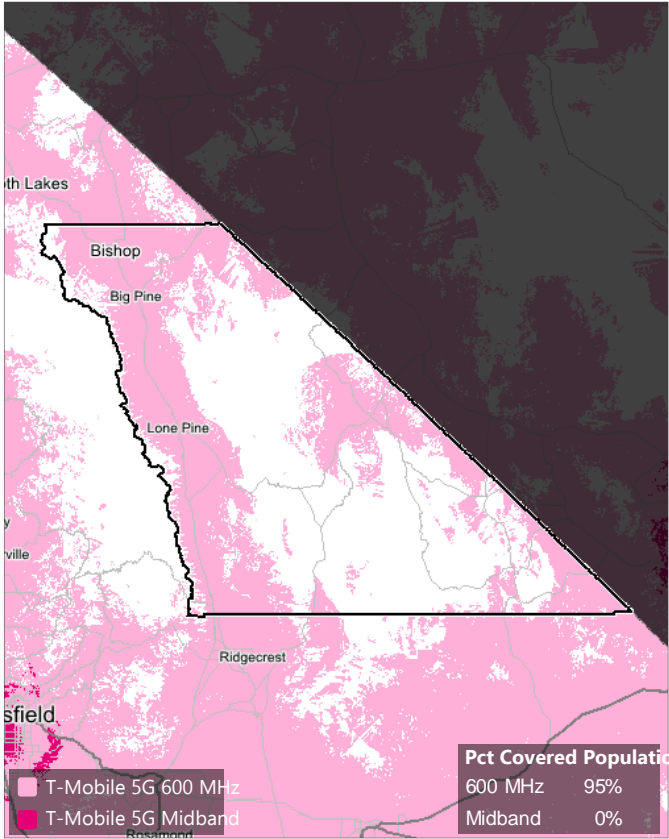


New T-Mobile

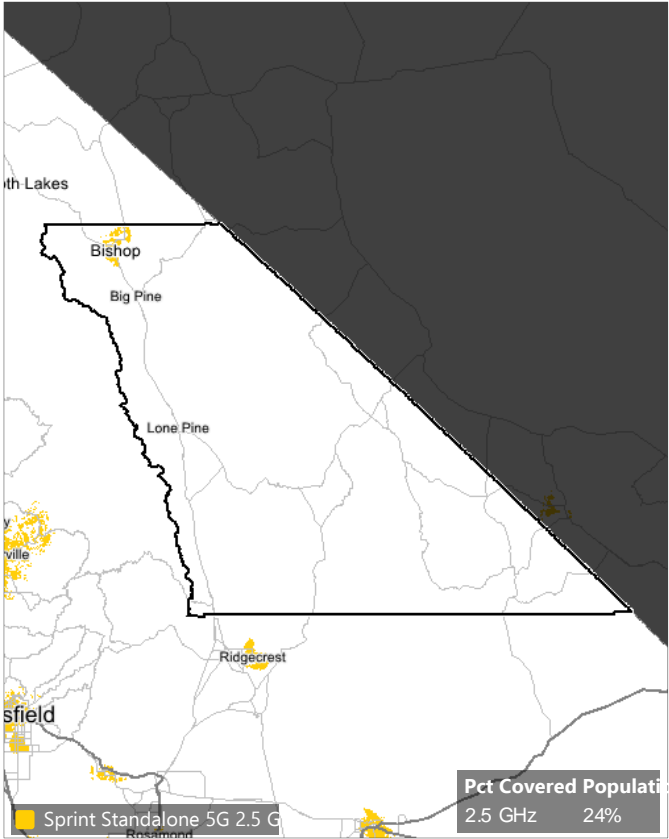


Projected 2024 5G Coverage: Inyo County (06027)

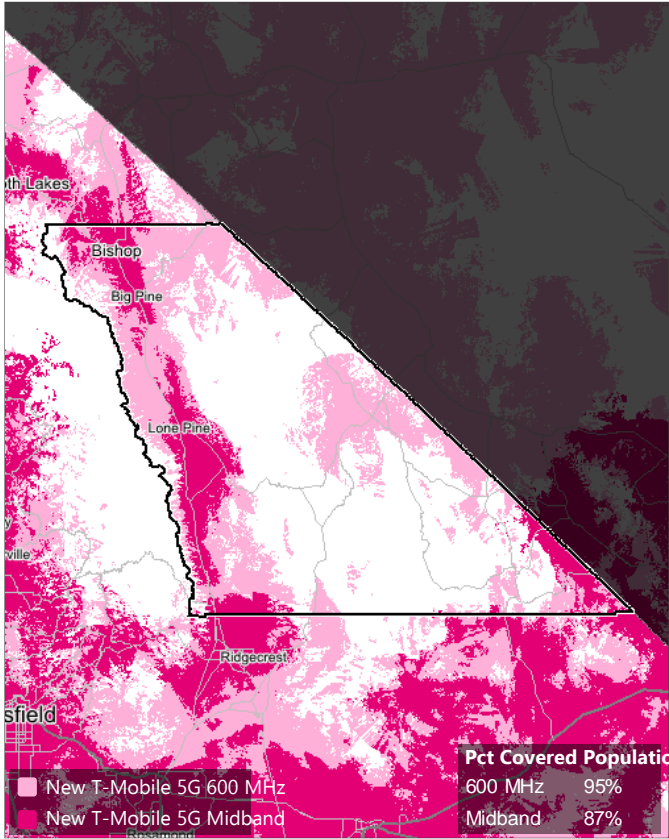
T-Mobile Standalone



Sprint Standalone

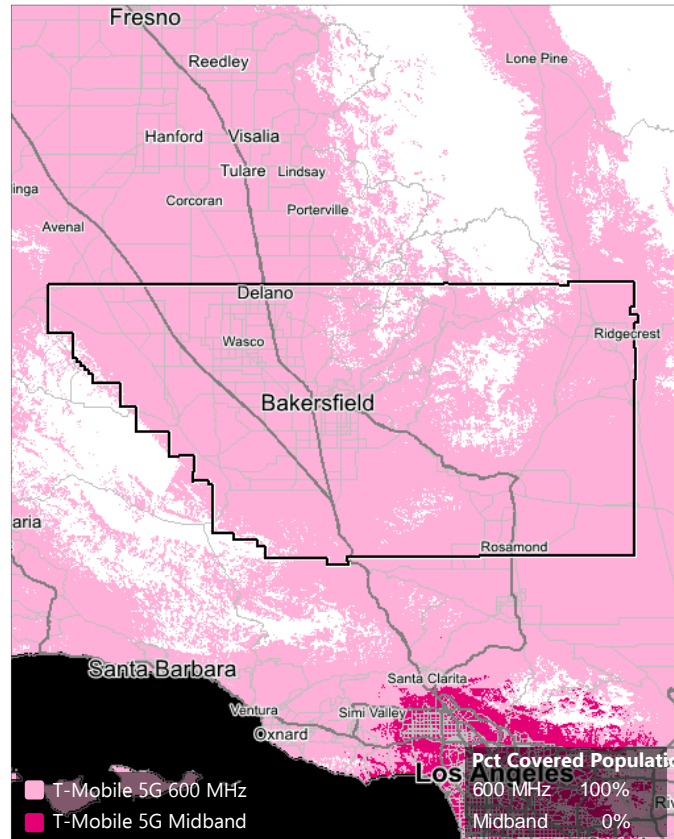


New T-Mobile

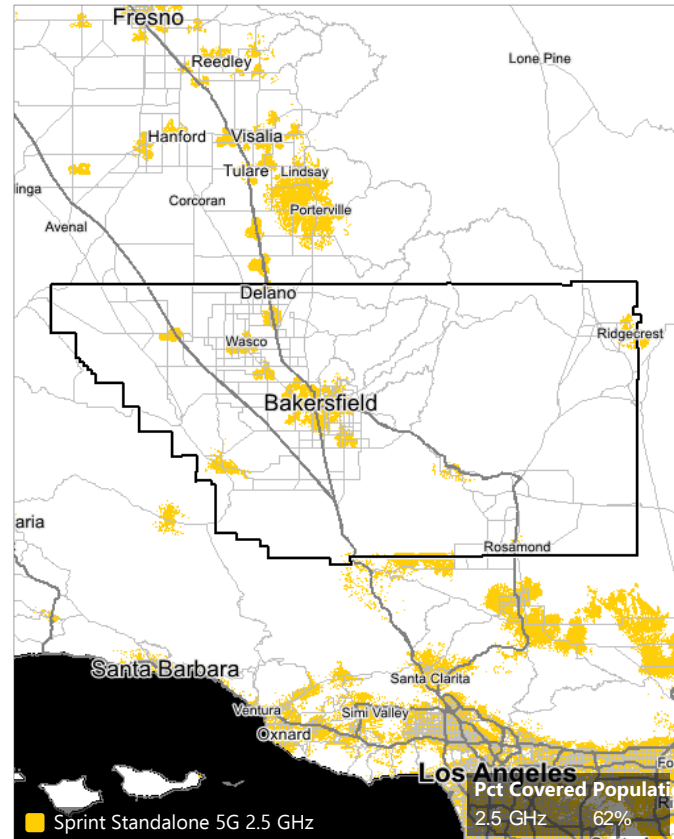


Projected 2021 5G Coverage: Kern County (06029)

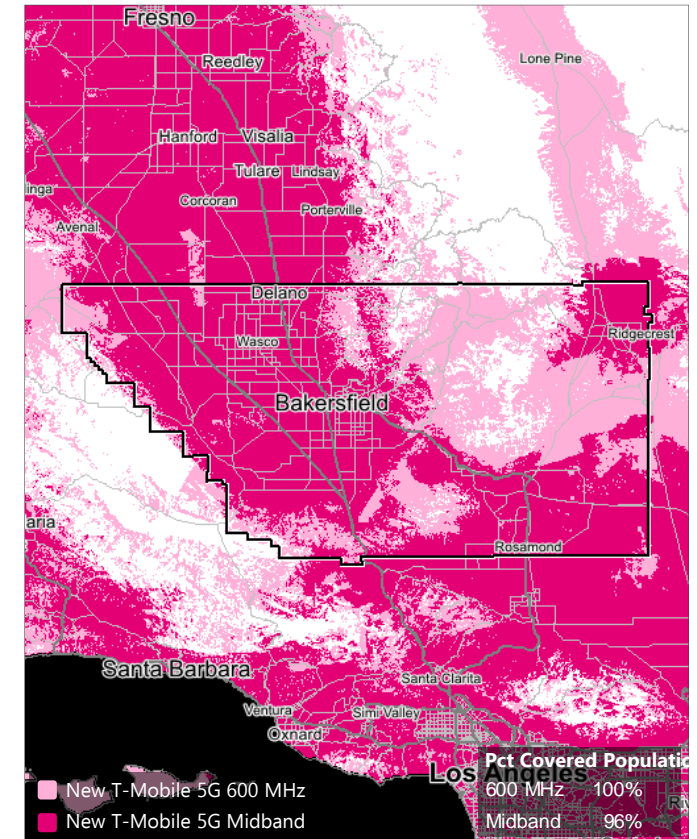
T-Mobile Standalone



Sprint Standalone

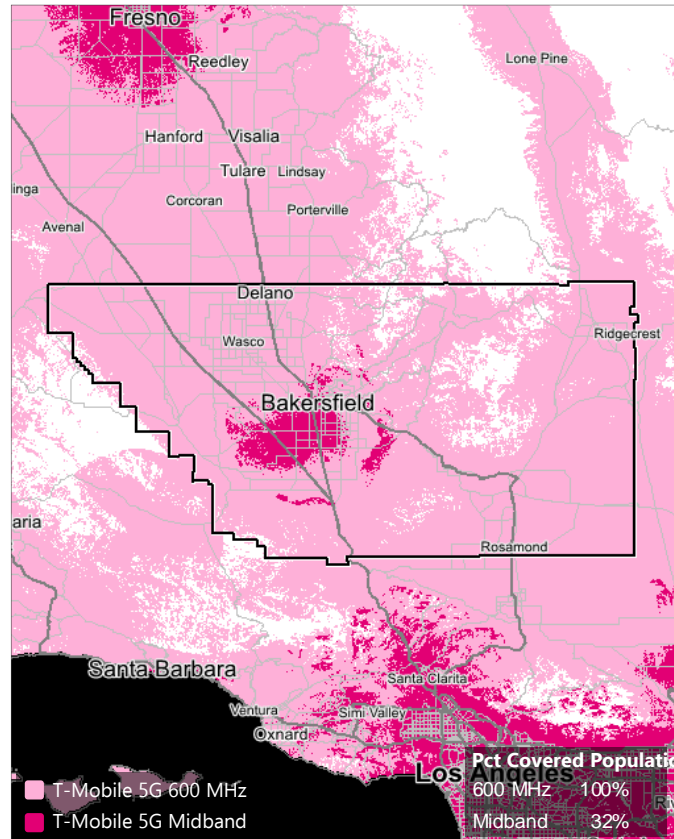


New T-Mobile

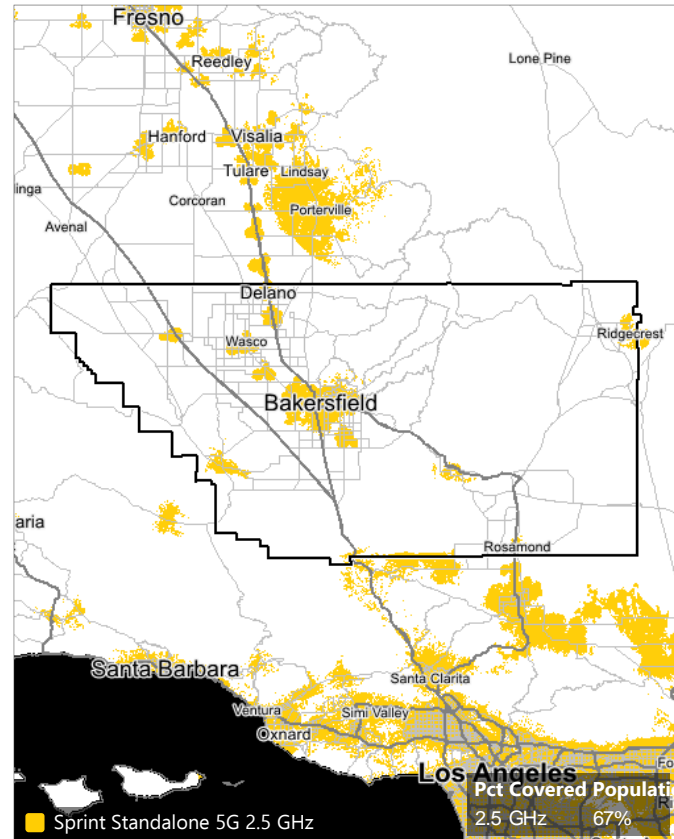


Projected 2024 5G Coverage: Kern County (06029)

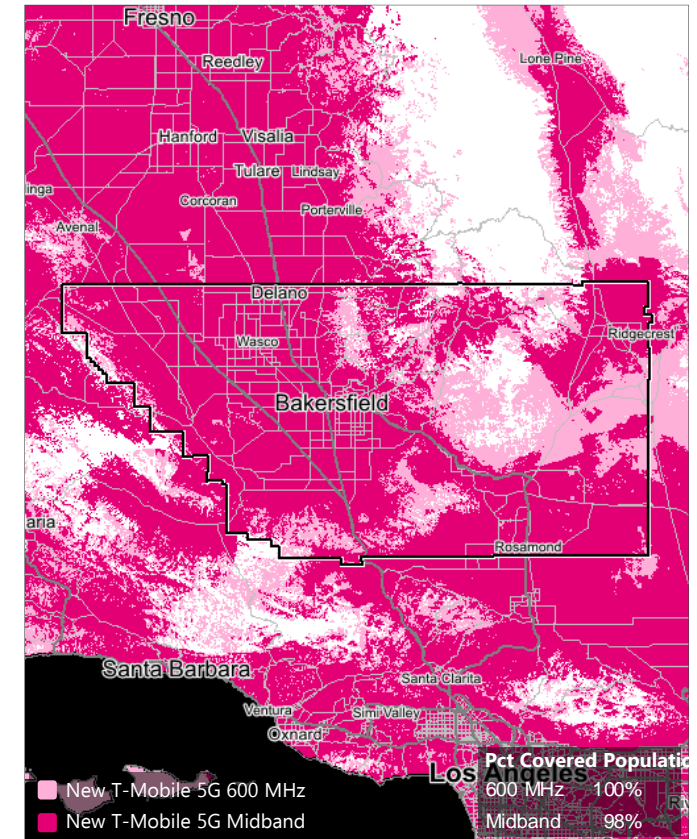
T-Mobile Standalone



Sprint Standalone

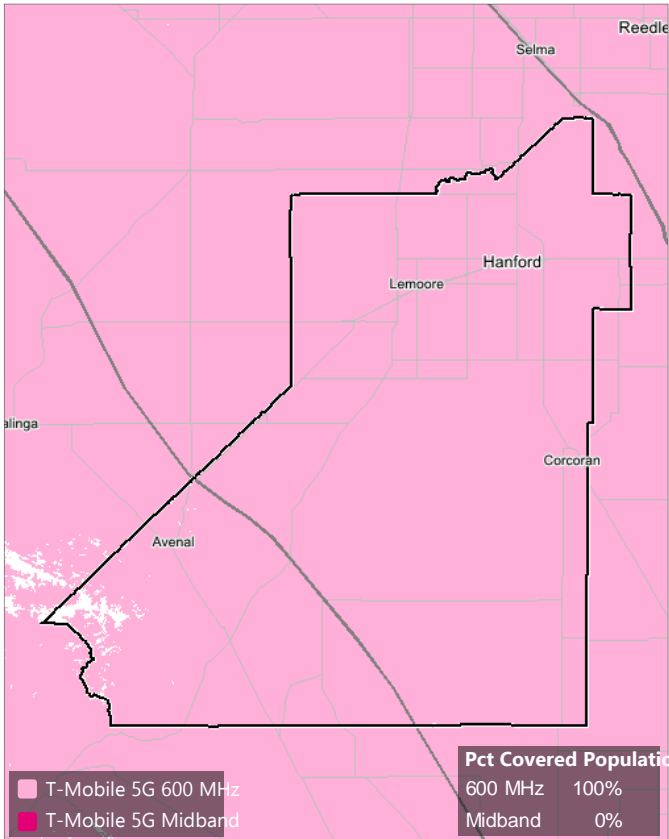


New T-Mobile

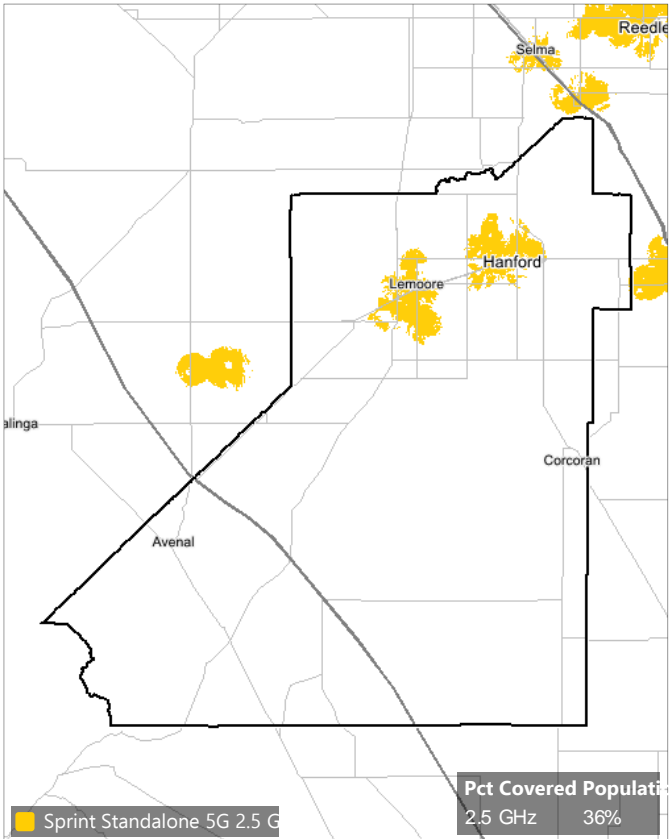


Projected 2021 5G Coverage: Kings County (06031)

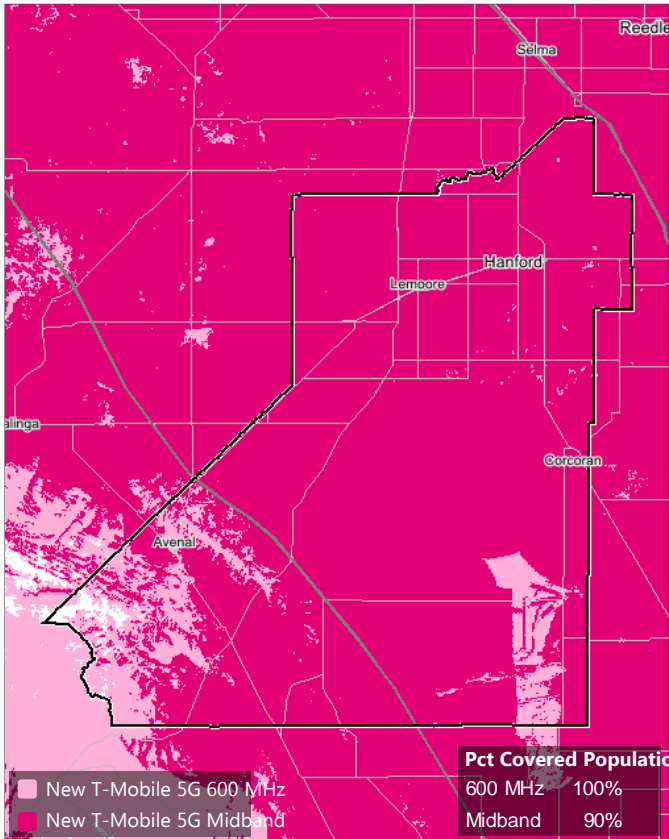
T-Mobile Standalone



Sprint Standalone

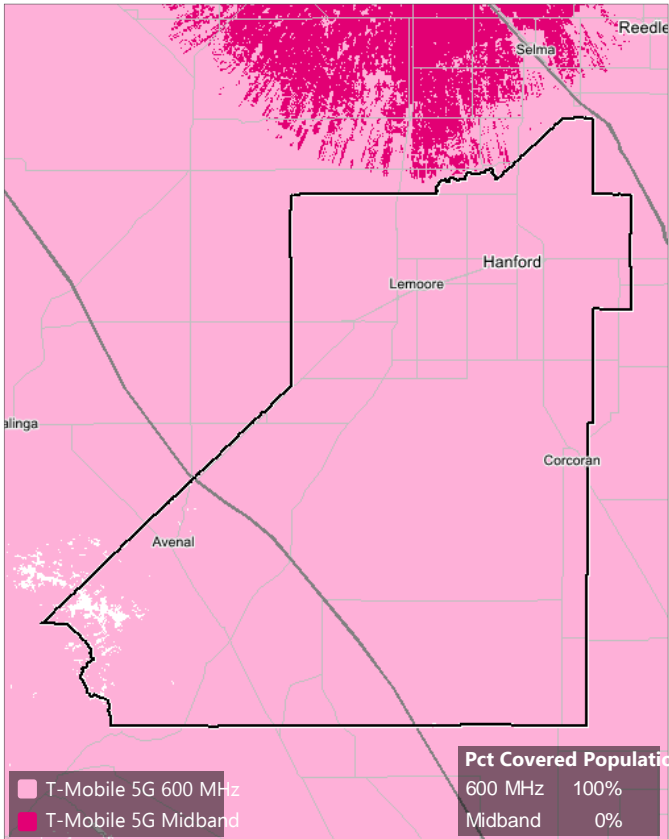


New T-Mobile

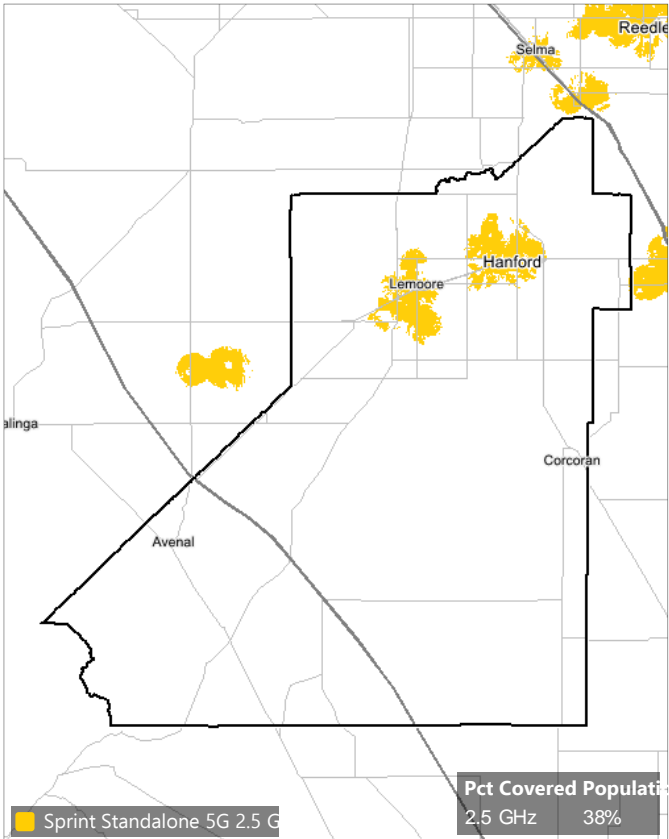


Projected 2024 5G Coverage: Kings County (06031)

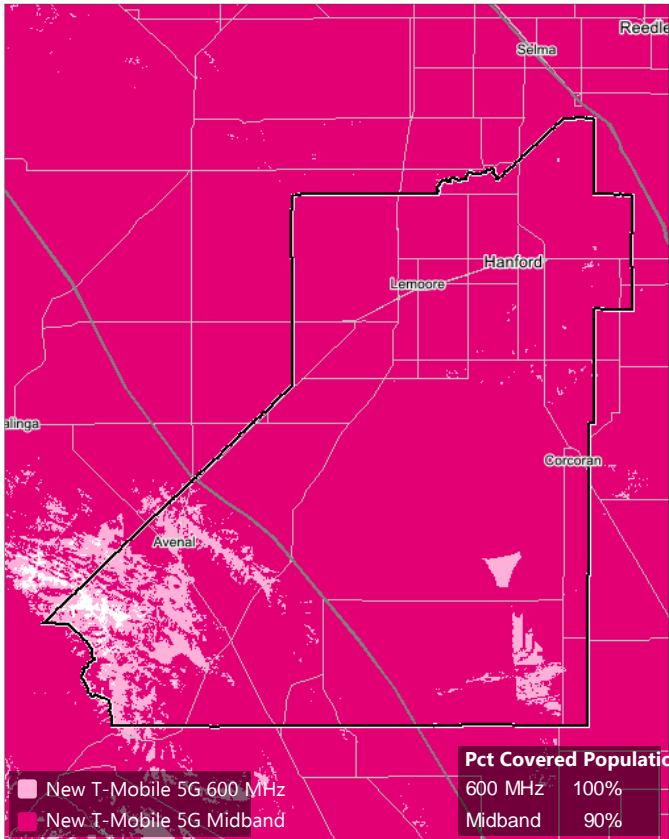
T-Mobile Standalone



Sprint Standalone

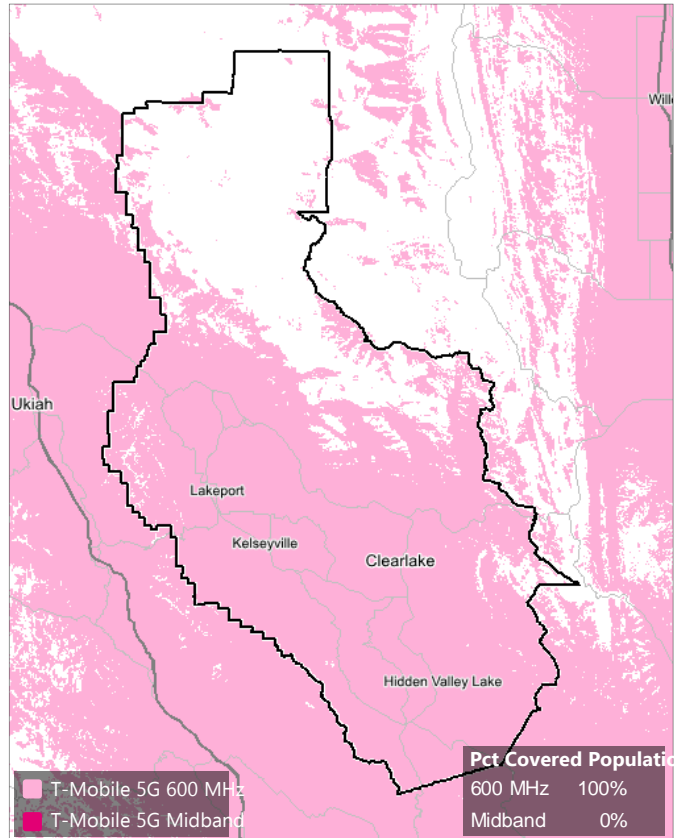


New T-Mobile

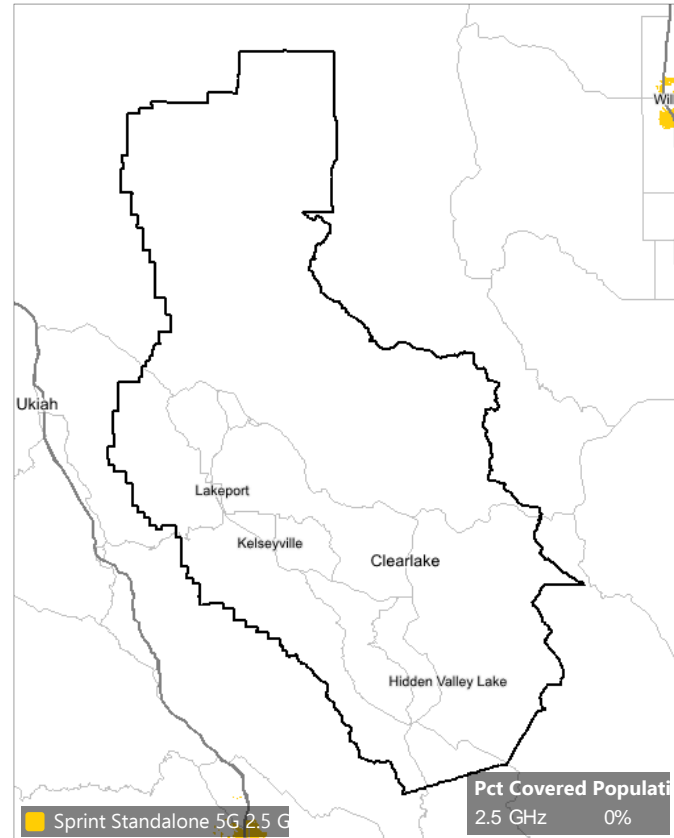


Projected 2021 5G Coverage: Lake County (06033)

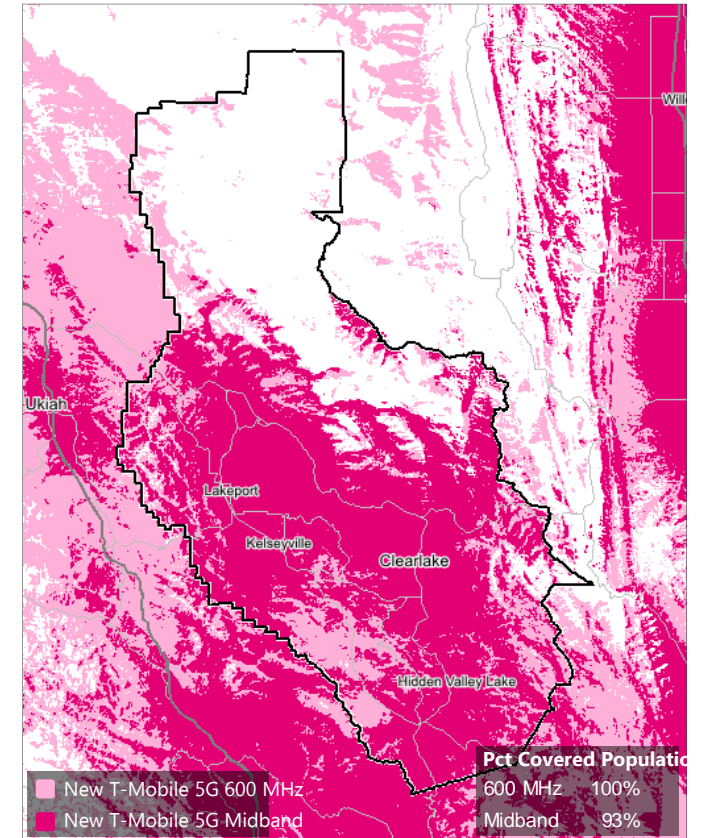
T-Mobile Standalone



Sprint Standalone

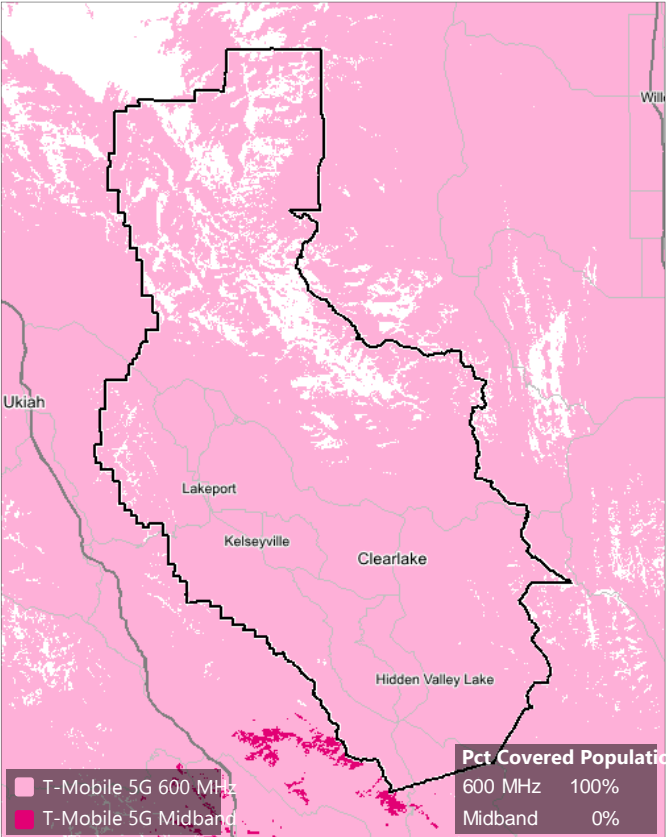


New T-Mobile

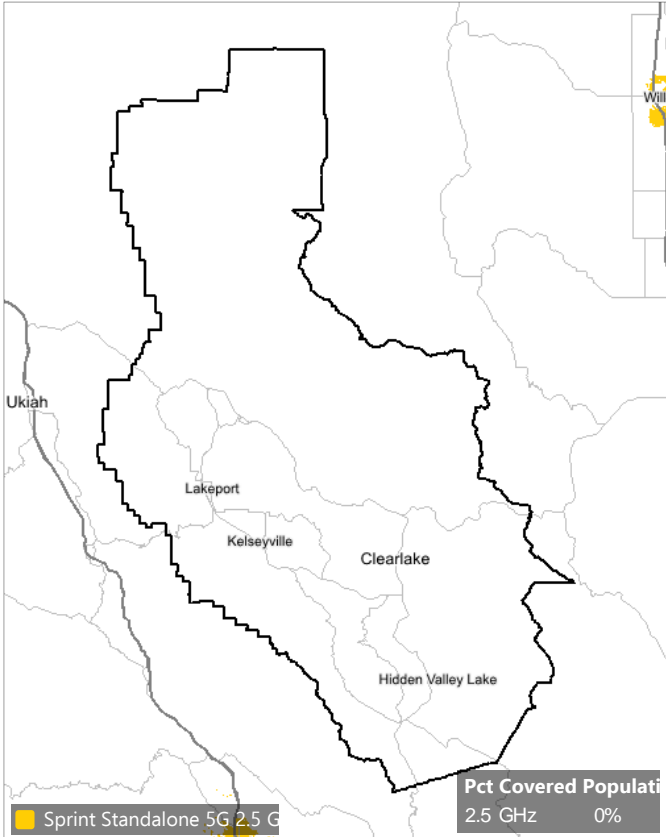


Projected 2024 5G Coverage: Lake County (06033)

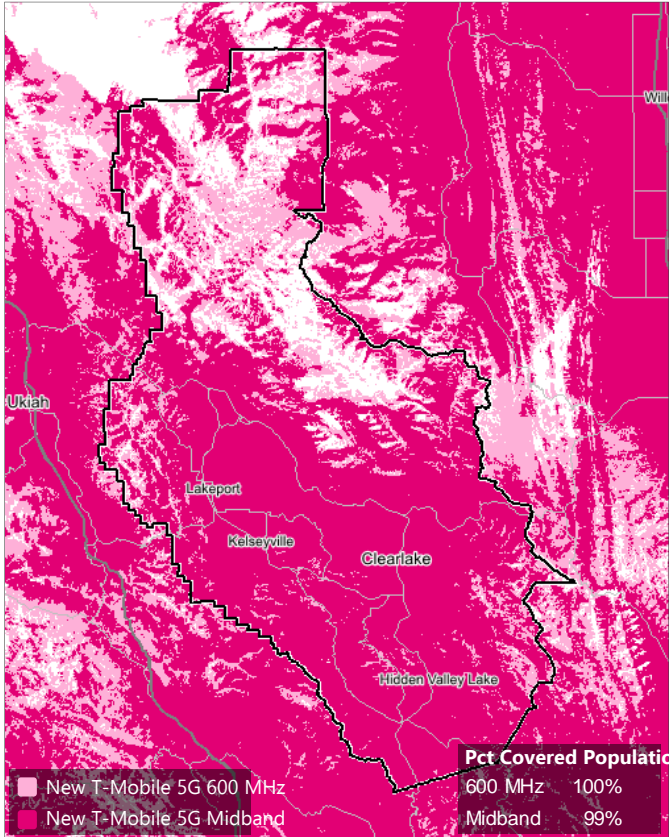
T-Mobile Standalone



Sprint Standalone

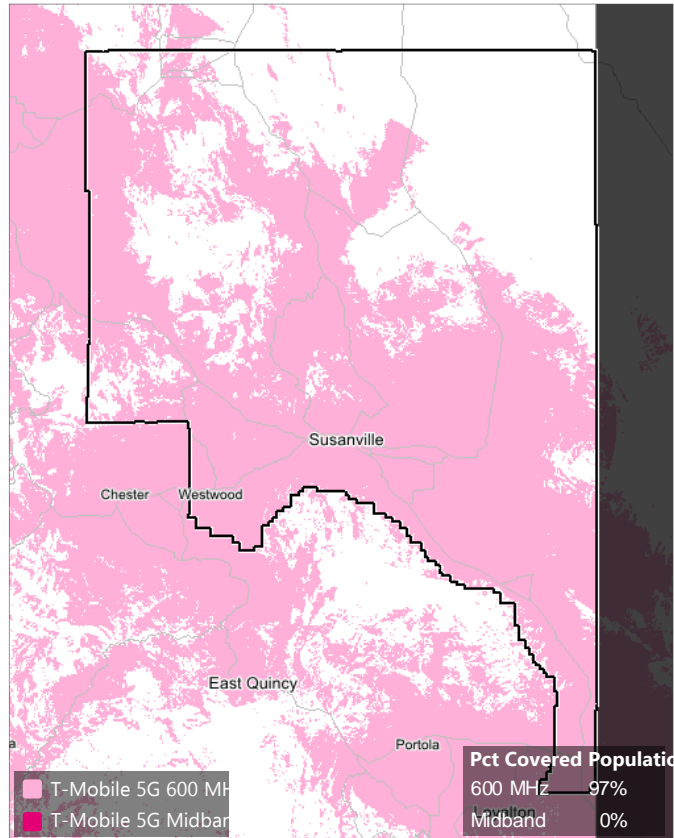


New T-Mobile

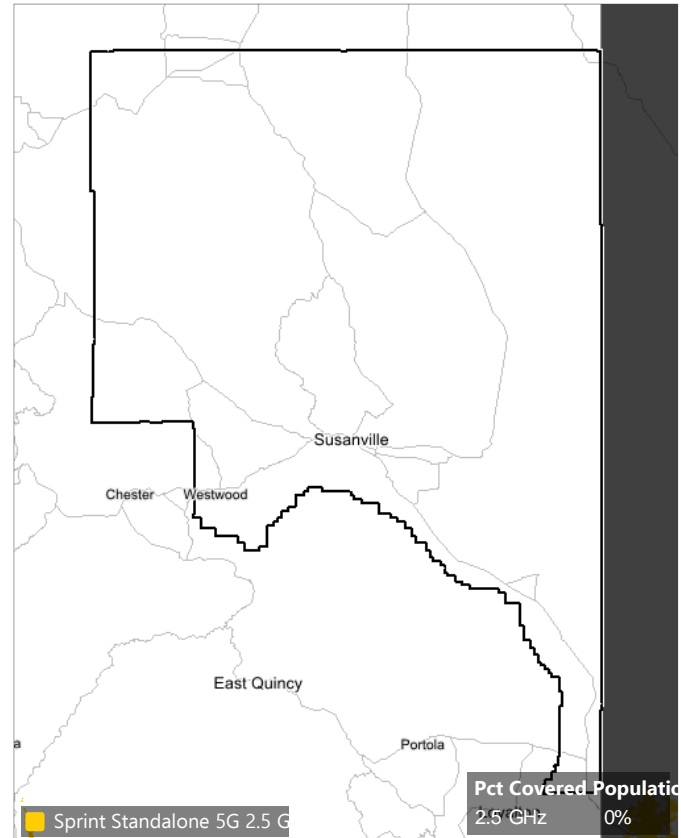


Projected 2021 5G Coverage: Lassen County (06035)

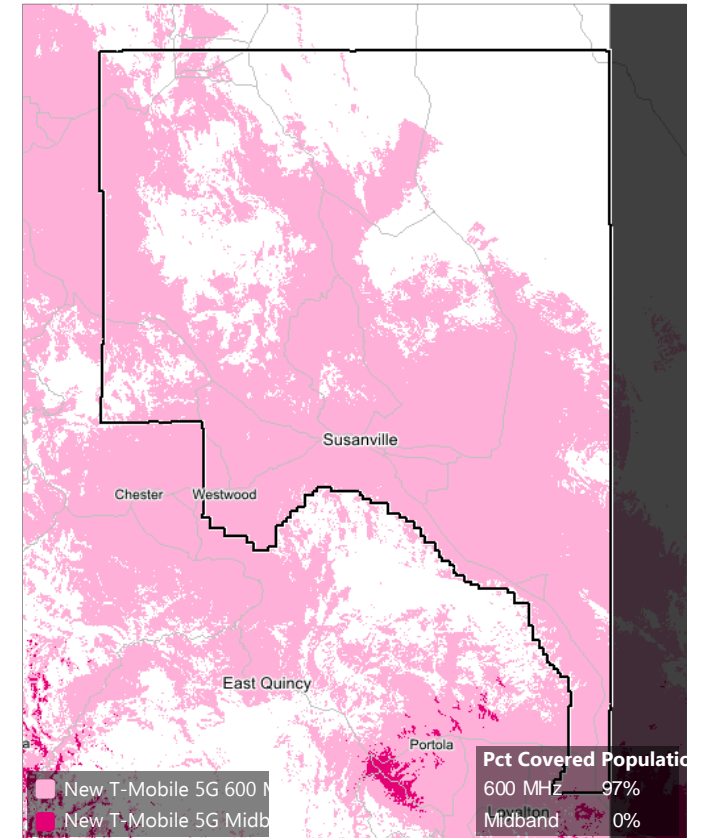
T-Mobile Standalone



Sprint Standalone

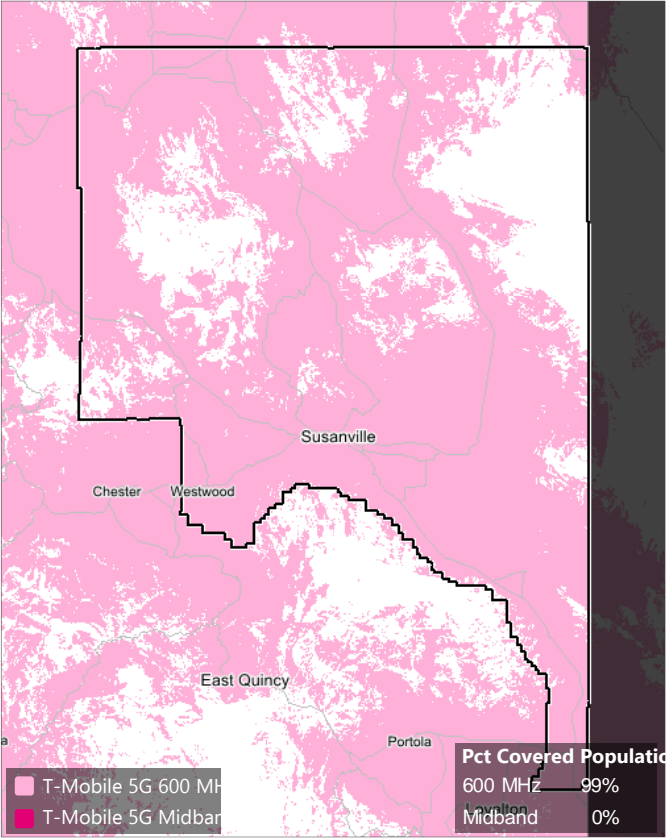


New T-Mobile

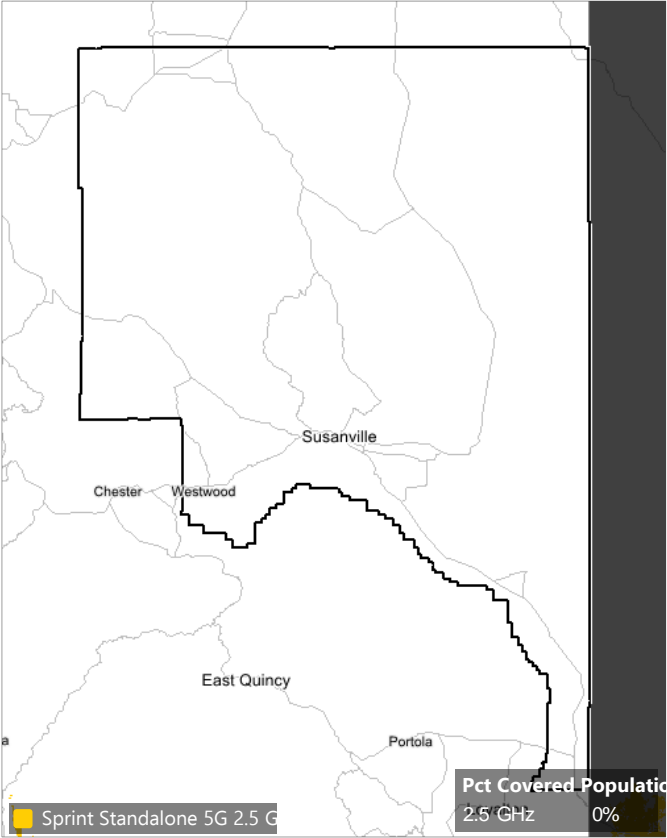


Projected 2024 5G Coverage: Lassen County (06035)

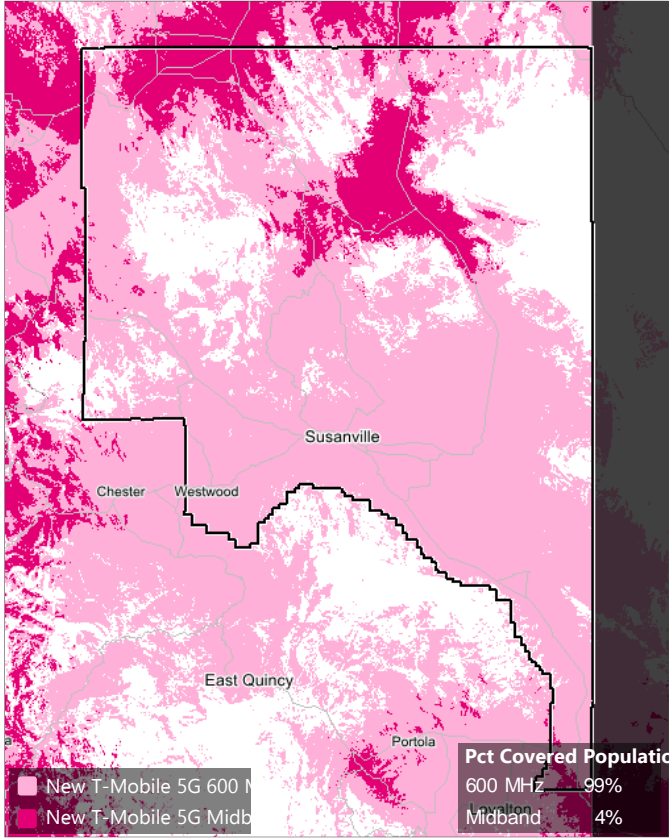
T-Mobile Standalone



Sprint Standalone



New T-Mobile

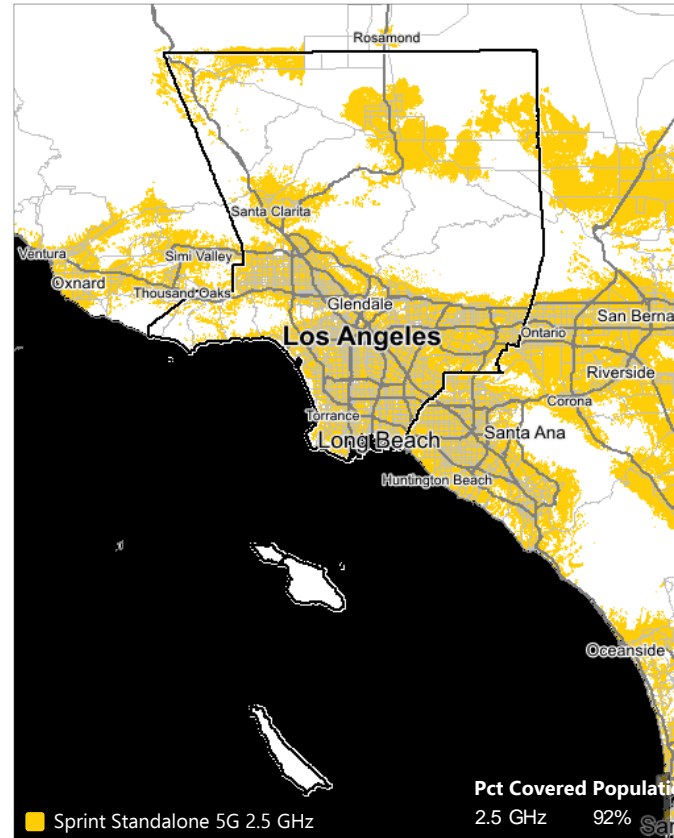


Projected 2021 5G Coverage: Los Angeles County (06037)

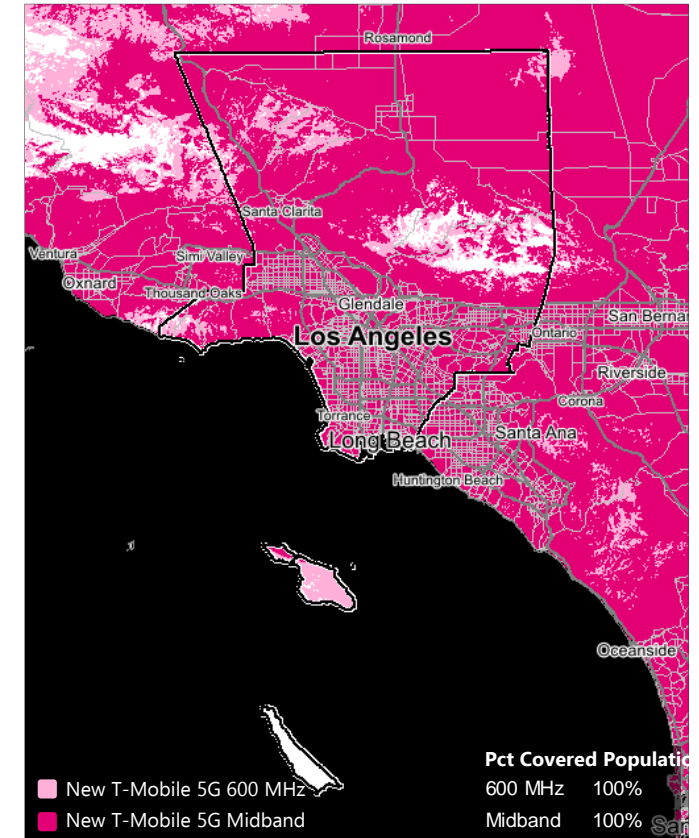
T-Mobile Standalone



Sprint Standalone

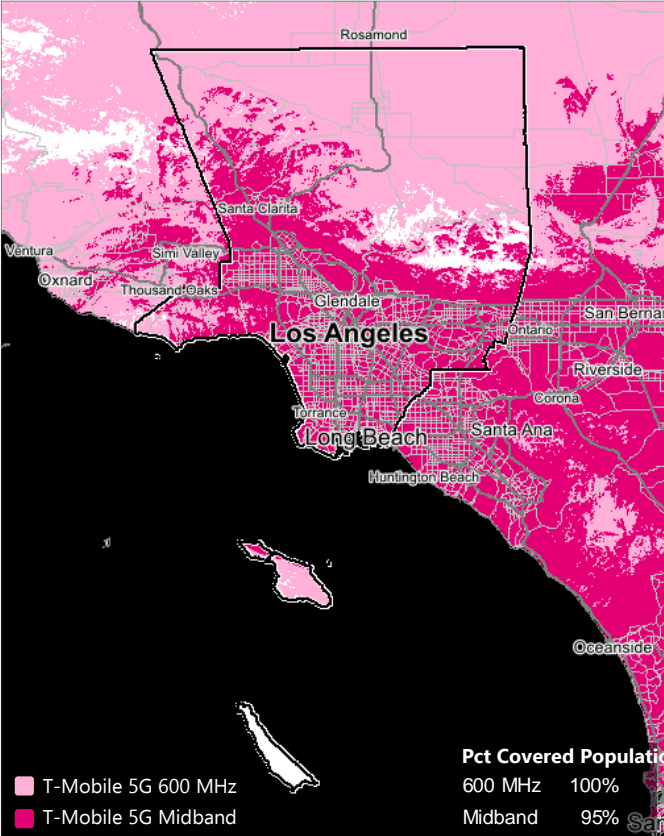


New T-Mobile

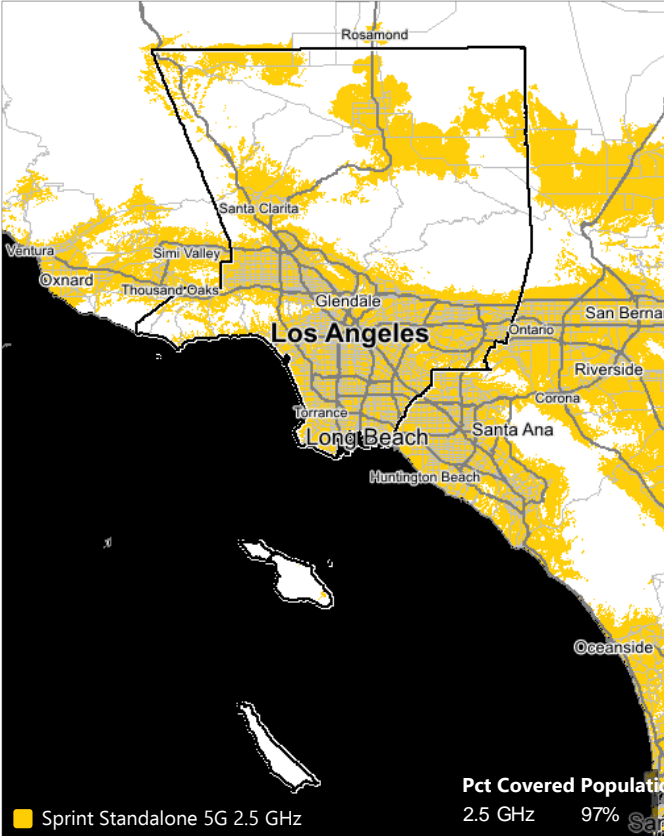


Projected 2024 5G Coverage: Los Angeles County (06037)

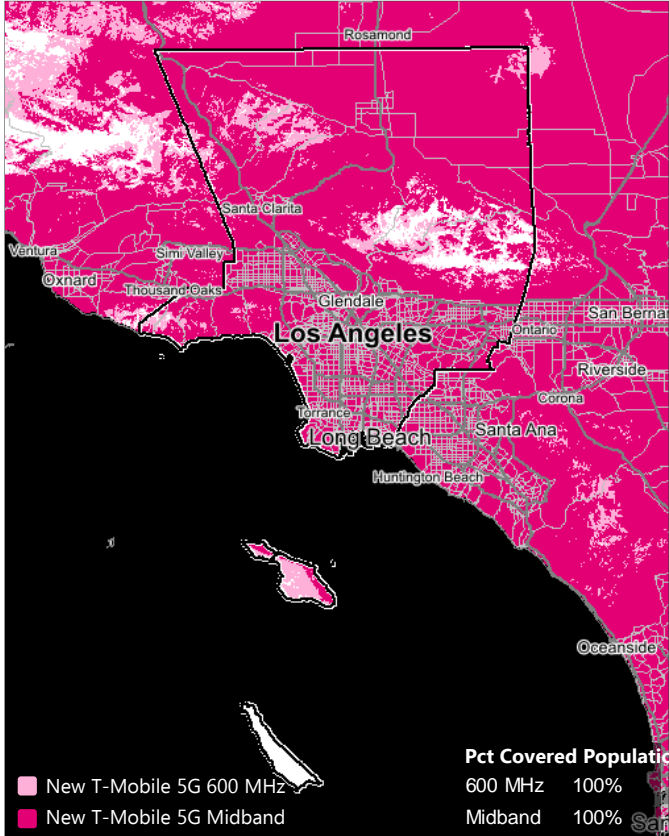
T-Mobile Standalone



Sprint Standalone

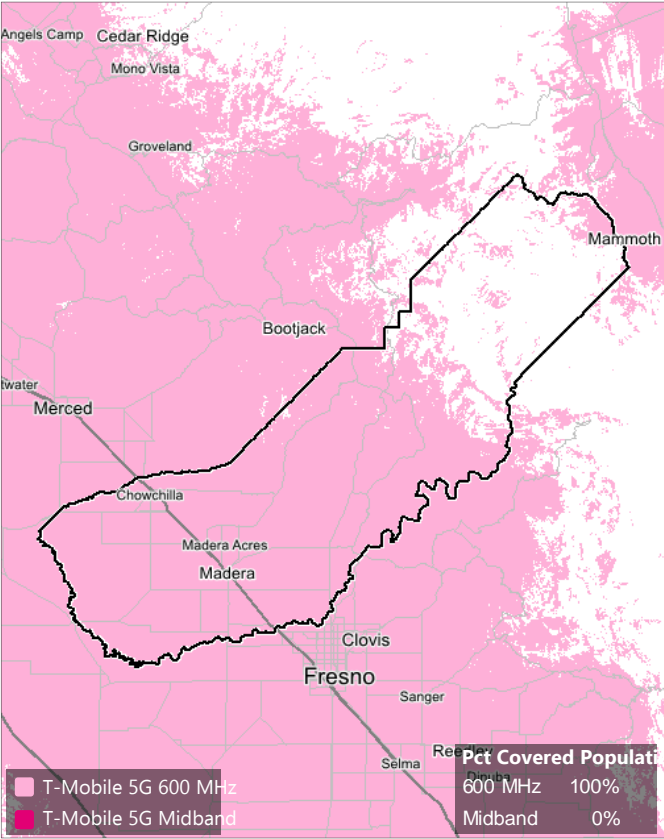


New T-Mobile

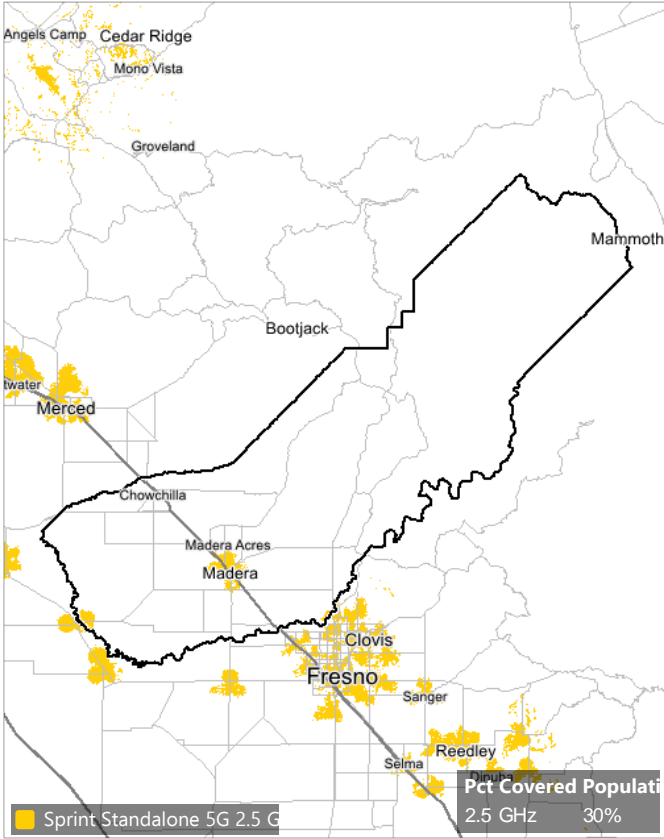


Projected 2021 5G Coverage: Madera County (06039)

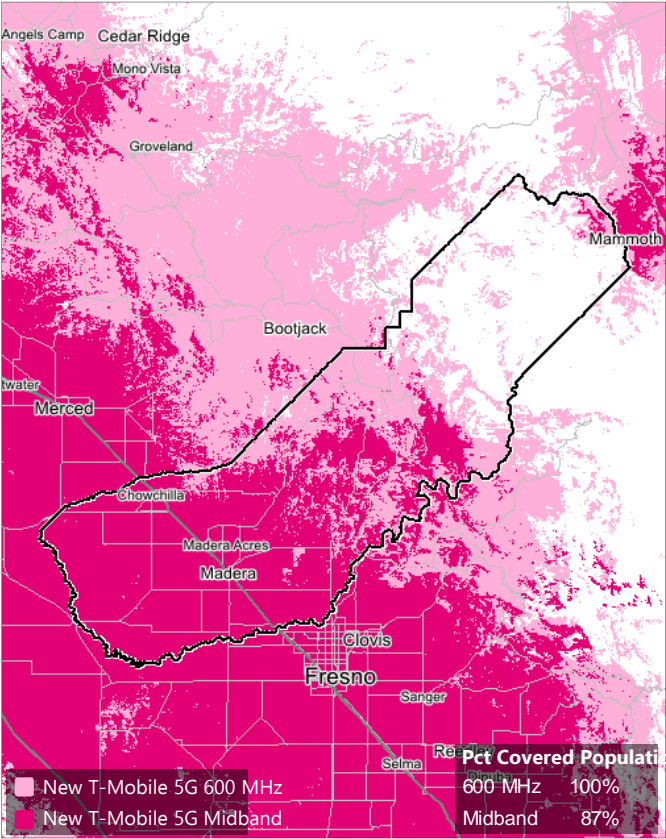
T-Mobile Standalone



Sprint Standalone

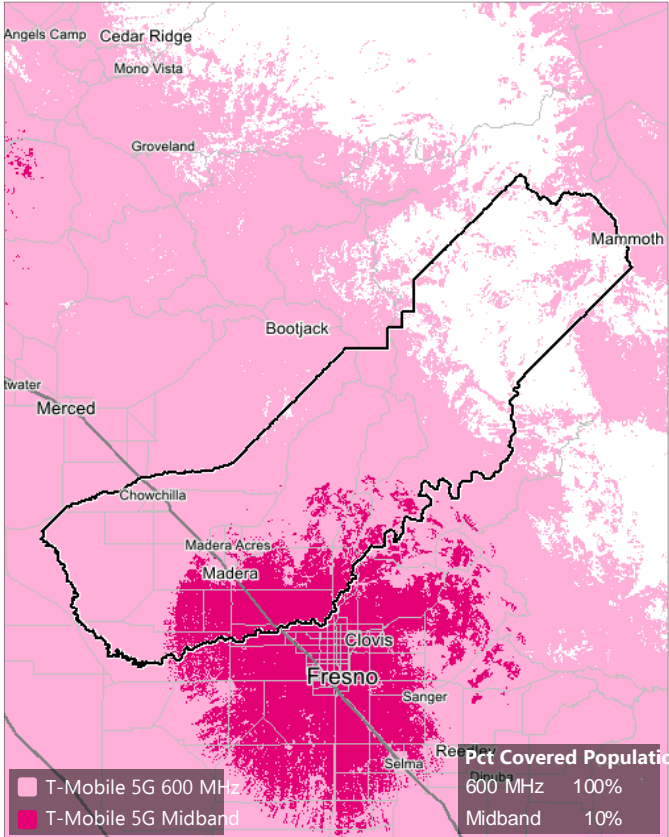


New T-Mobile

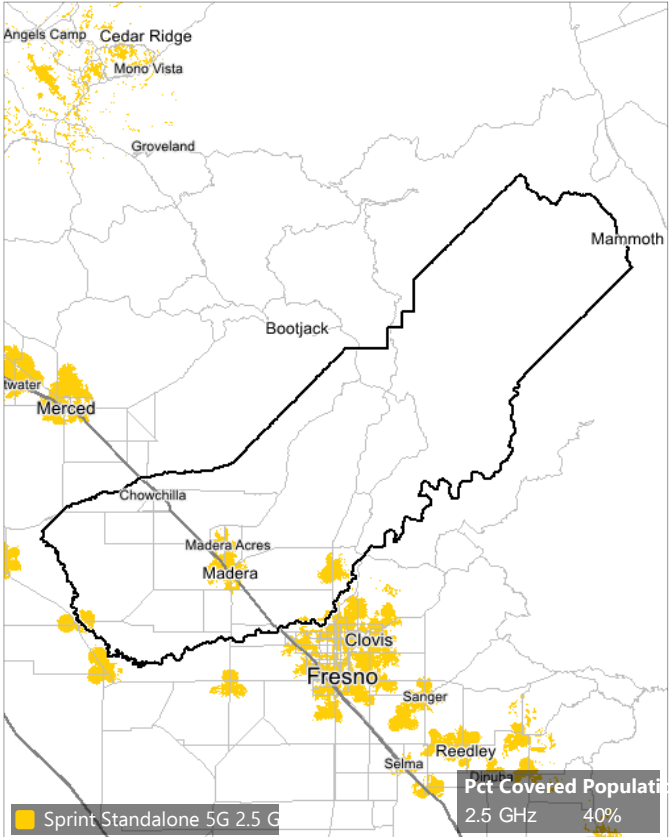


Projected 2024 5G Coverage: Madera County (06039)

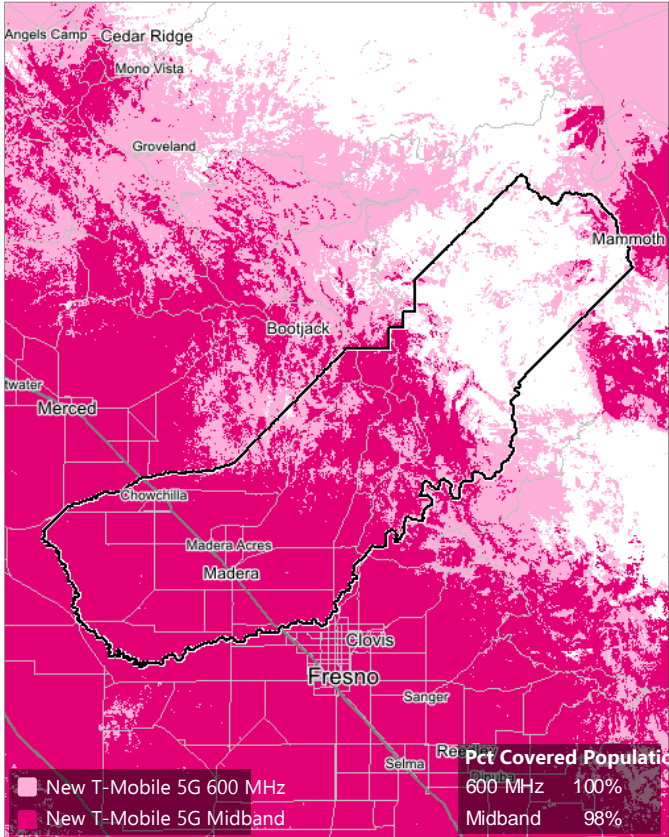
T-Mobile Standalone



Sprint Standalone

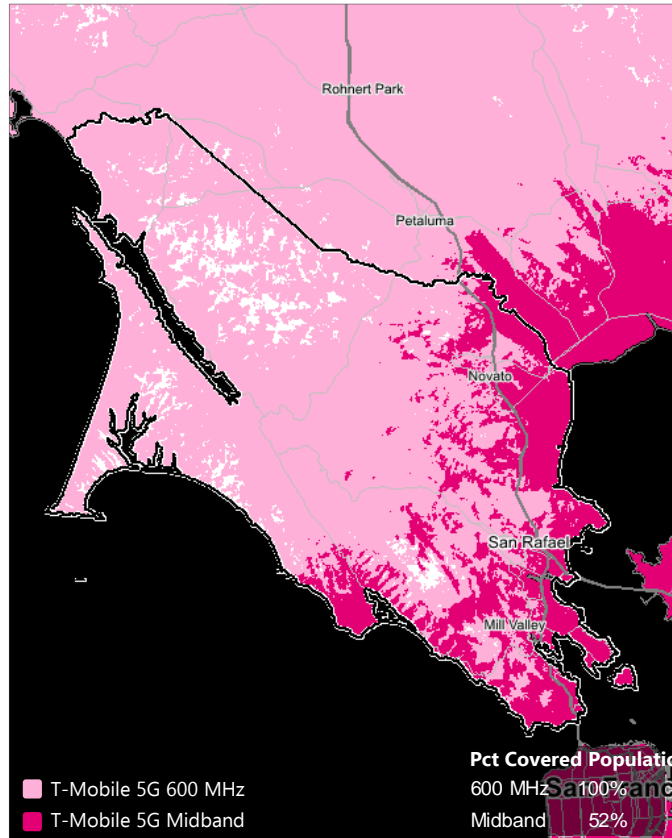


New T-Mobile

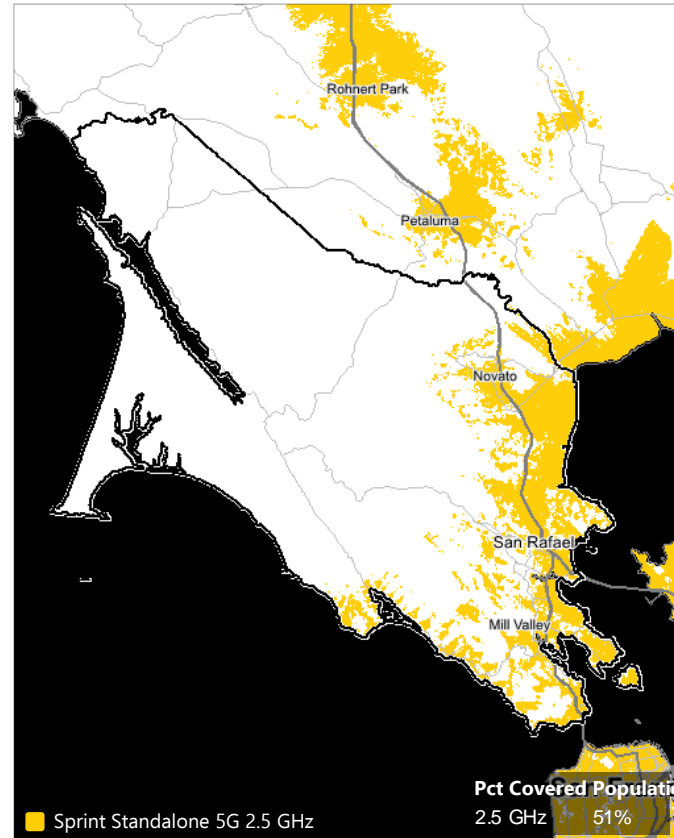


Projected 2021 5G Coverage: Marin County (06041)

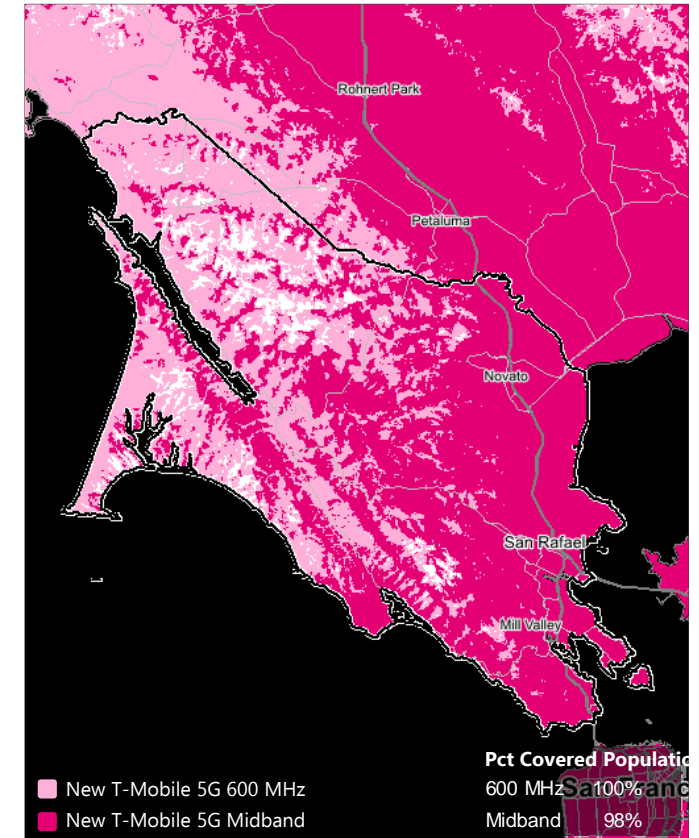
T-Mobile Standalone



Sprint Standalone

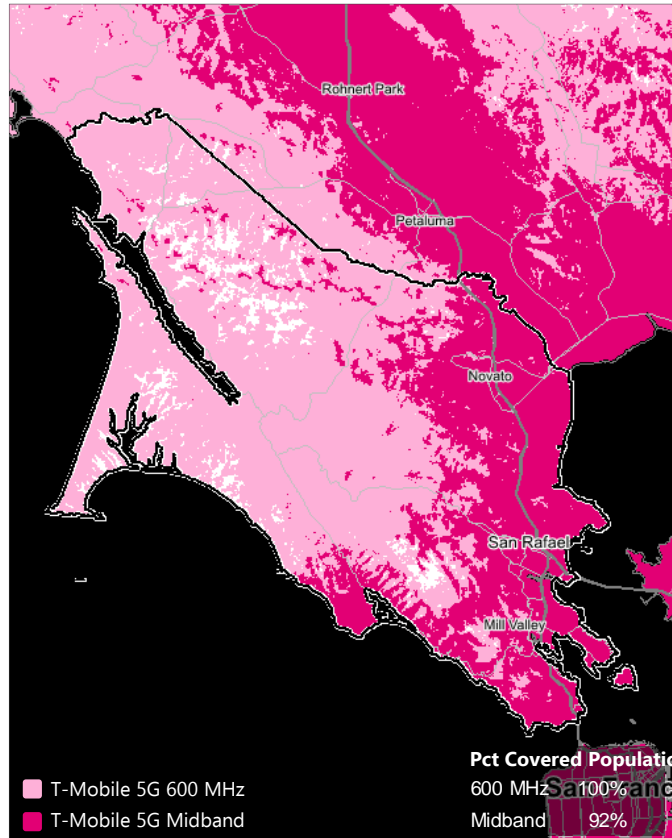


New T-Mobile

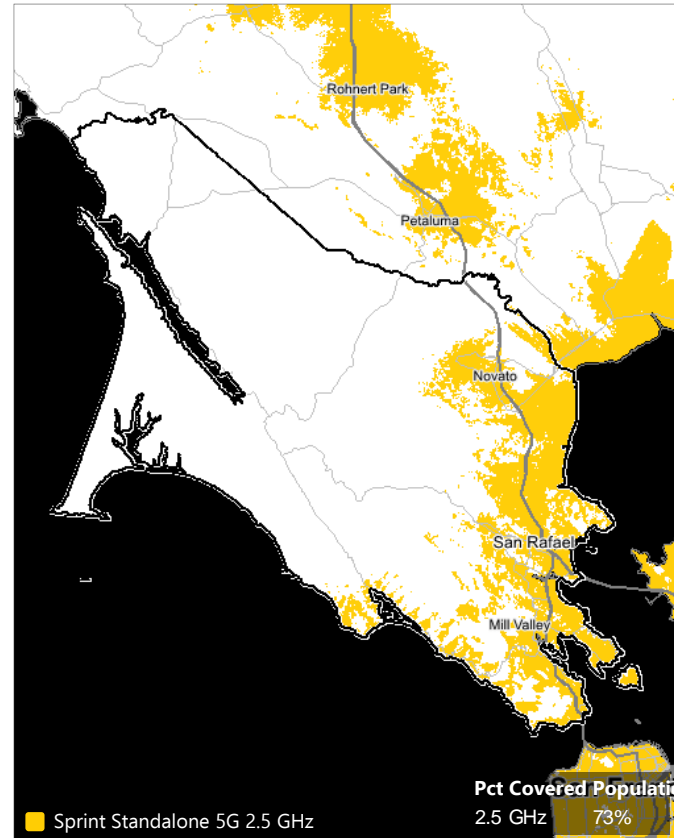


Projected 2024 5G Coverage: Marin County (06041)

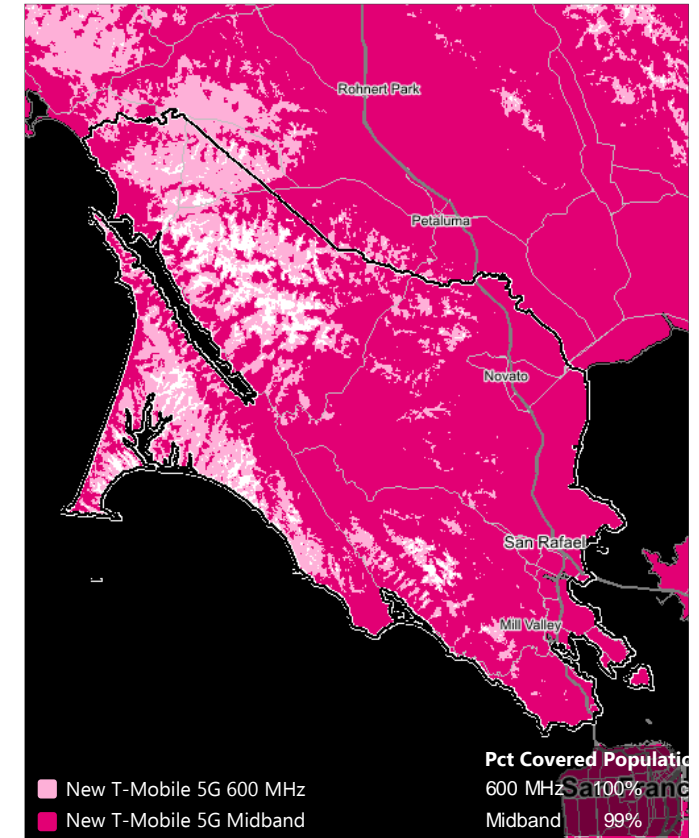
T-Mobile Standalone



Sprint Standalone

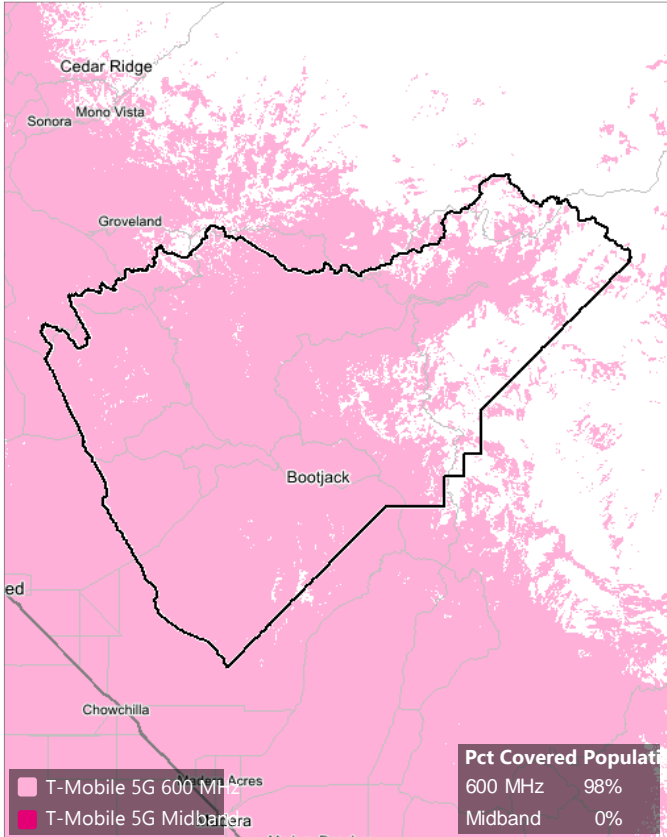


New T-Mobile

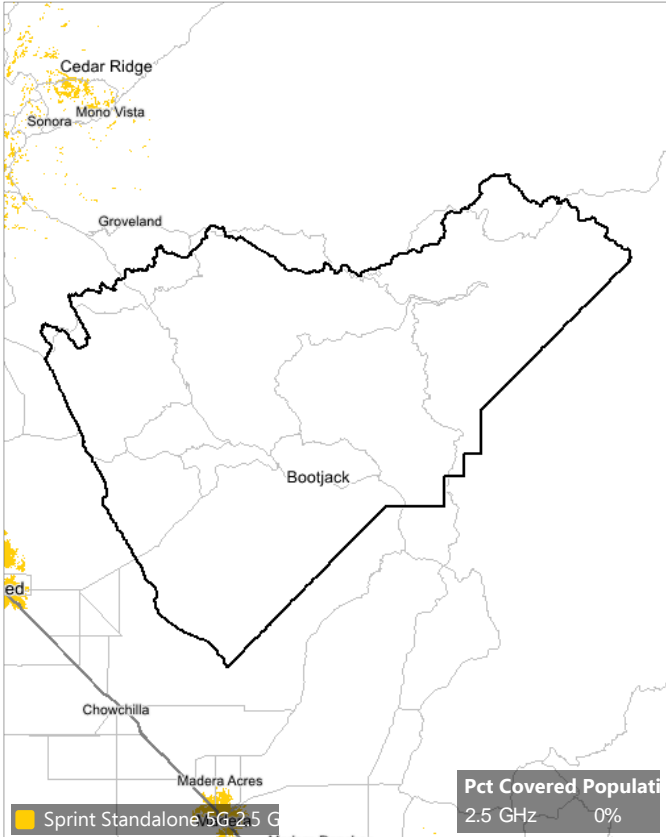


Projected 2021 5G Coverage: Mariposa County (06043)

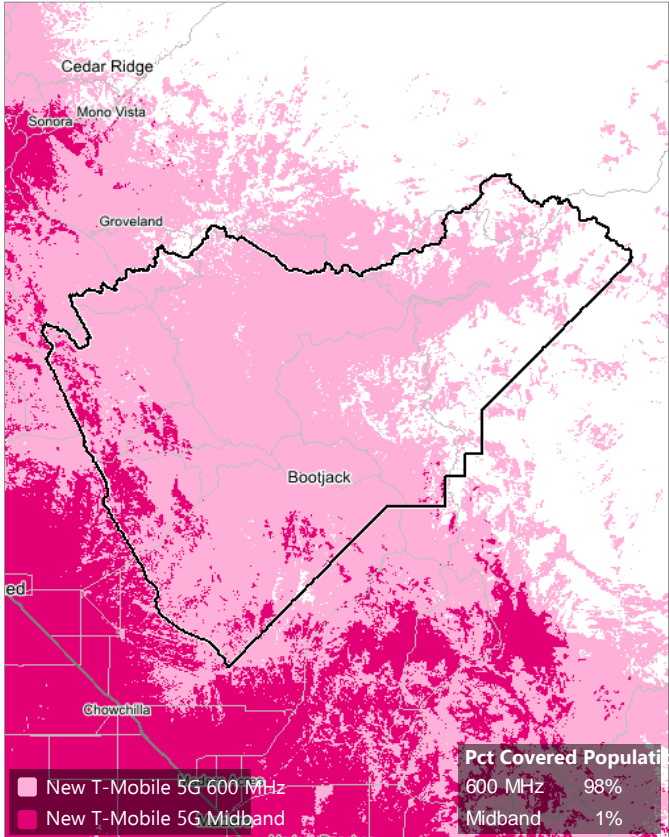
T-Mobile Standalone



Sprint Standalone

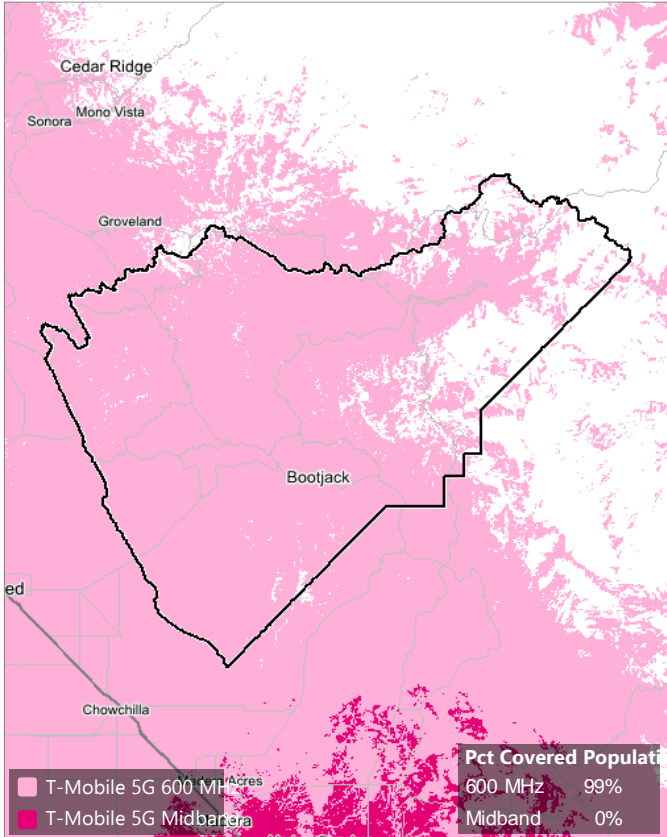


New T-Mobile



Projected 2024 5G Coverage: Mariposa County (06043)

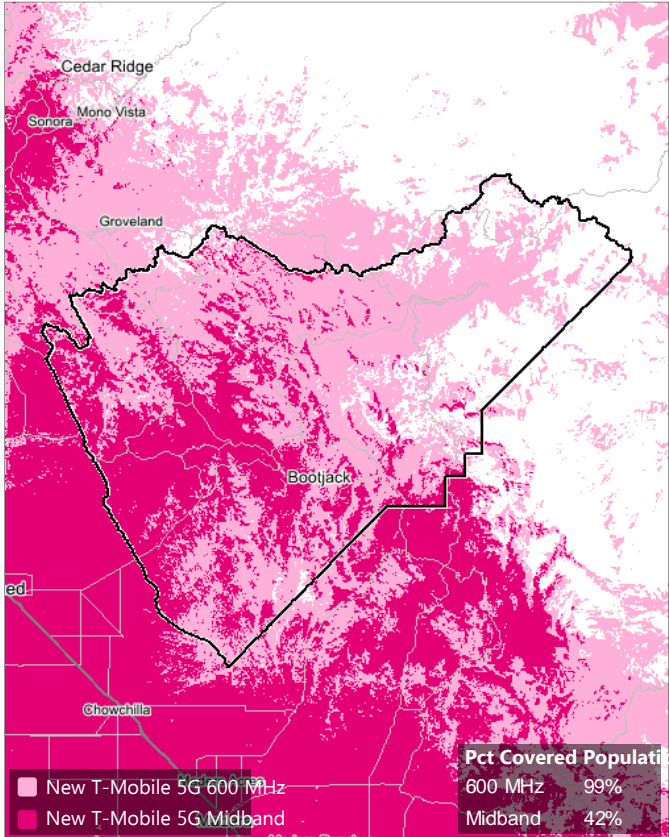
T-Mobile Standalone



Sprint Standalone

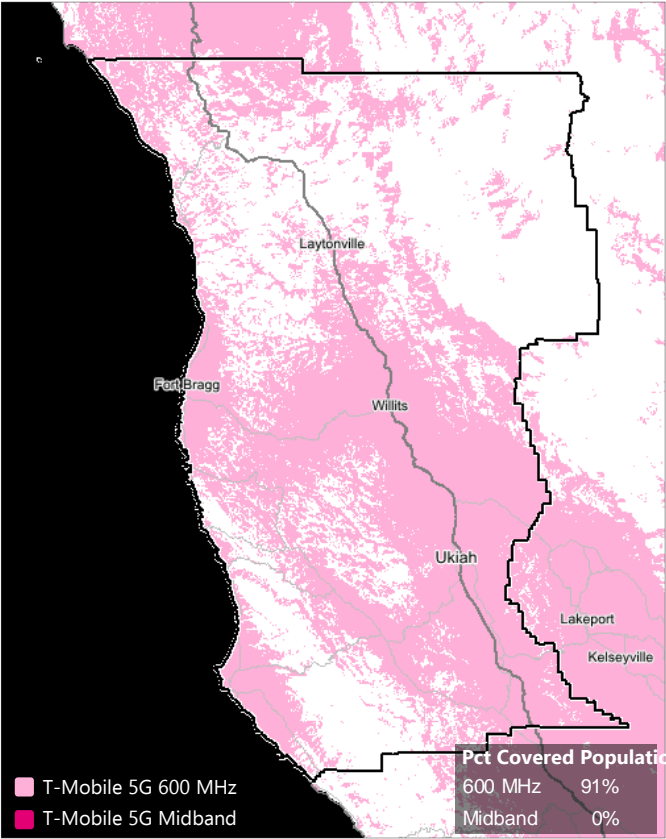


New T-Mobile

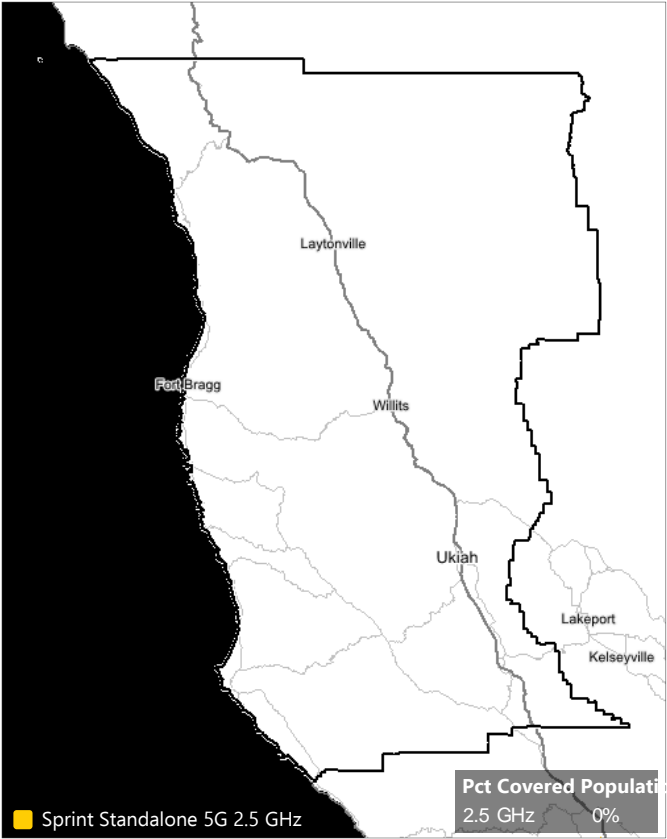


Projected 2021 5G Coverage: Mendocino County (06045)

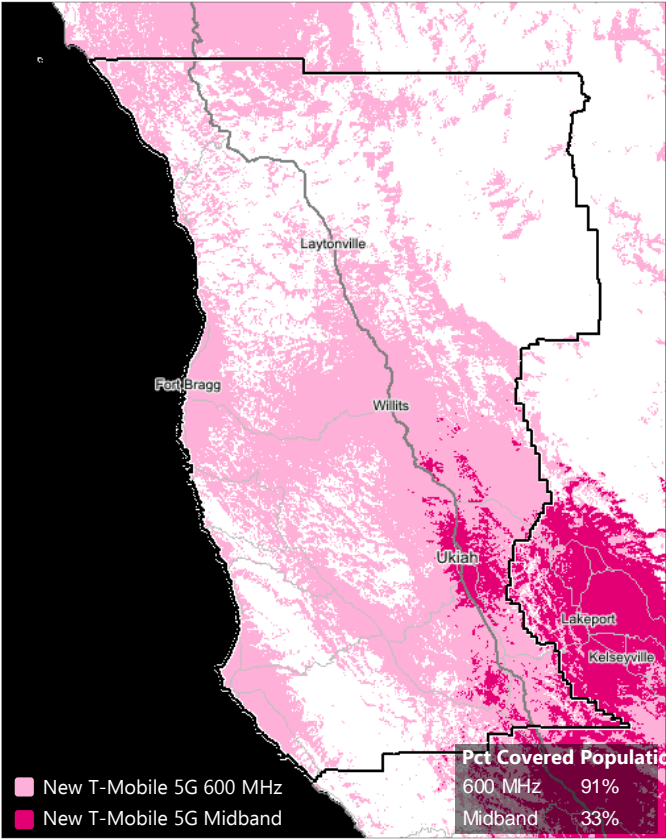
T-Mobile Standalone



Sprint Standalone

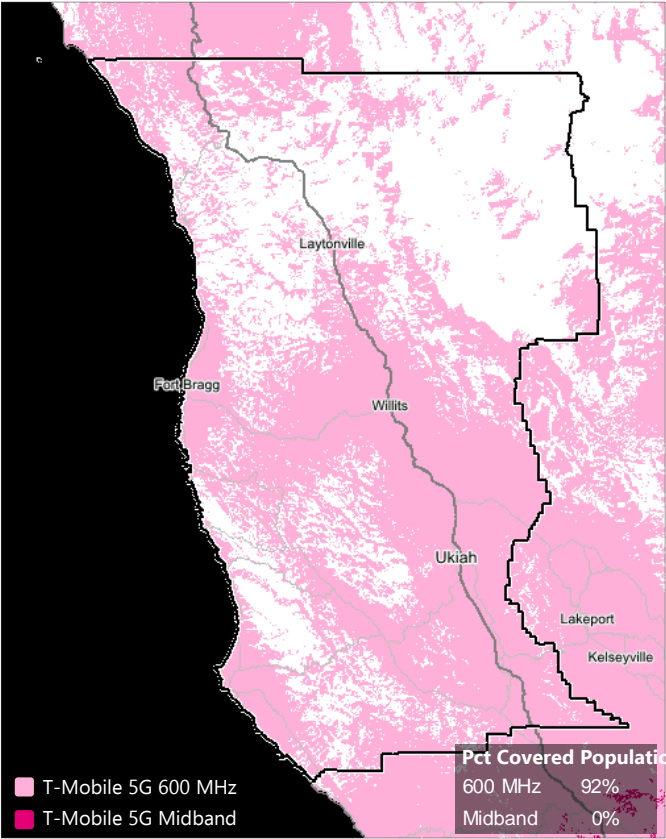


New T-Mobile

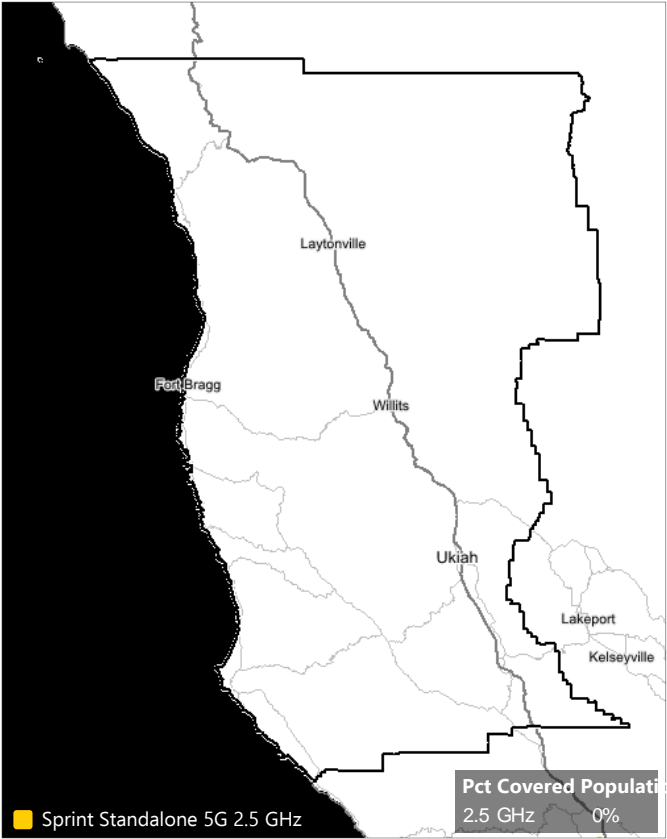


Projected 2024 5G Coverage: Mendocino County (06045)

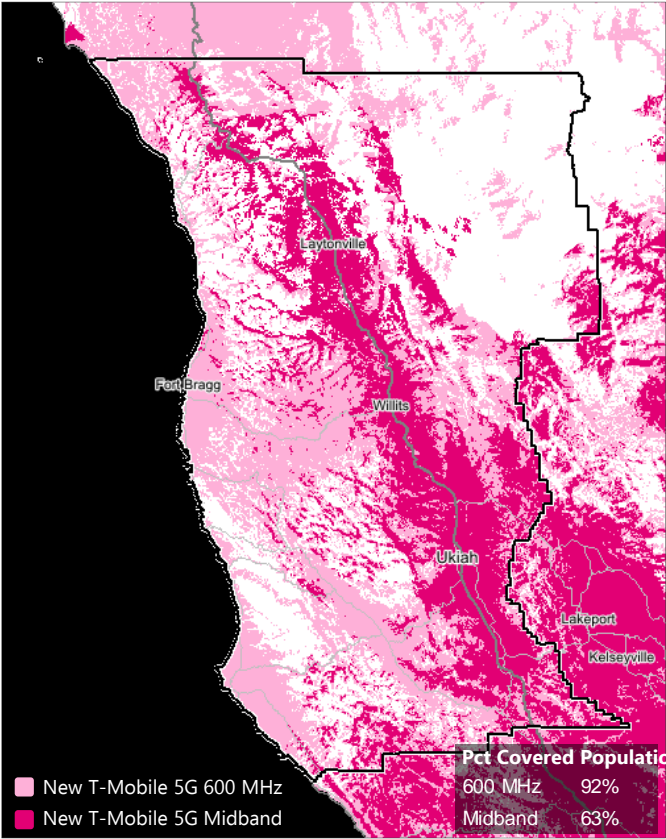
T-Mobile Standalone



Sprint Standalone

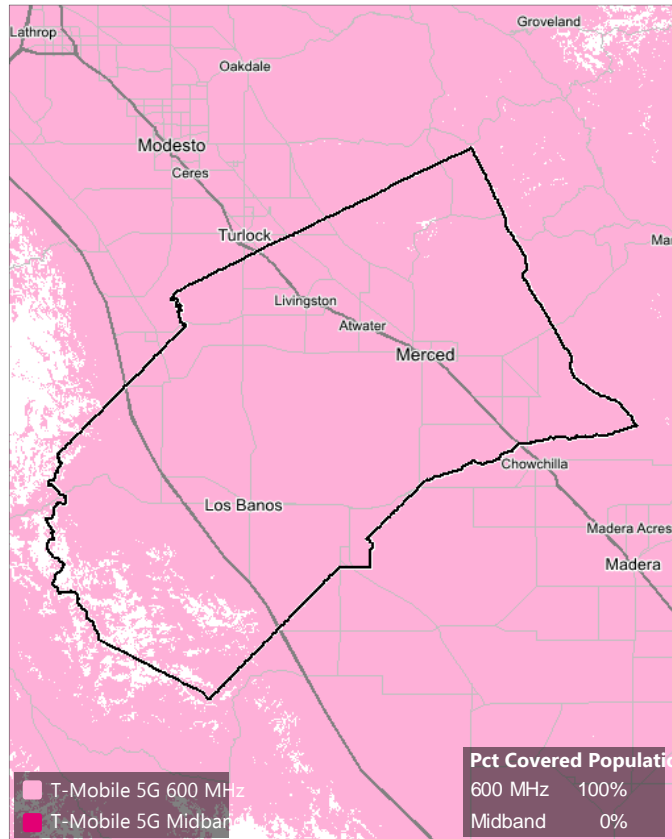


New T-Mobile

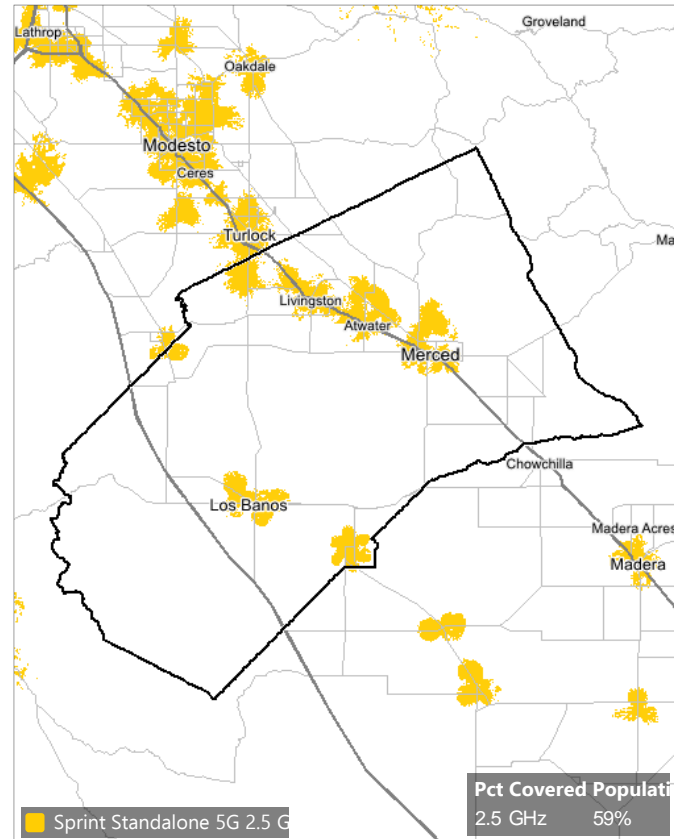


Projected 2021 5G Coverage: Merced County (06047)

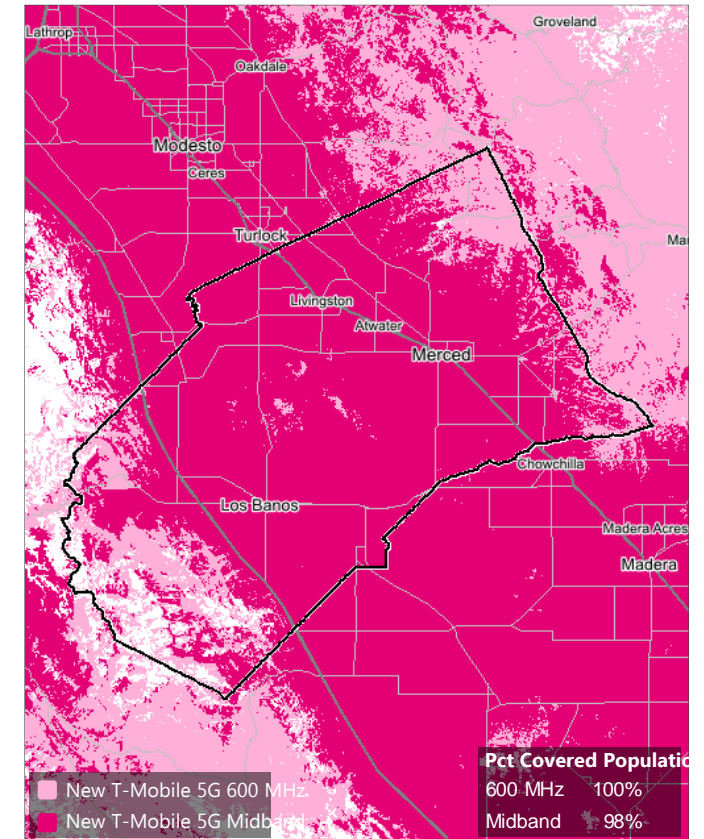
T-Mobile Standalone



Sprint Standalone

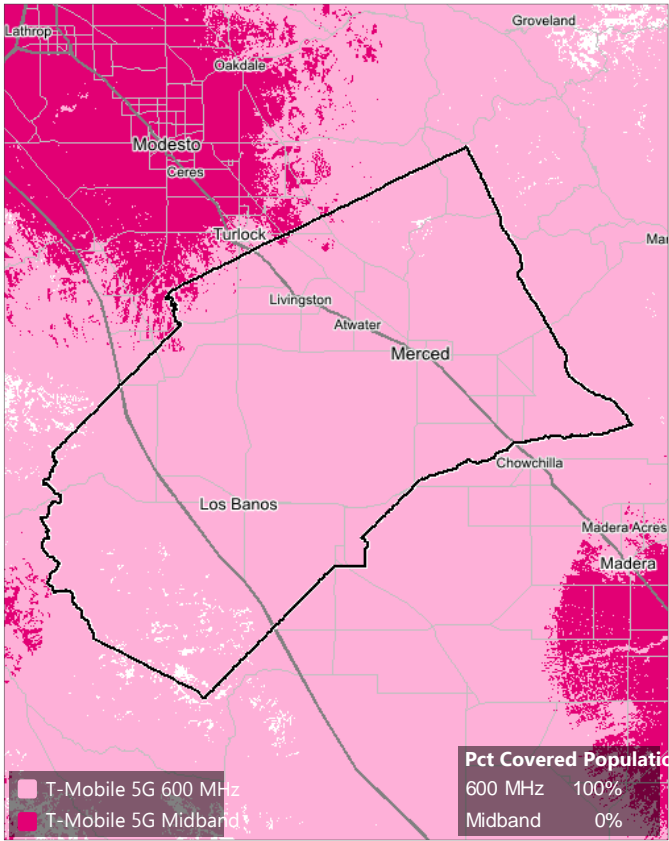


New T-Mobile

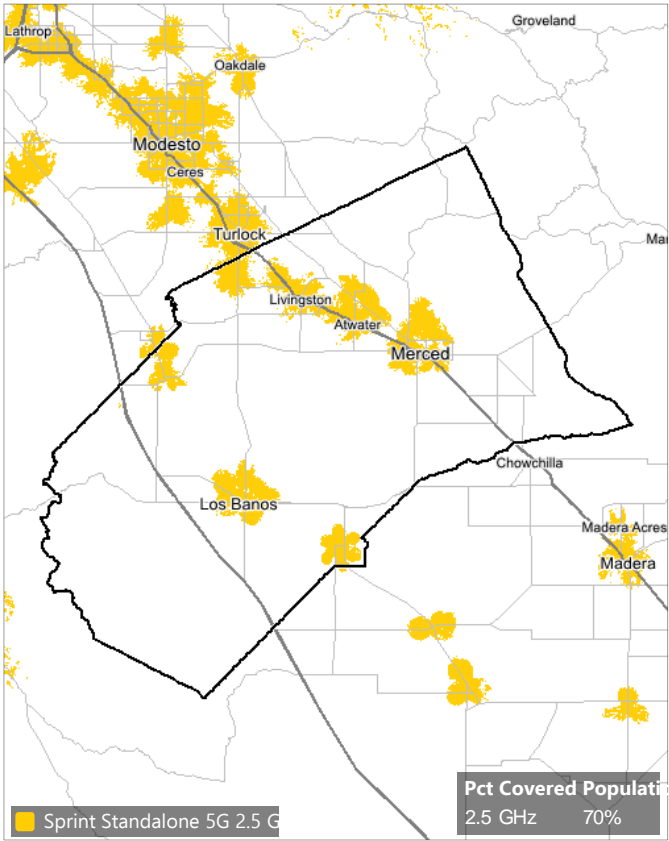


Projected 2024 5G Coverage: Merced County (06047)

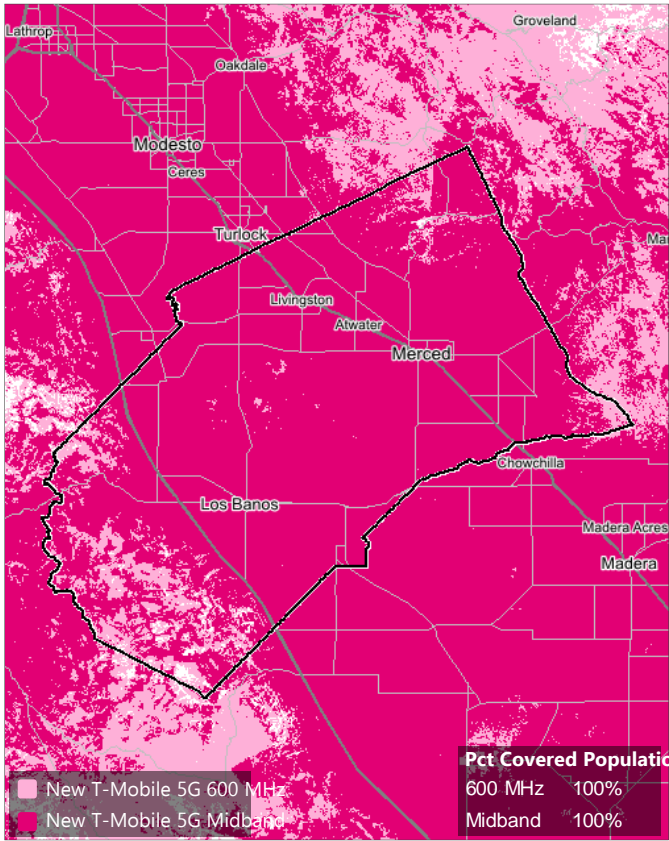
T-Mobile Standalone



Sprint Standalone

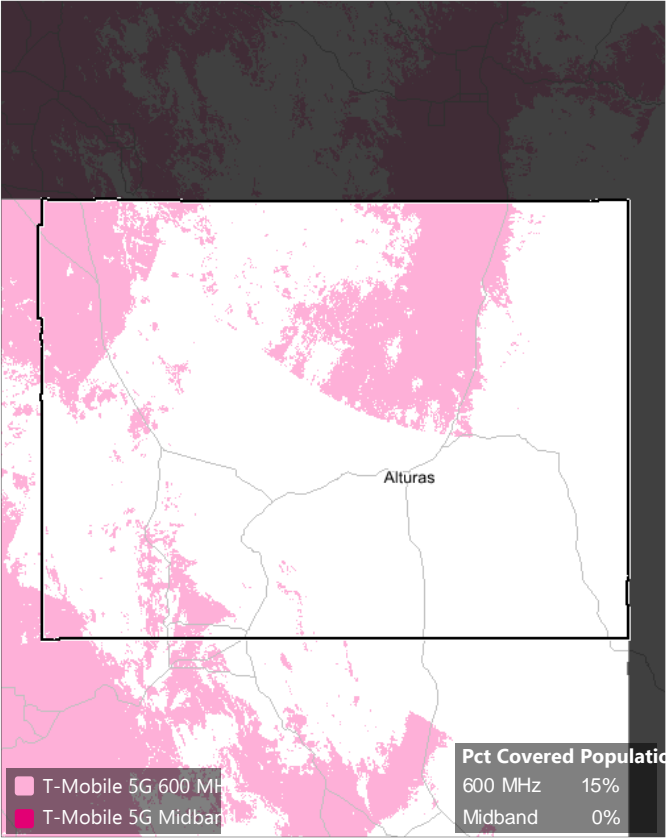


New T-Mobile



Projected 2021 5G Coverage: Modoc County (06049)

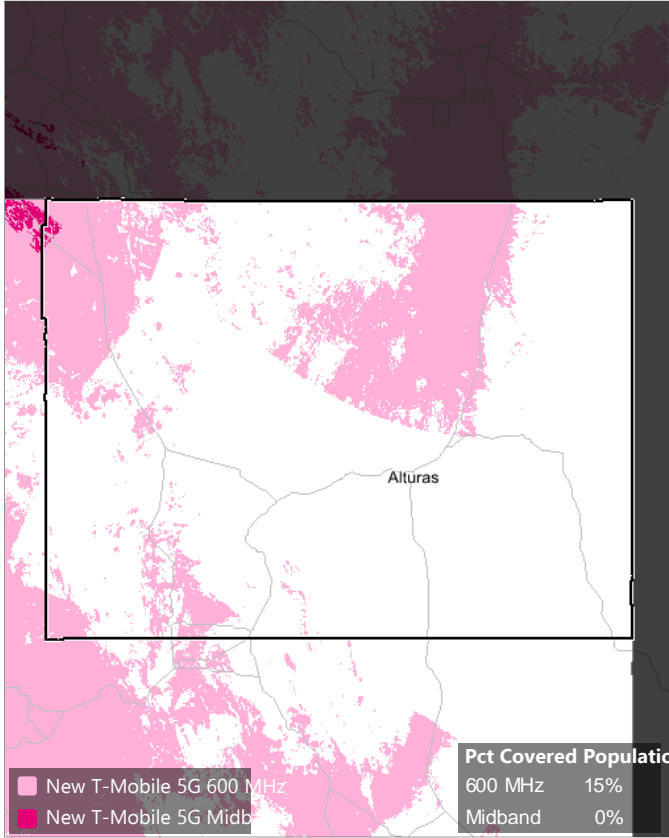
T-Mobile Standalone



Sprint Standalone

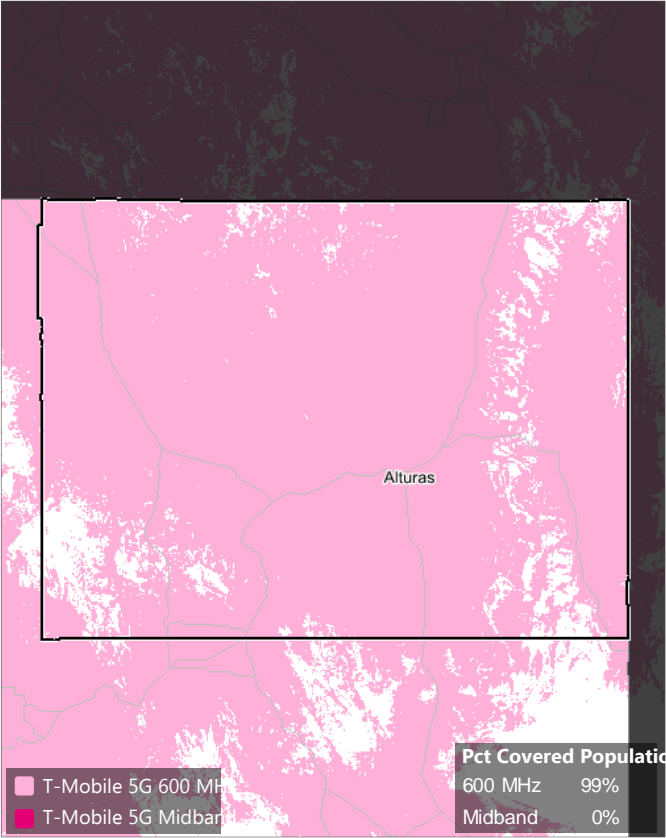


New T-Mobile



Projected 2024 5G Coverage: Modoc County (06049)

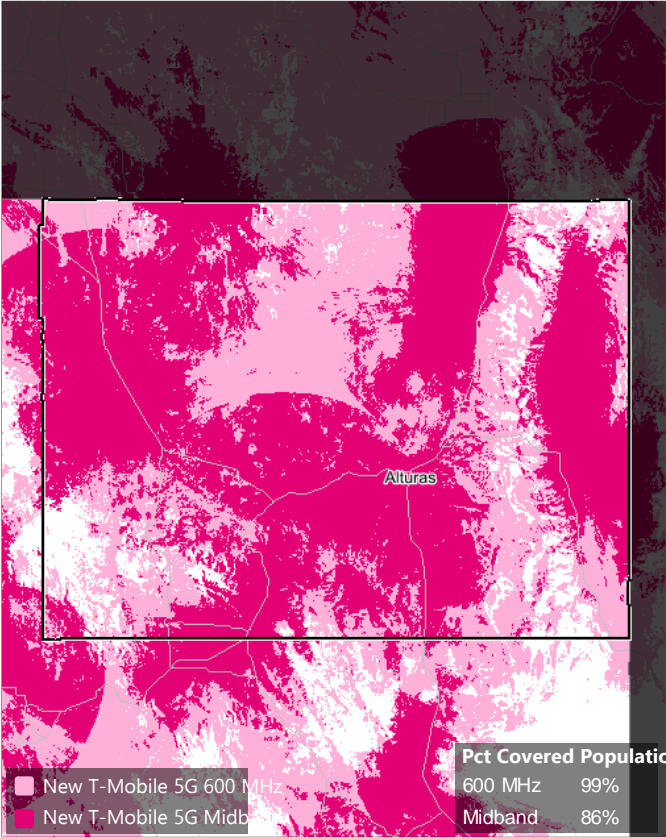
T-Mobile Standalone



Sprint Standalone

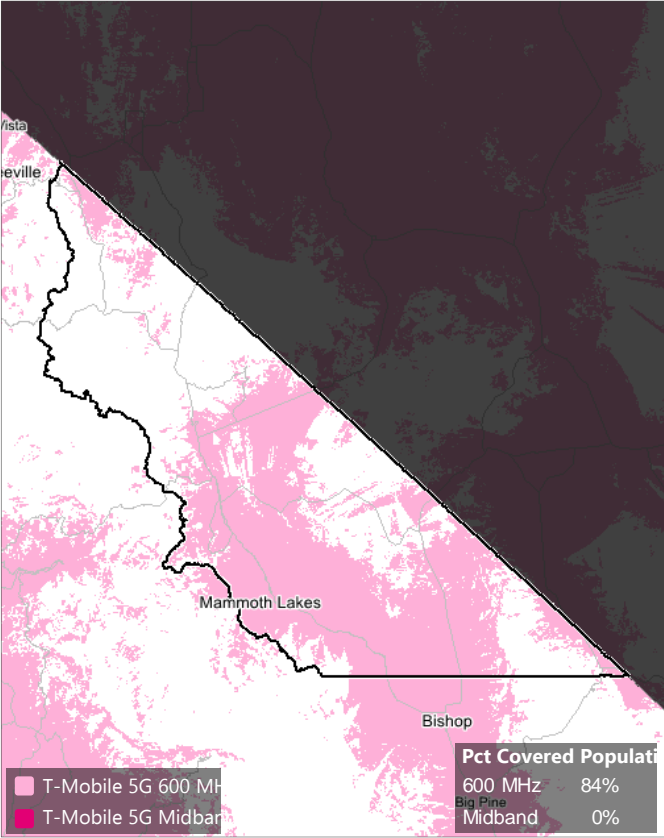


New T-Mobile

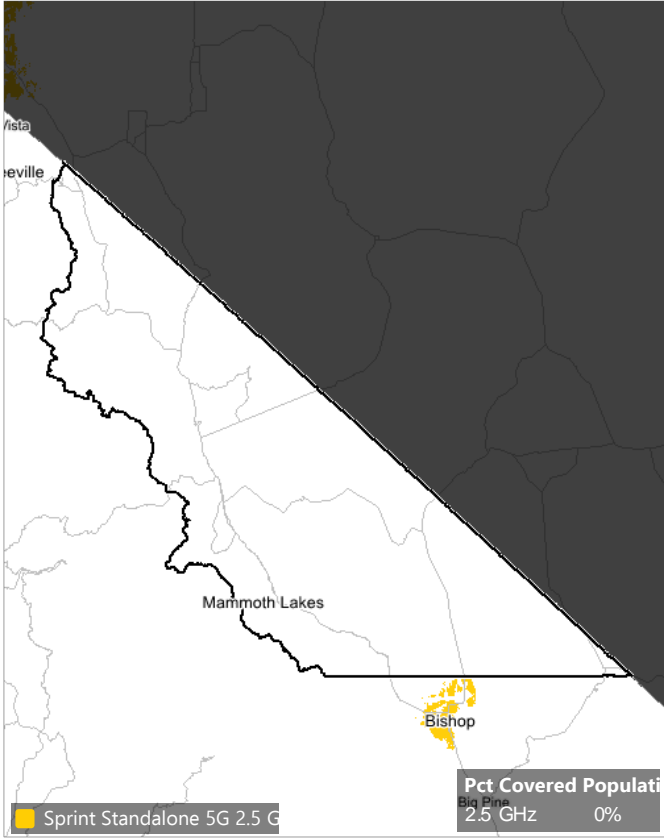


Projected 2021 5G Coverage: Mono County (06051)

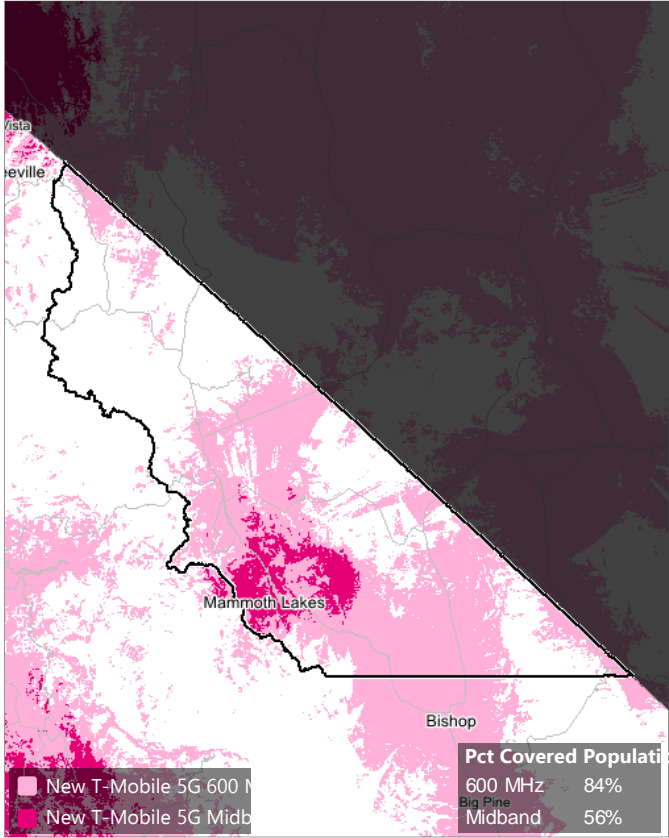
T-Mobile Standalone



Sprint Standalone

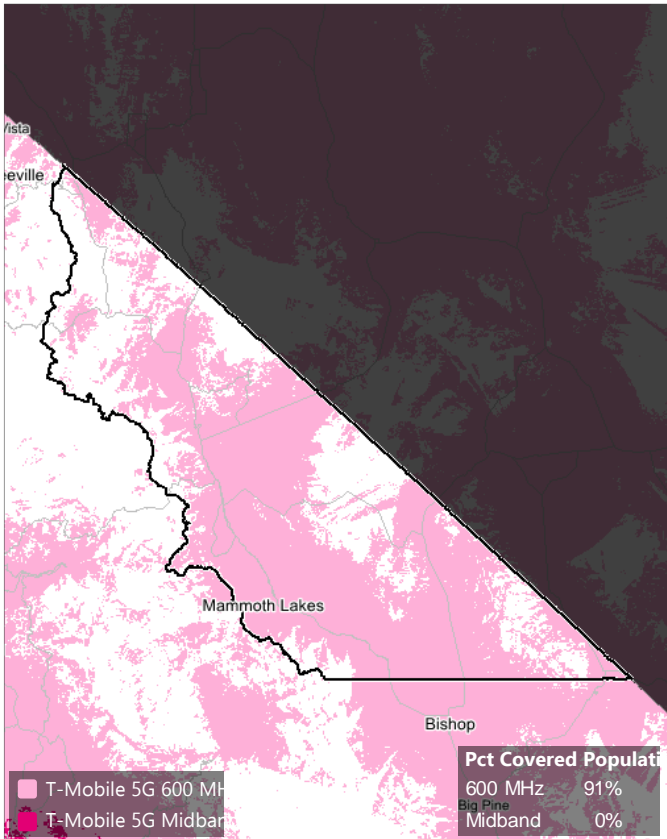


New T-Mobile

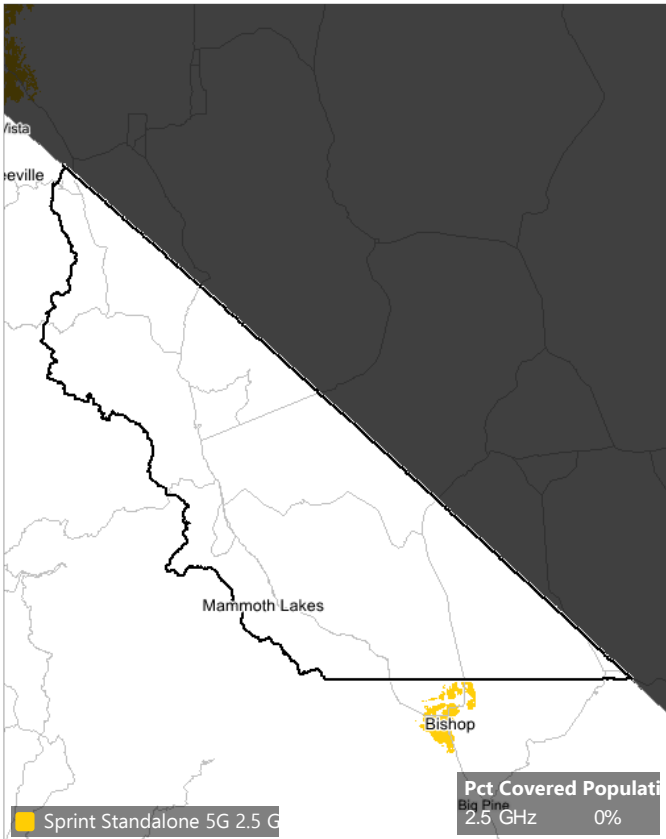


Projected 2024 5G Coverage: Mono County (06051)

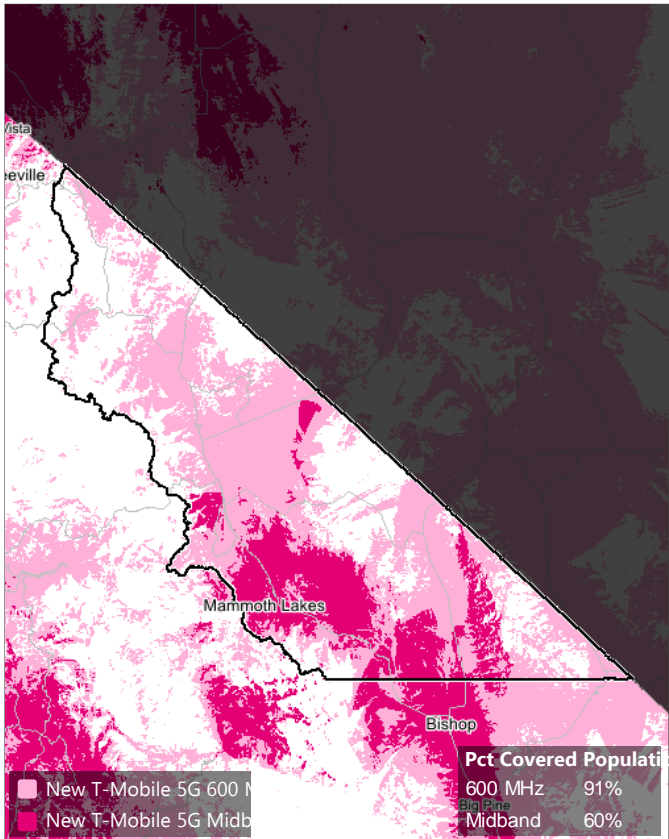
T-Mobile Standalone



Sprint Standalone

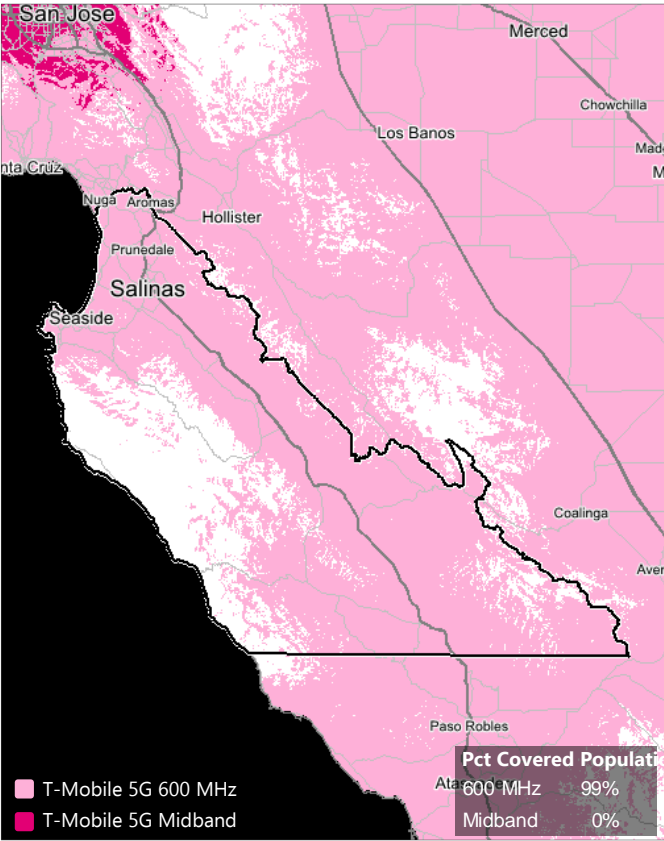


New T-Mobile

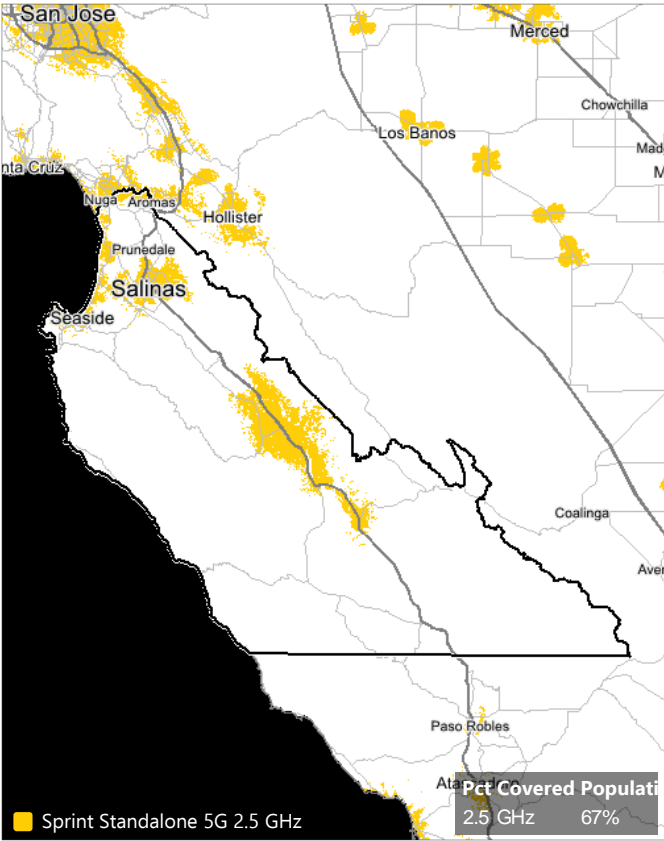


Projected 2021 5G Coverage: Monterey County (06053)

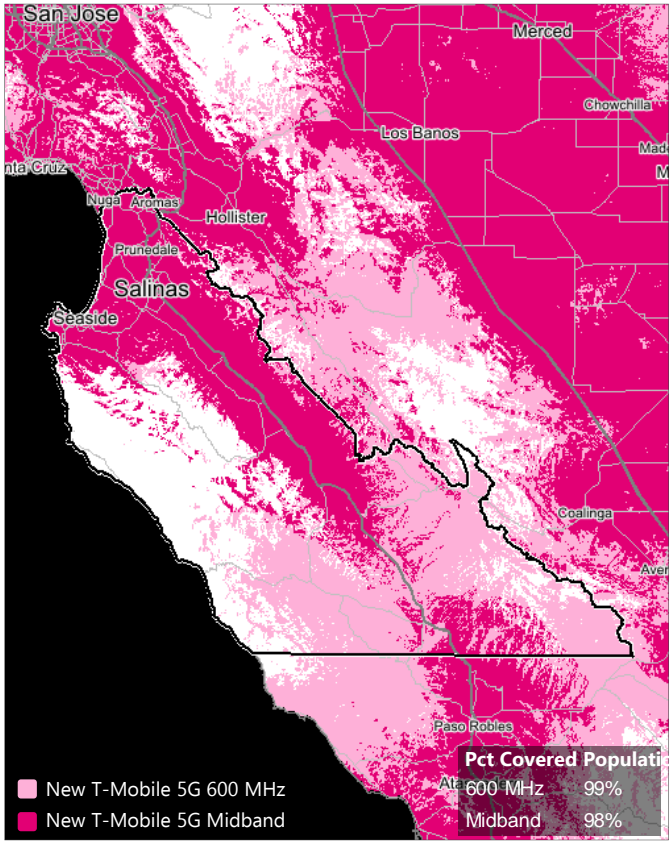
T-Mobile Standalone



Sprint Standalone

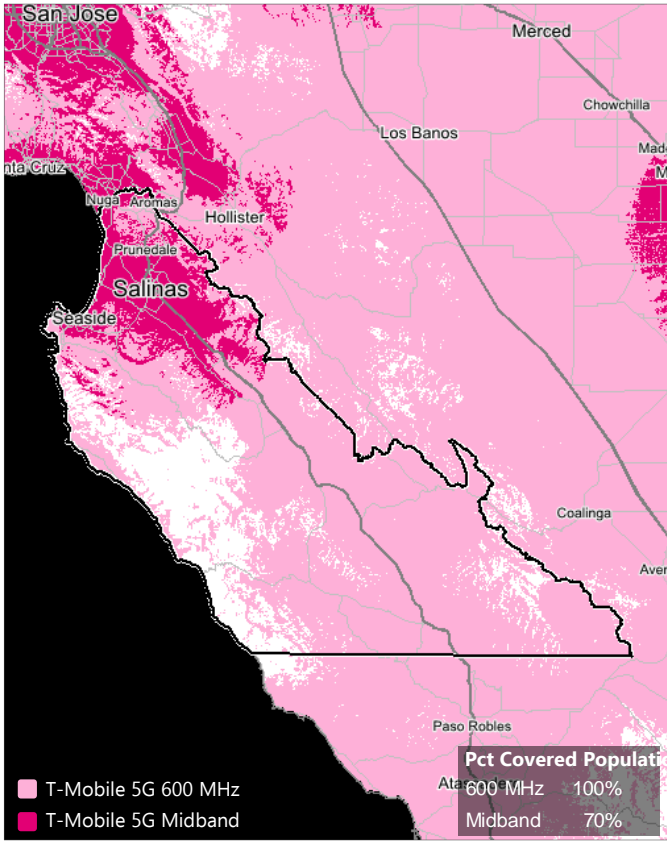


New T-Mobile

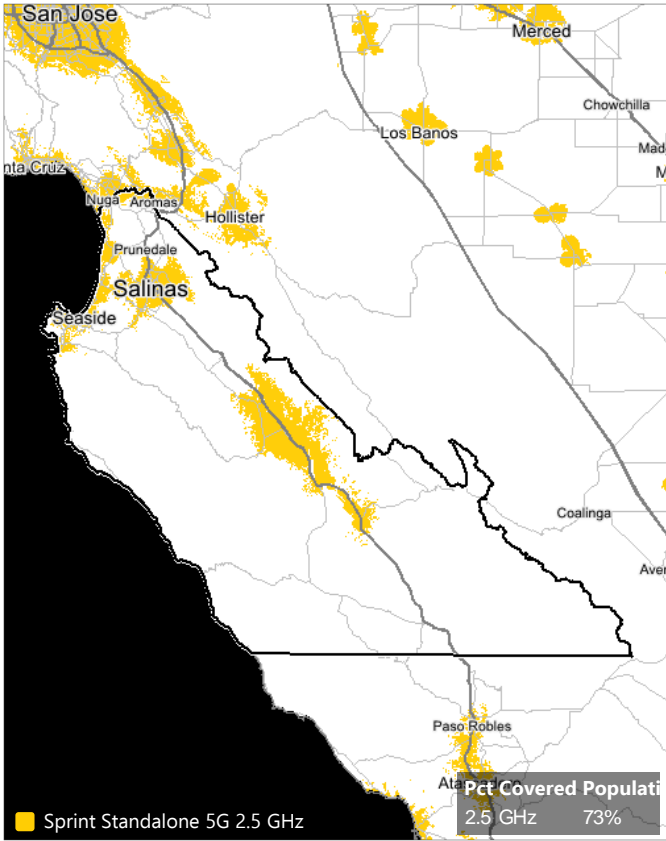


Projected 2024 5G Coverage: Monterey County (06053)

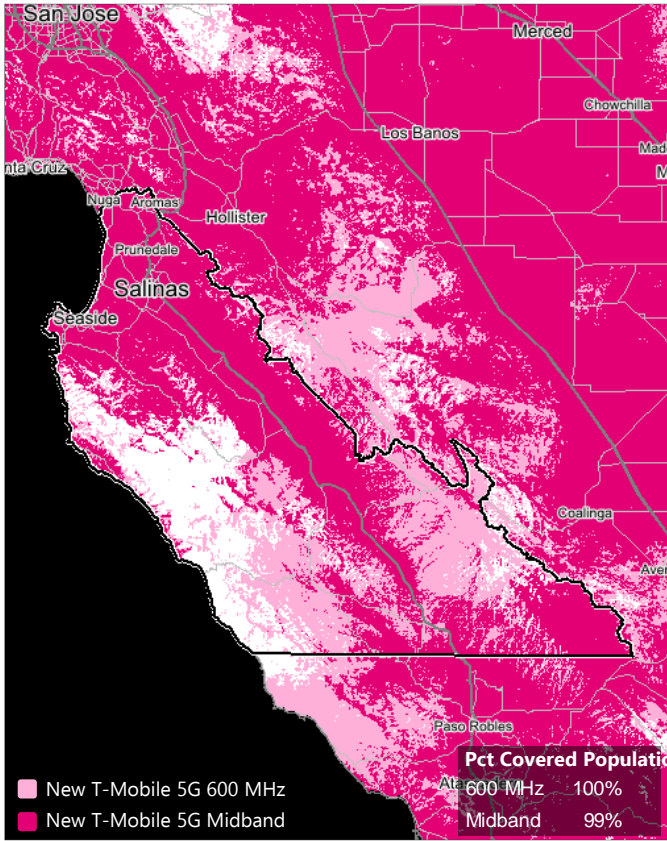
T-Mobile Standalone



Sprint Standalone

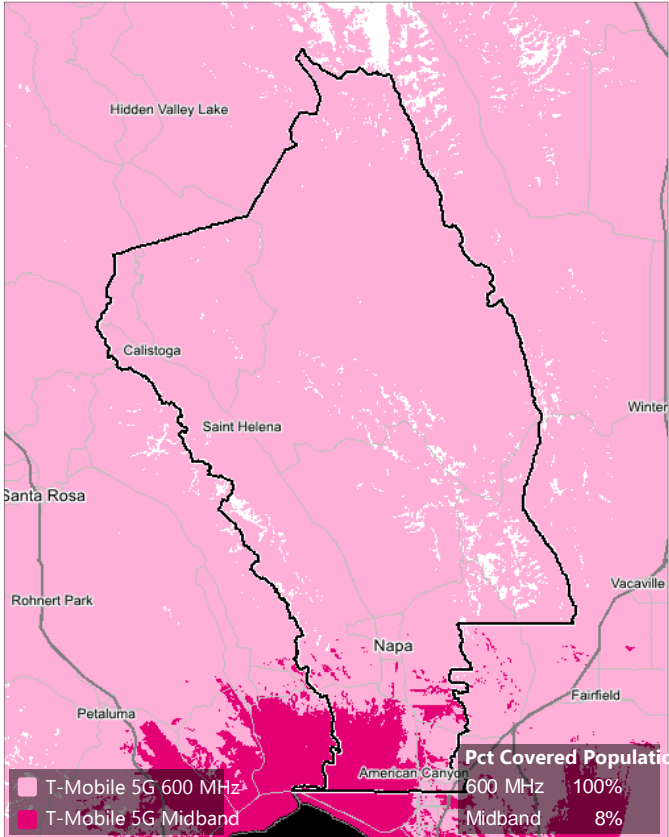


New T-Mobile

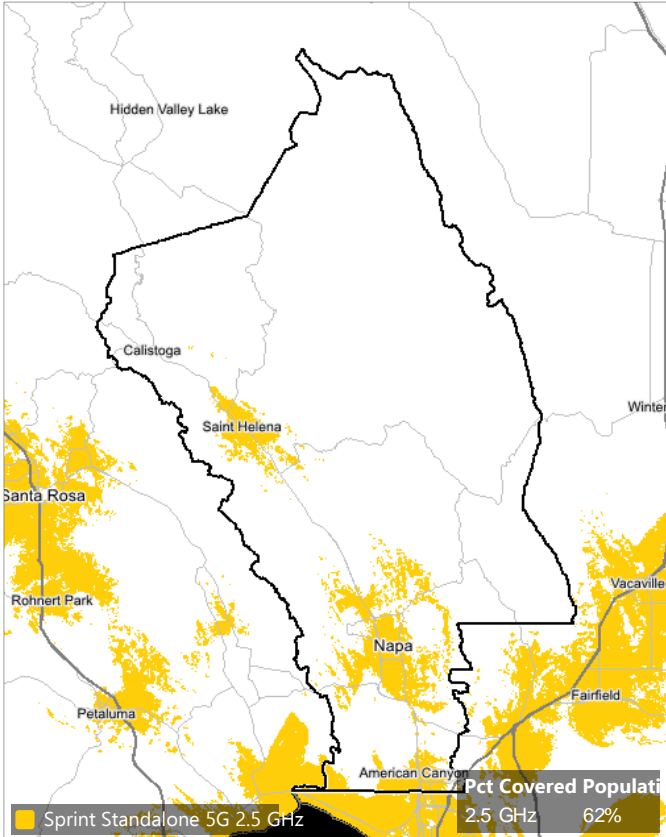


Projected 2021 5G Coverage: Napa County (06055)

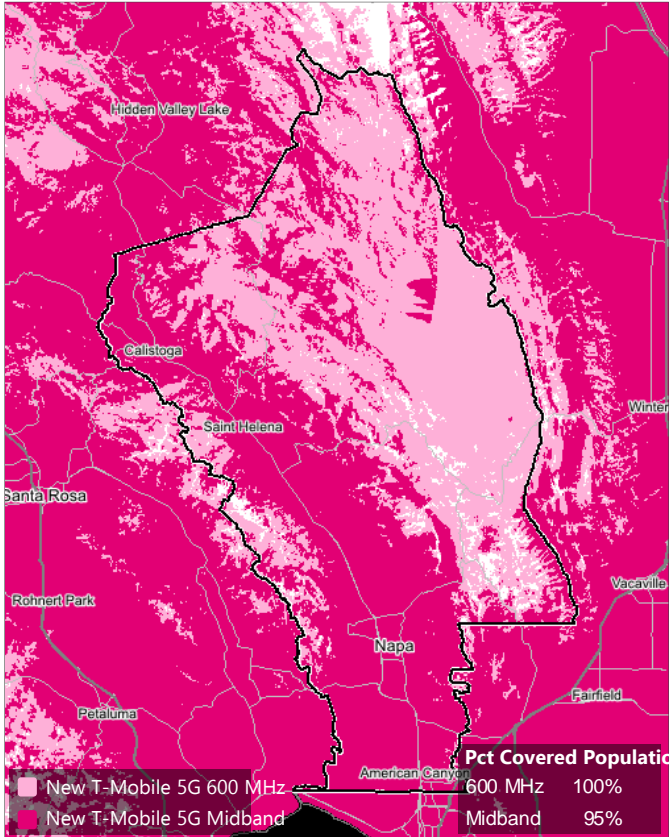
T-Mobile Standalone



Sprint Standalone

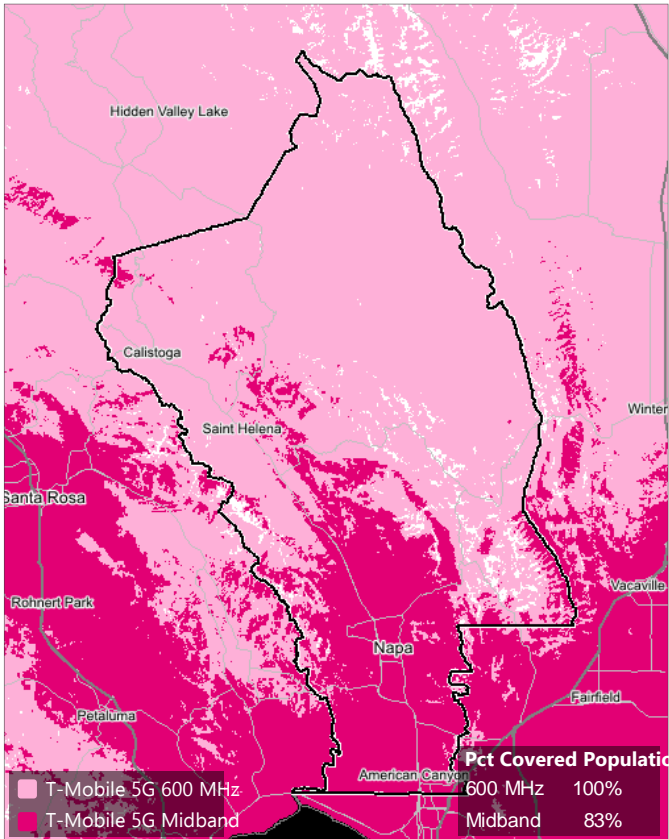


New T-Mobile

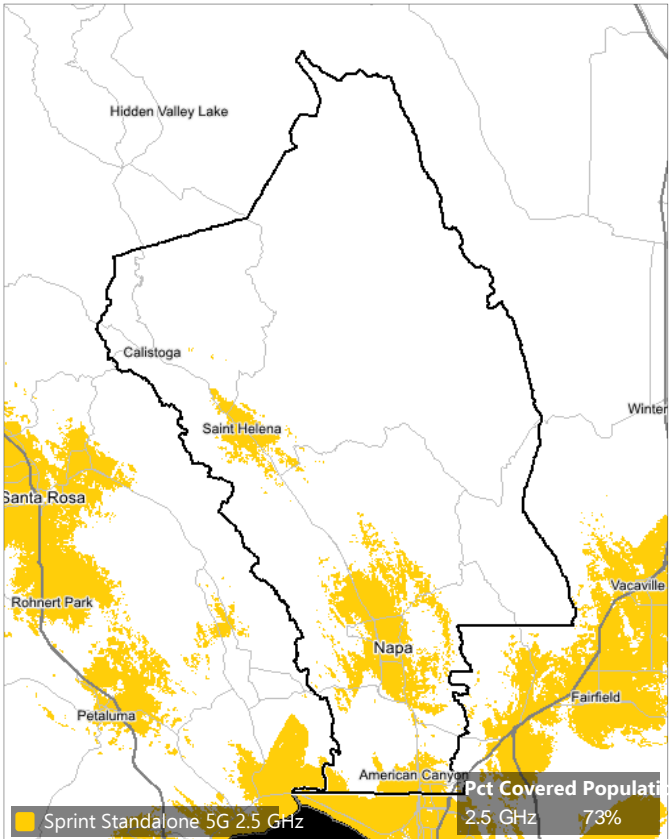


Projected 2024 5G Coverage: Napa County (06055)

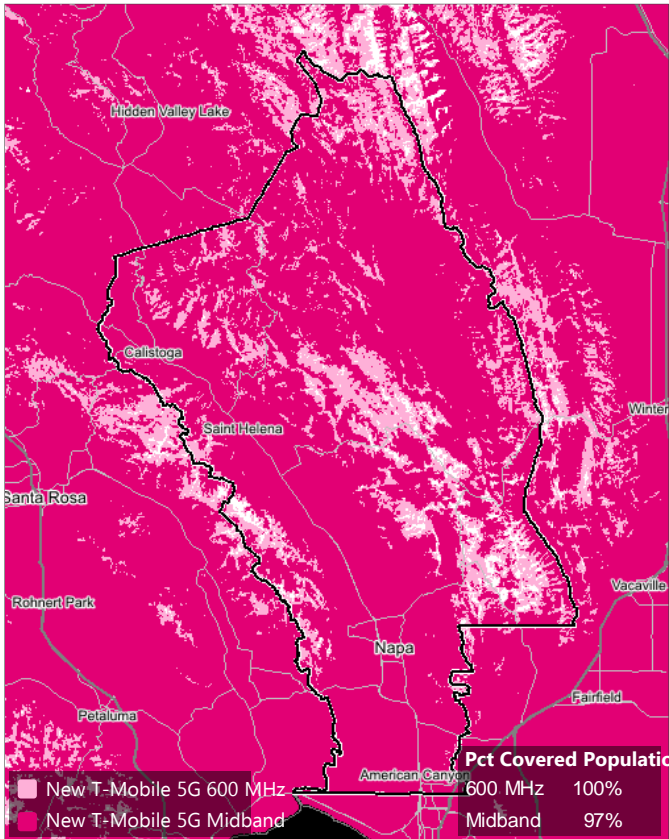
T-Mobile Standalone



Sprint Standalone

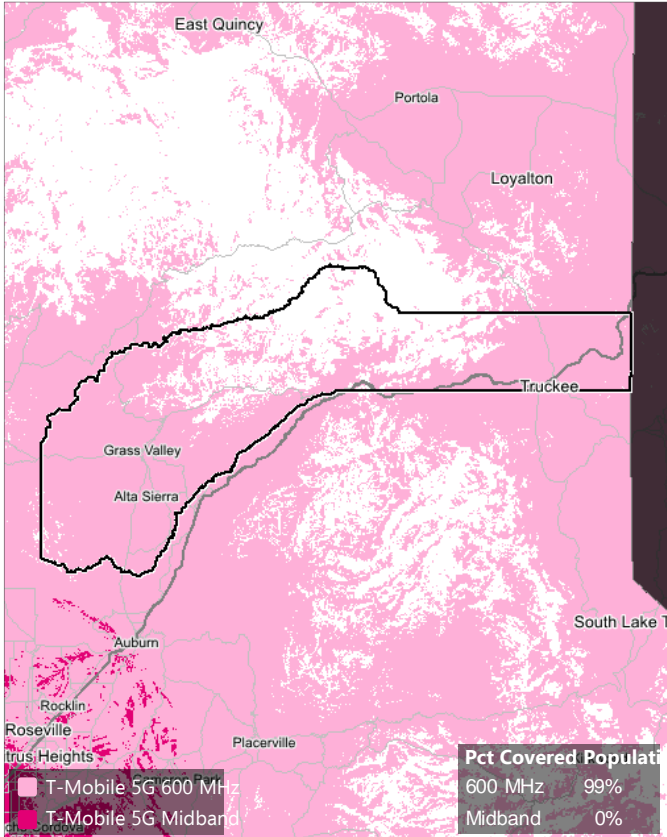


New T-Mobile

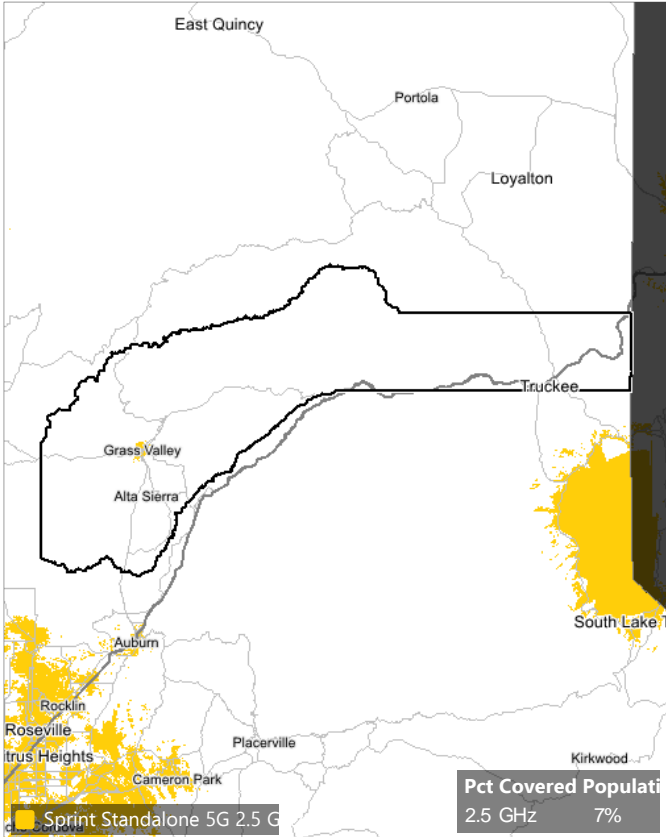


Projected 2021 5G Coverage: Nevada County (06057)

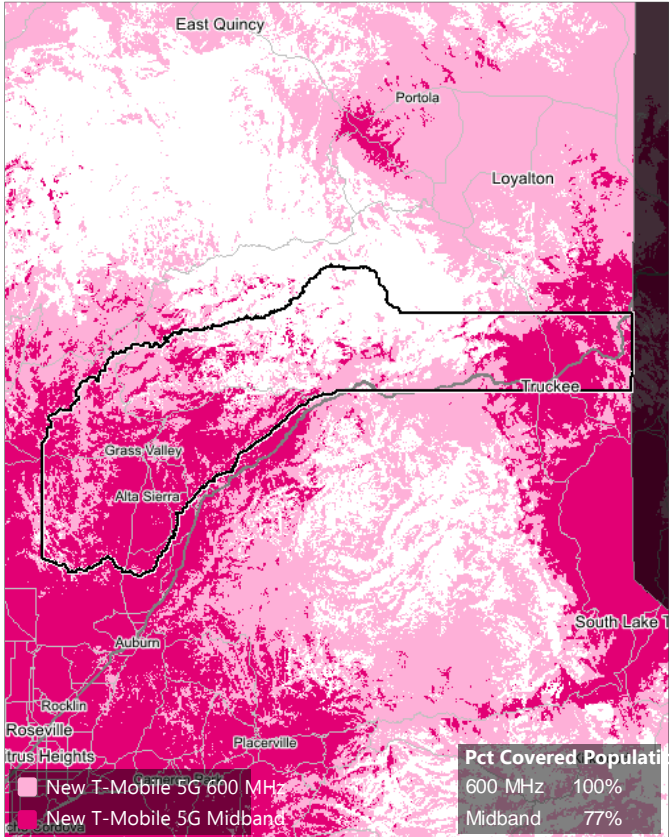
T-Mobile Standalone



Sprint Standalone

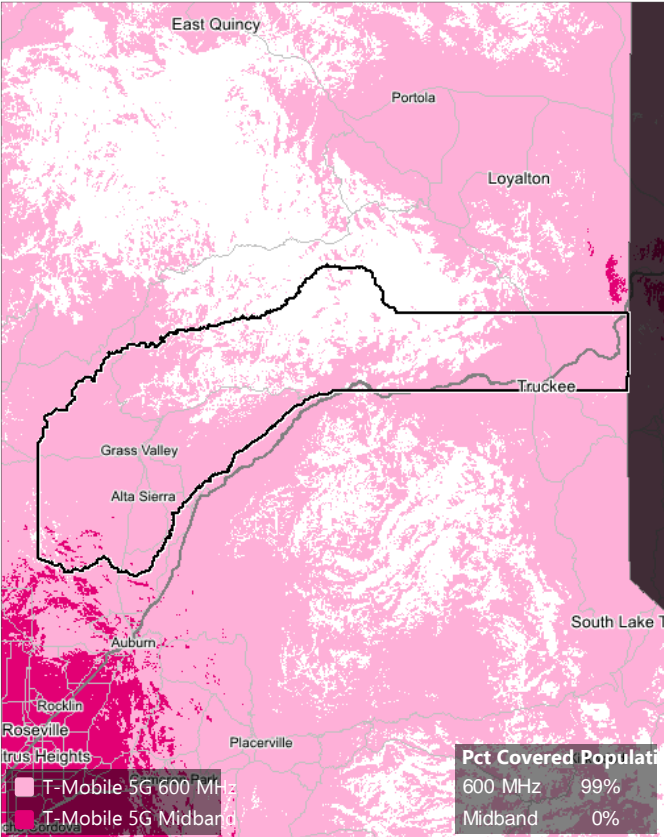


New T-Mobile

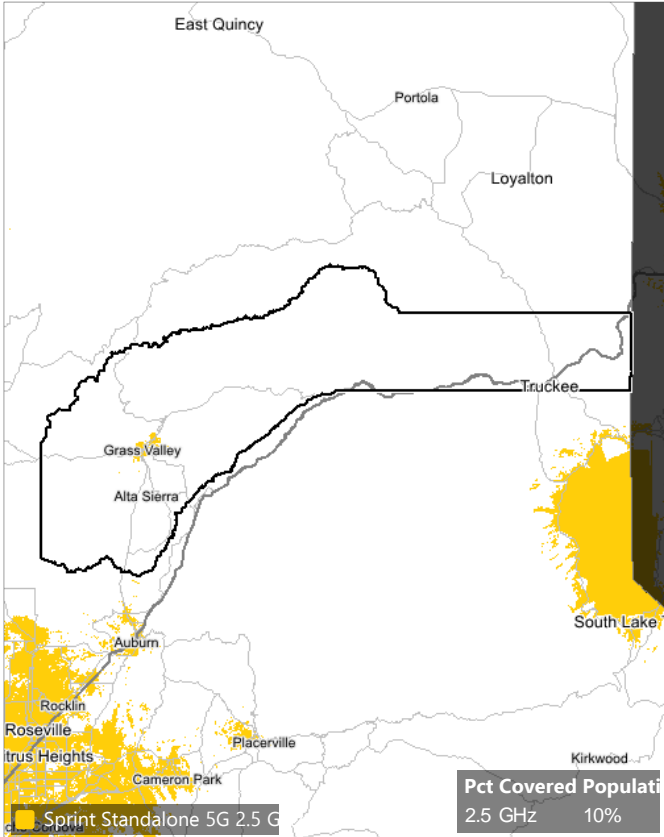


Projected 2024 5G Coverage: Nevada County (06057)

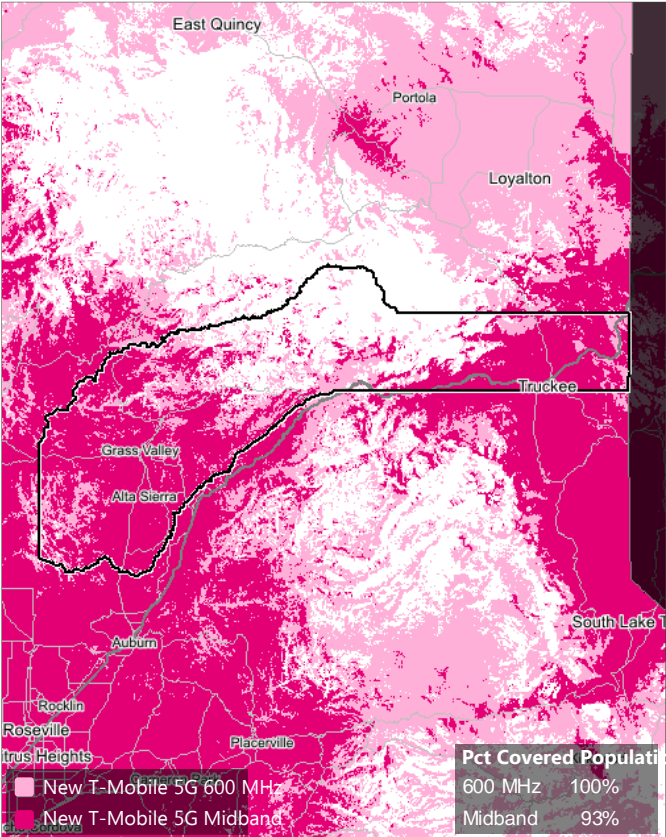
T-Mobile Standalone



Sprint Standalone

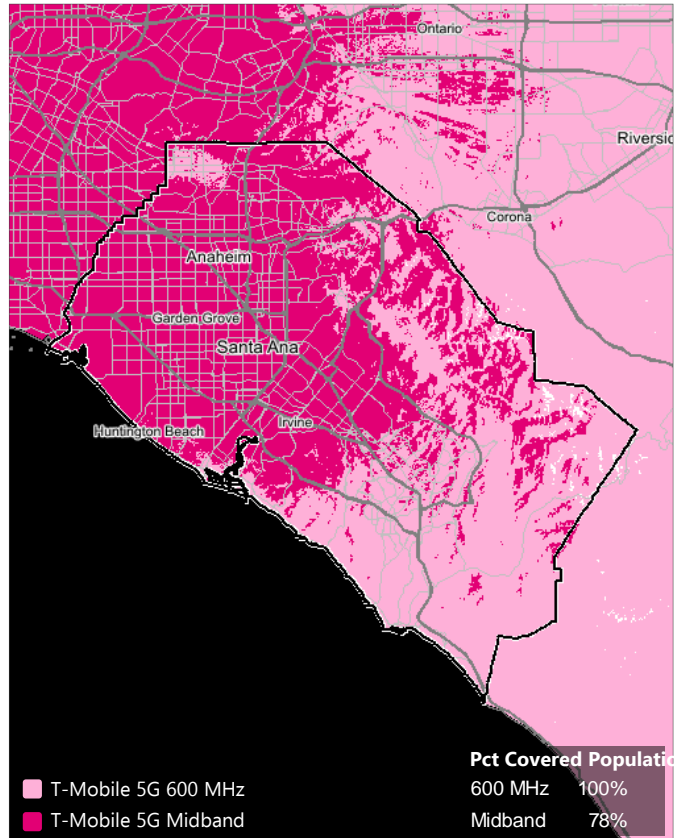


New T-Mobile

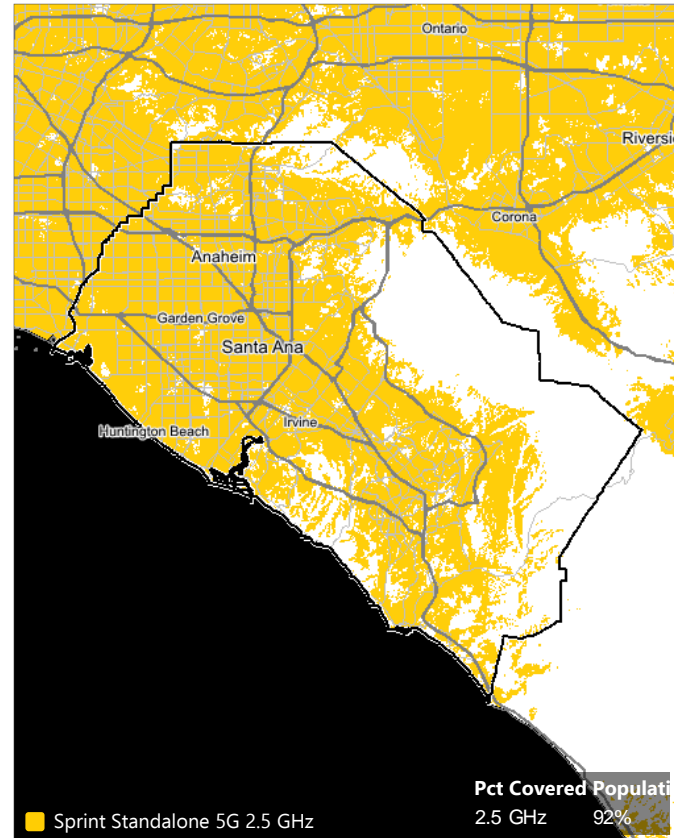


Projected 2021 5G Coverage: Orange County (06059)

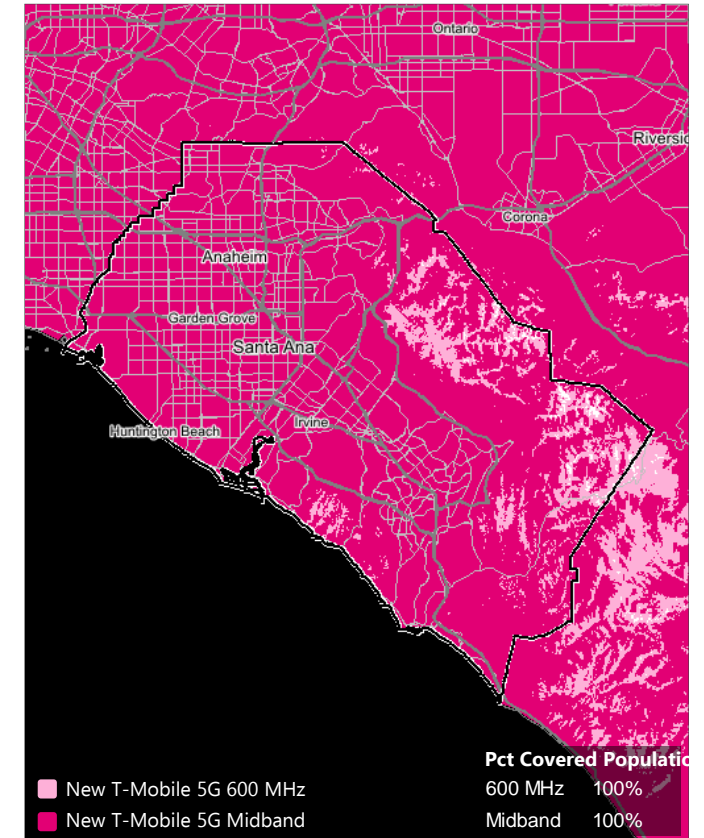
T-Mobile Standalone



Sprint Standalone

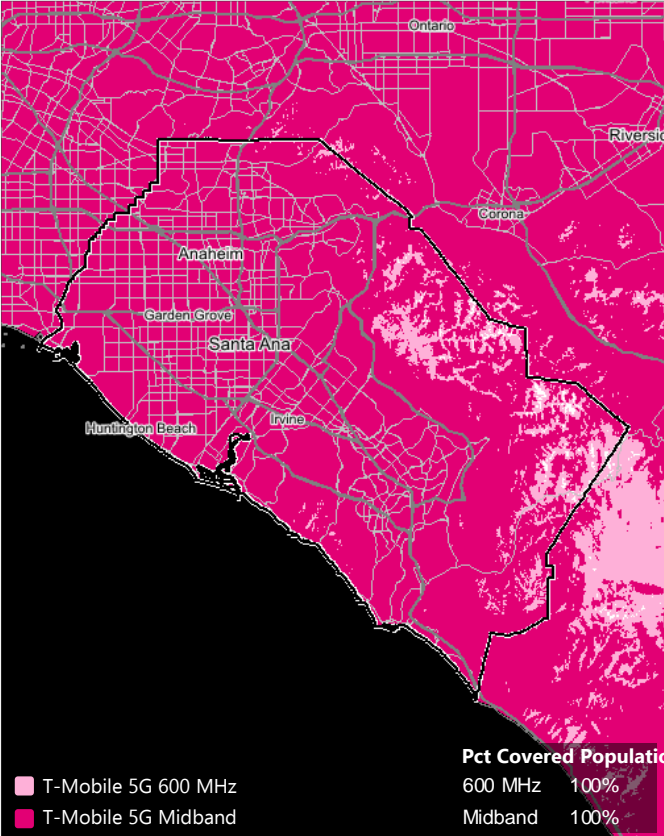


New T-Mobile

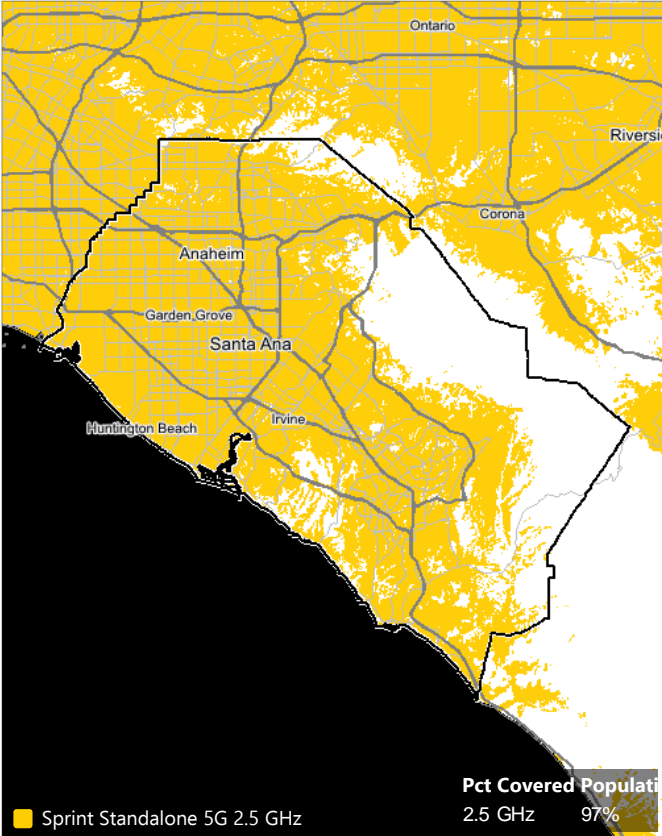


Projected 2024 5G Coverage: Orange County (06059)

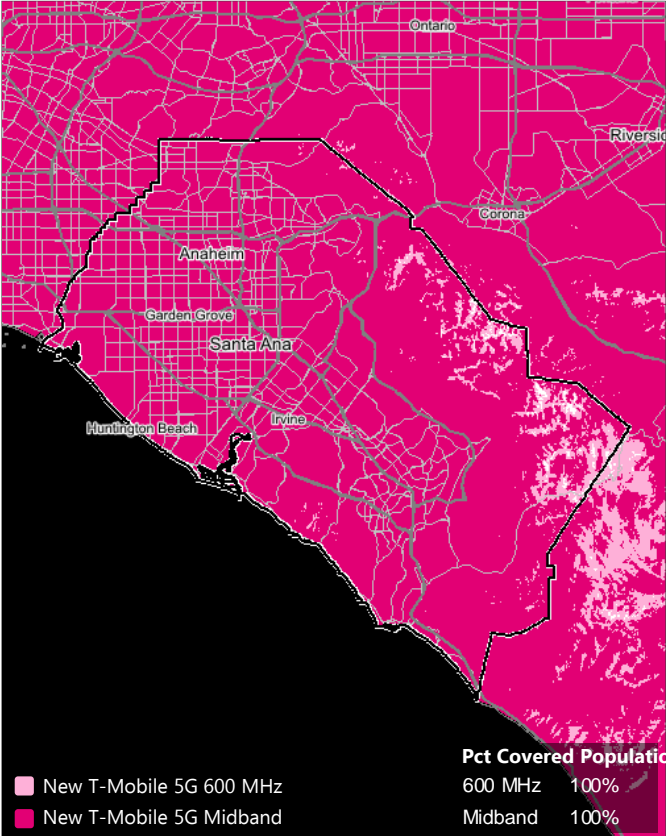
T-Mobile Standalone



Sprint Standalone

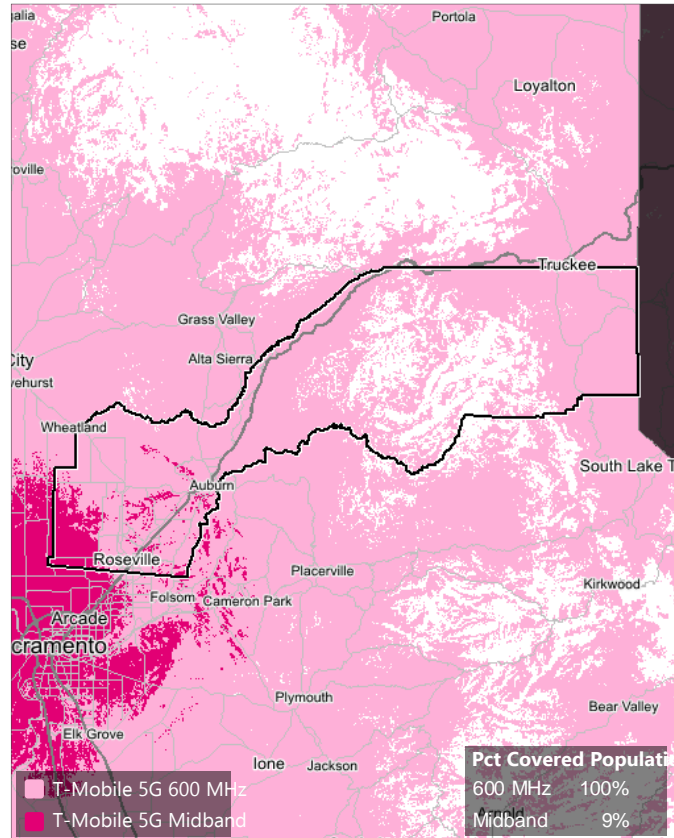


New T-Mobile

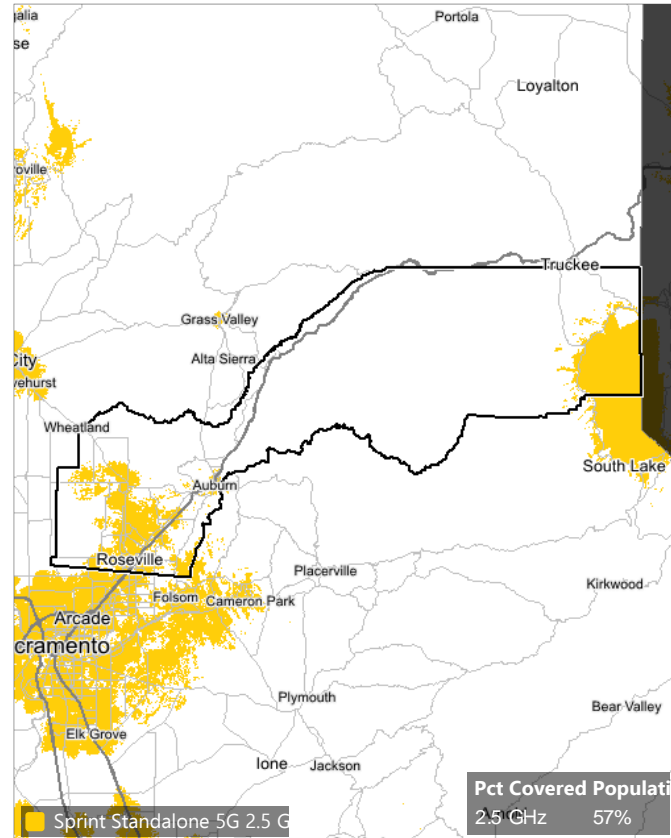


Projected 2021 5G Coverage: Placer County (06061)

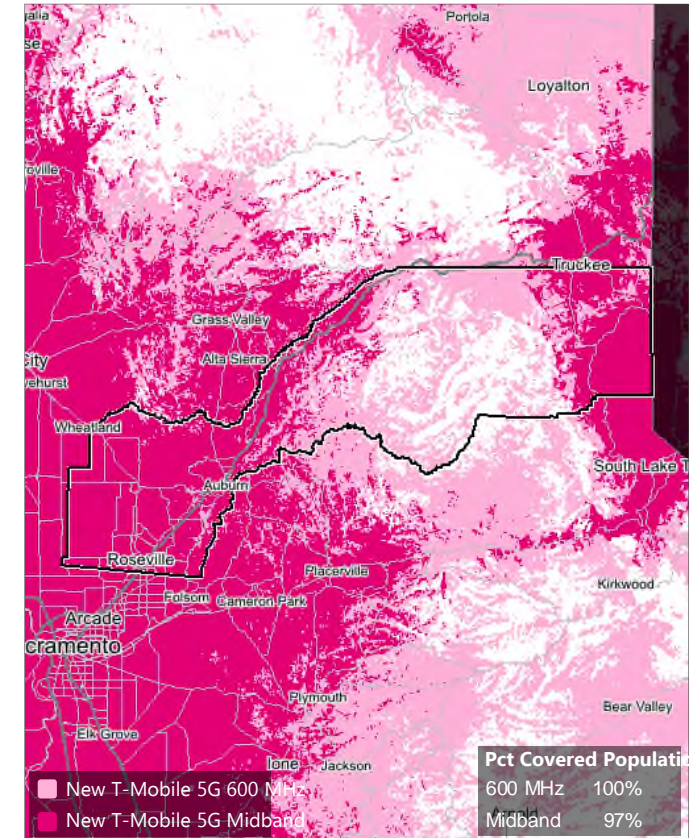
T-Mobile Standalone



Sprint Standalone

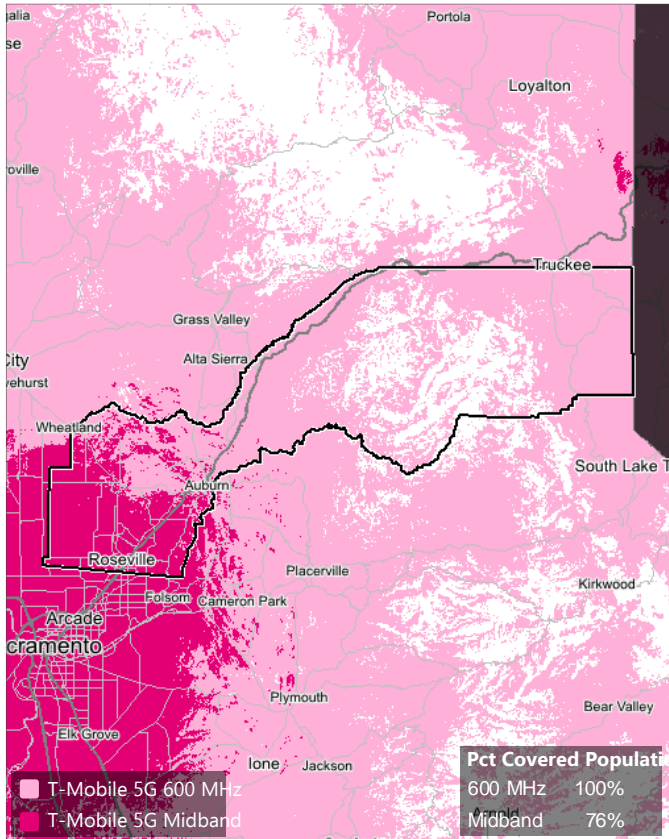


New T-Mobile

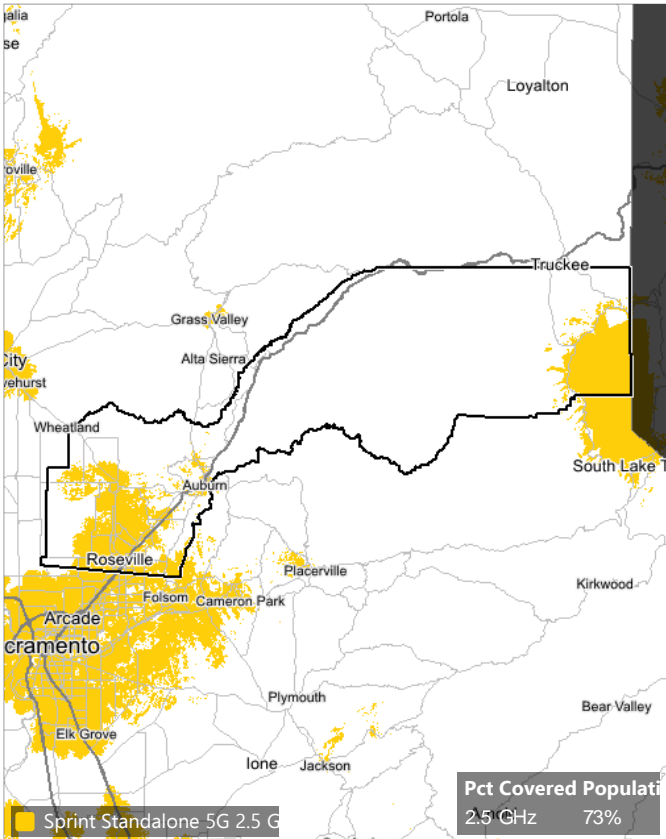


Projected 2024 5G Coverage: Placer County (06061)

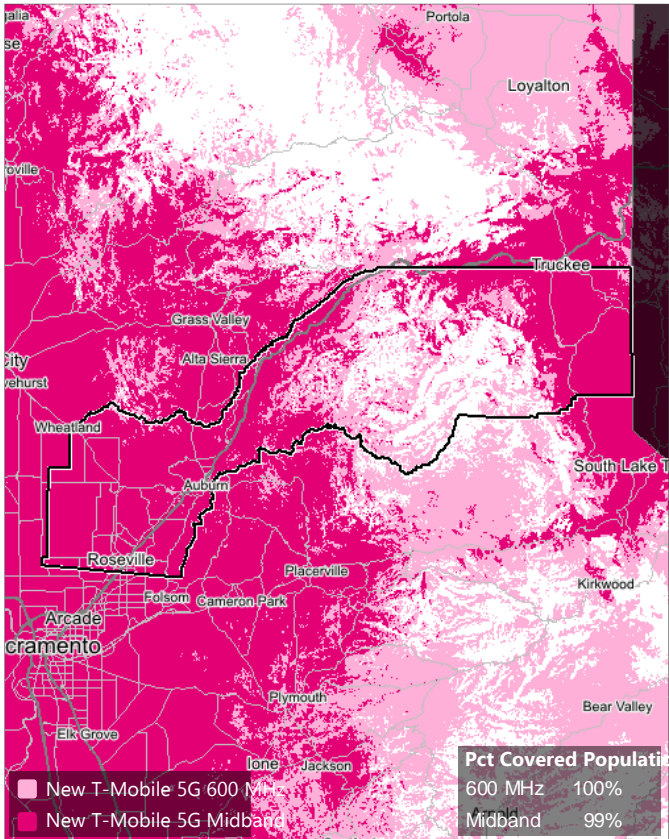
T-Mobile Standalone



Sprint Standalone

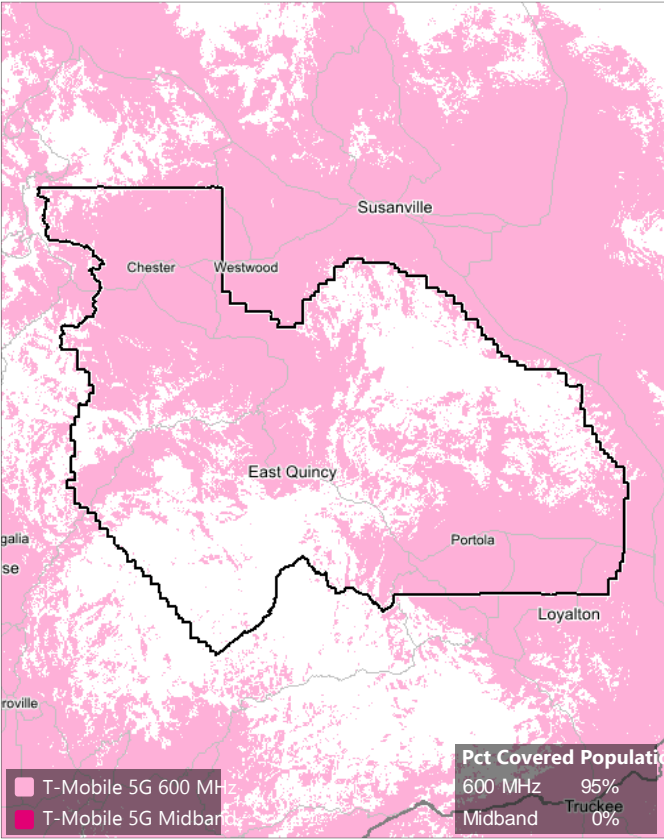


New T-Mobile

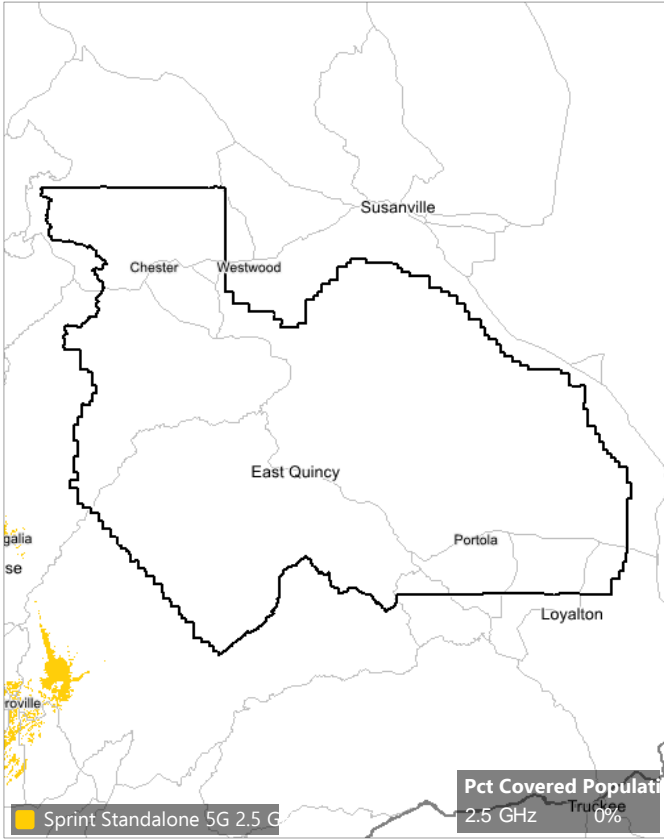


Projected 2021 5G Coverage: Plumas County (06063)

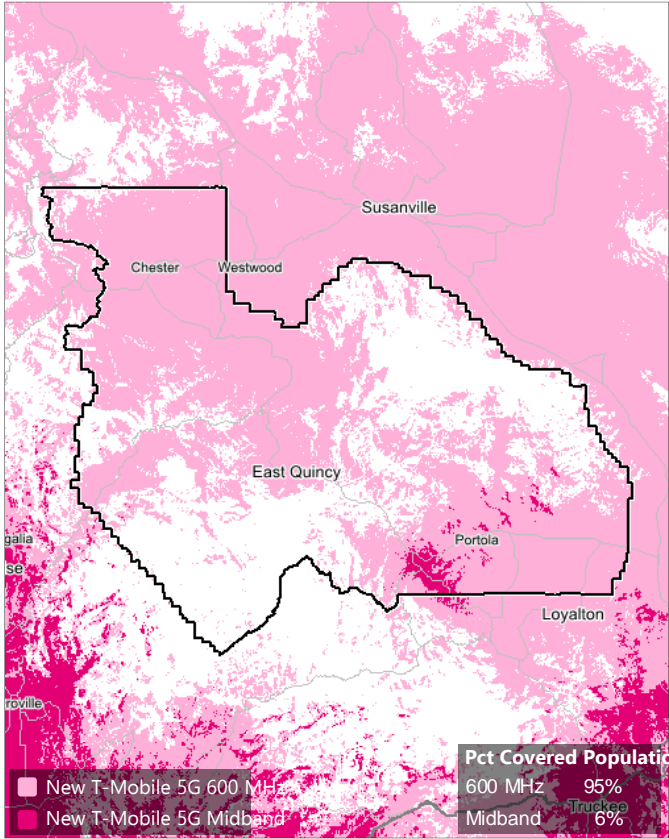
T-Mobile Standalone



Sprint Standalone

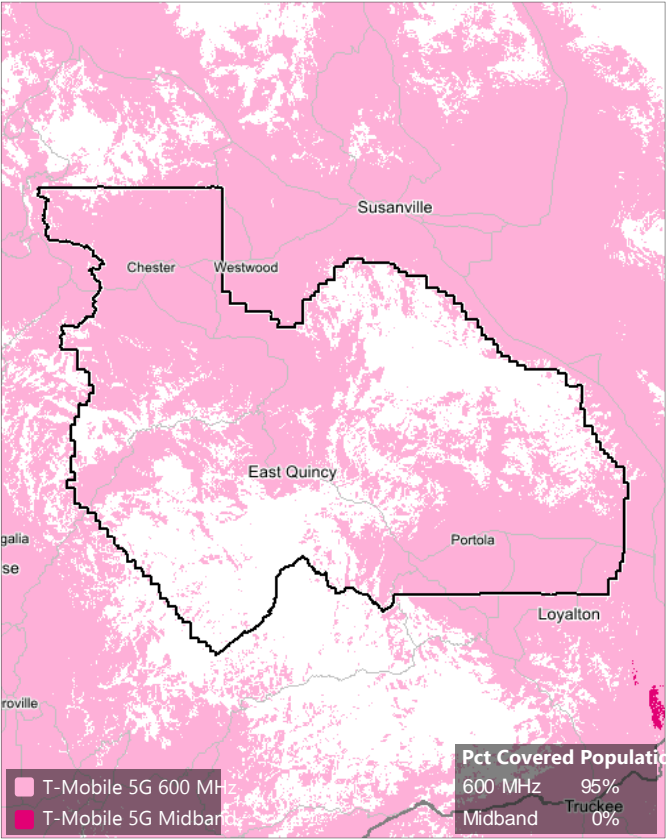


New T-Mobile

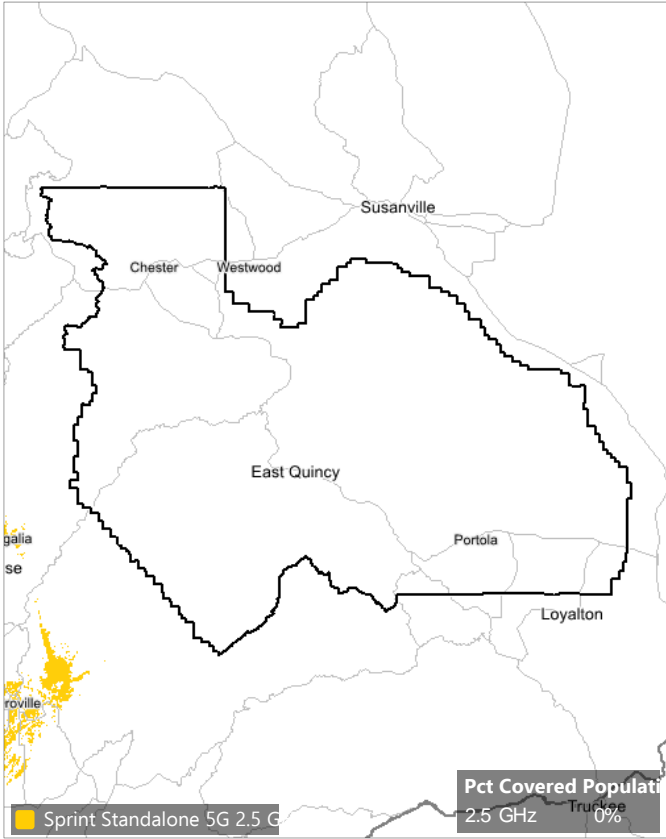


Projected 2024 5G Coverage: Plumas County (06063)

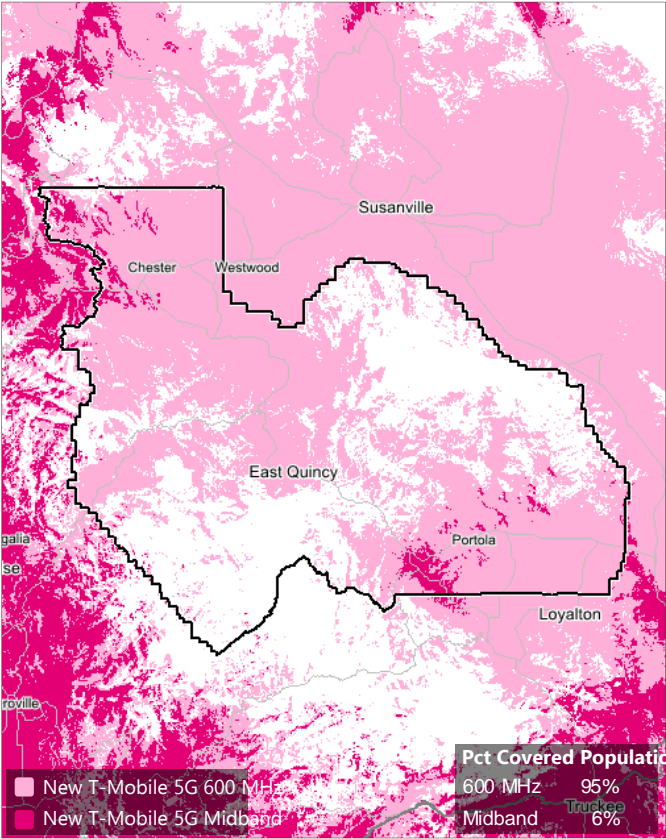
T-Mobile Standalone



Sprint Standalone

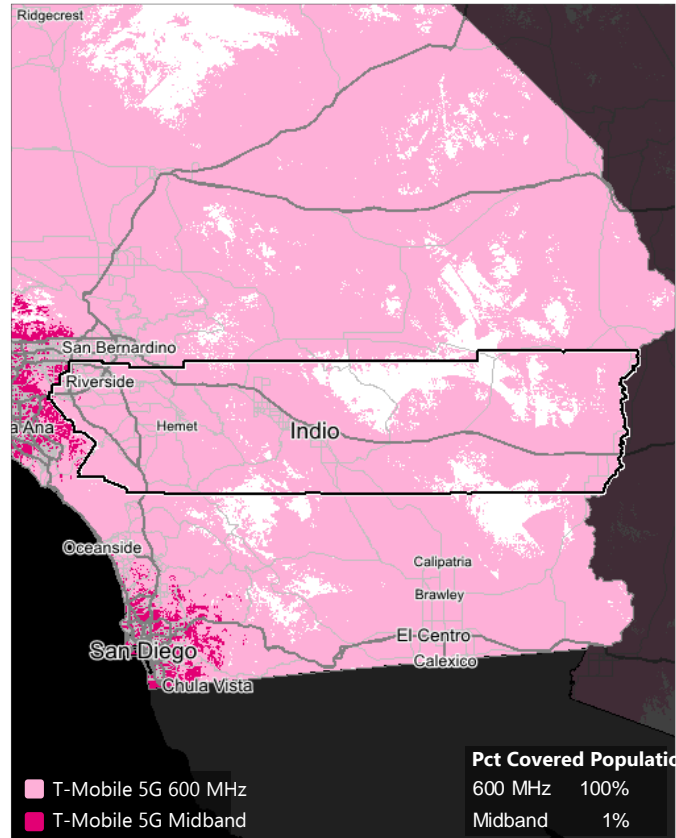


New T-Mobile

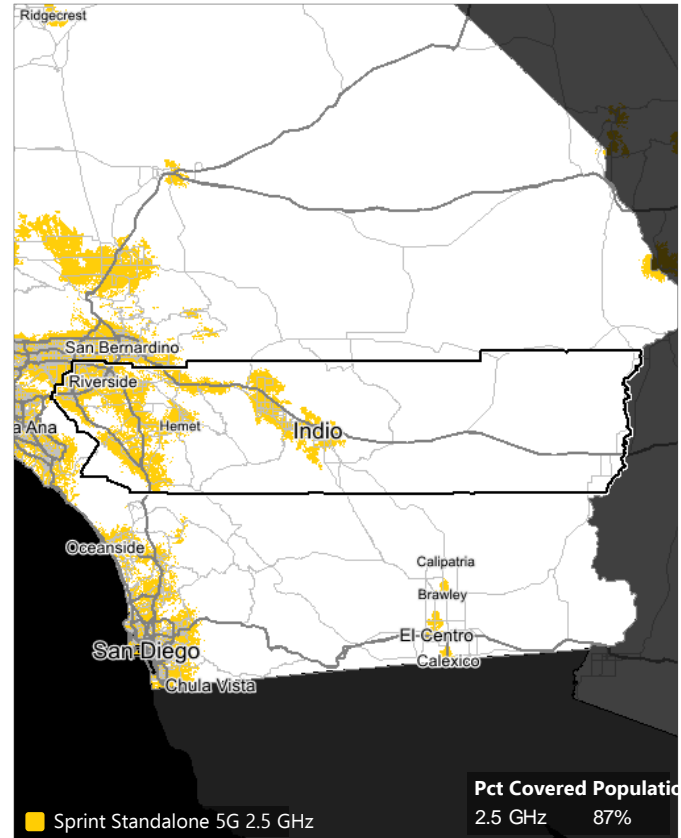


Projected 2021 5G Coverage: Riverside County (06065)

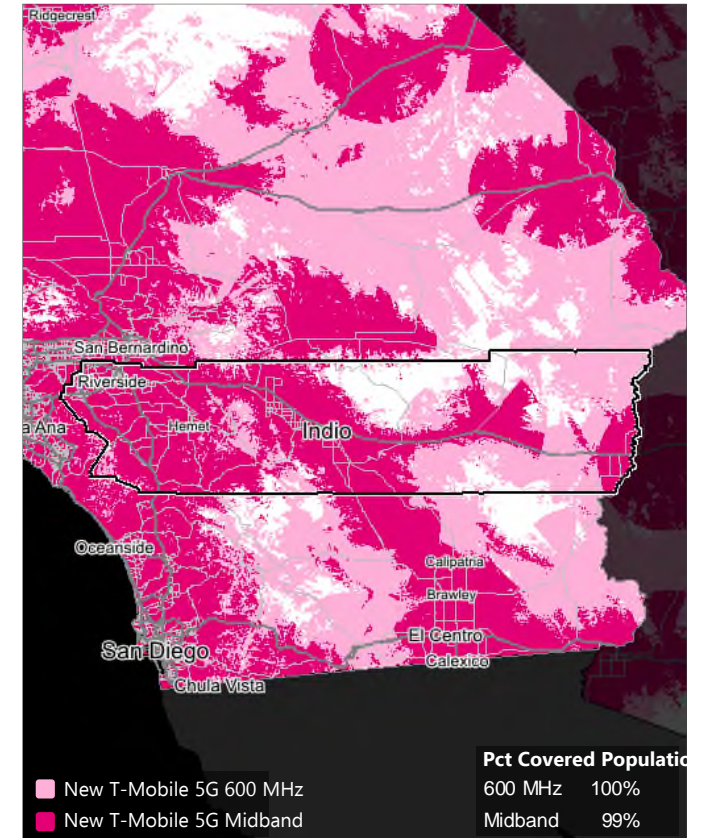
T-Mobile Standalone



Sprint Standalone

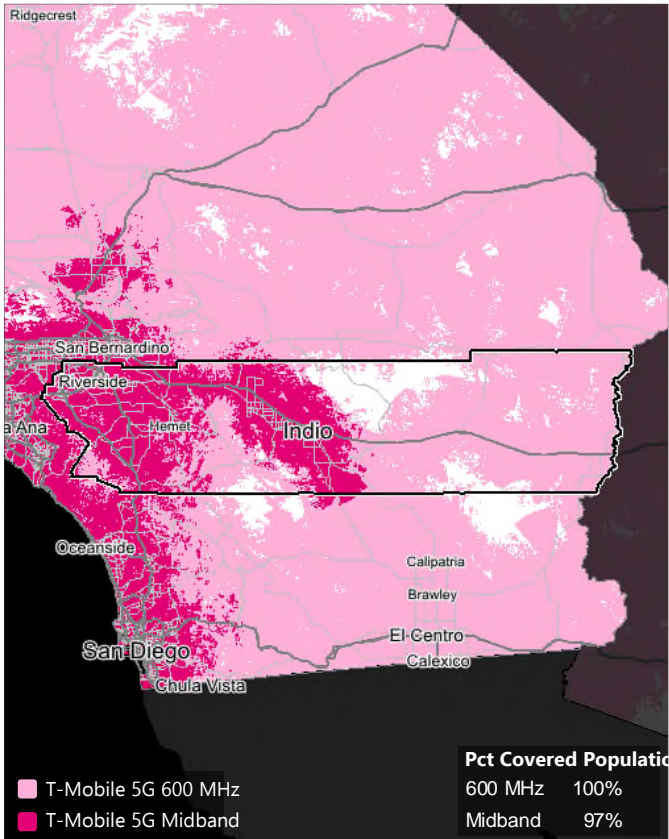


New T-Mobile

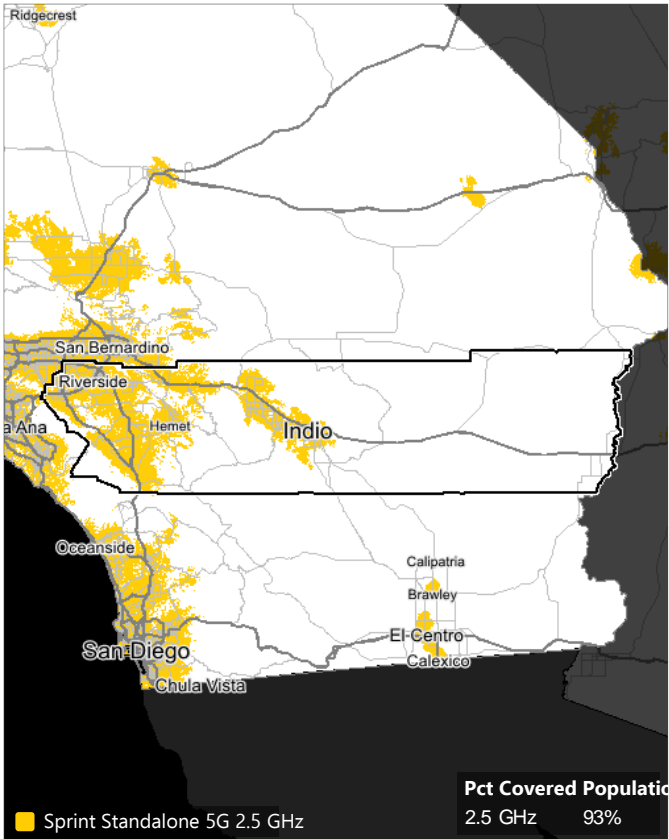


Projected 2024 5G Coverage: Riverside County (06065)

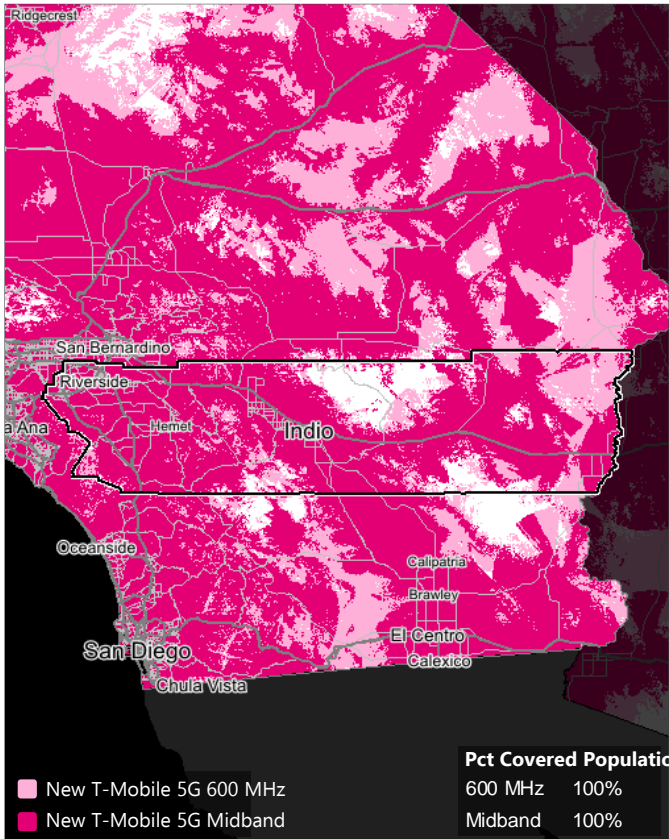
T-Mobile Standalone



Sprint Standalone

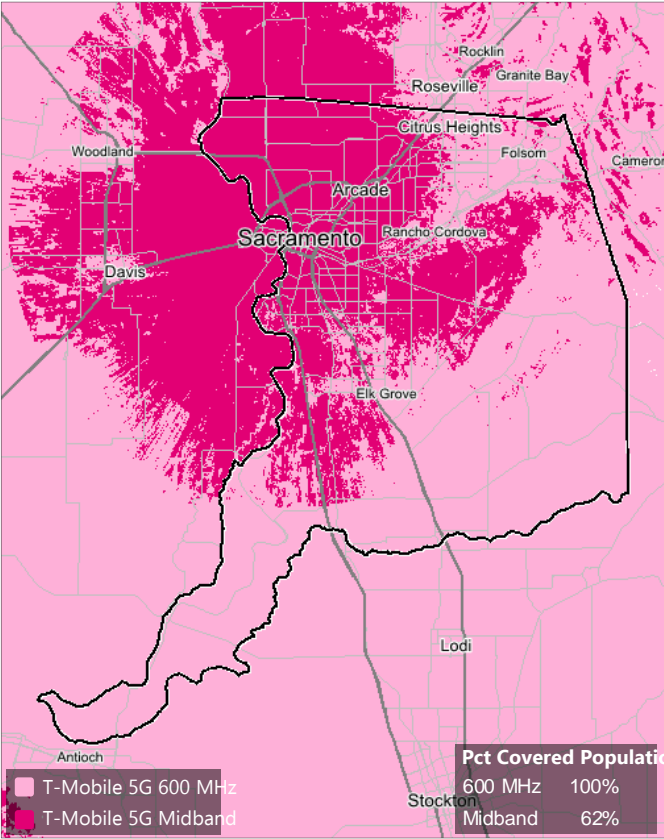


New T-Mobile

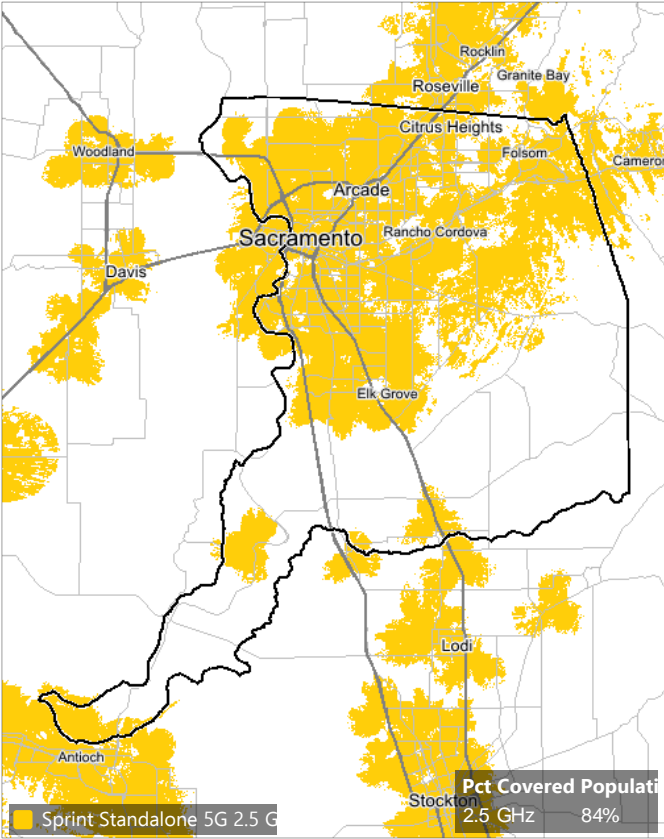


Projected 2021 5G Coverage: Sacramento County (06067)

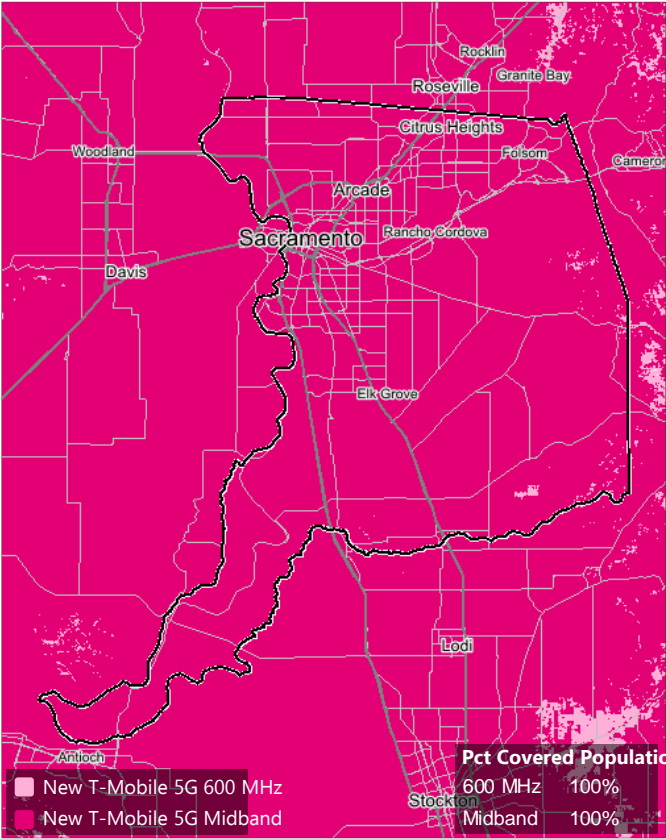
T-Mobile Standalone



Sprint Standalone

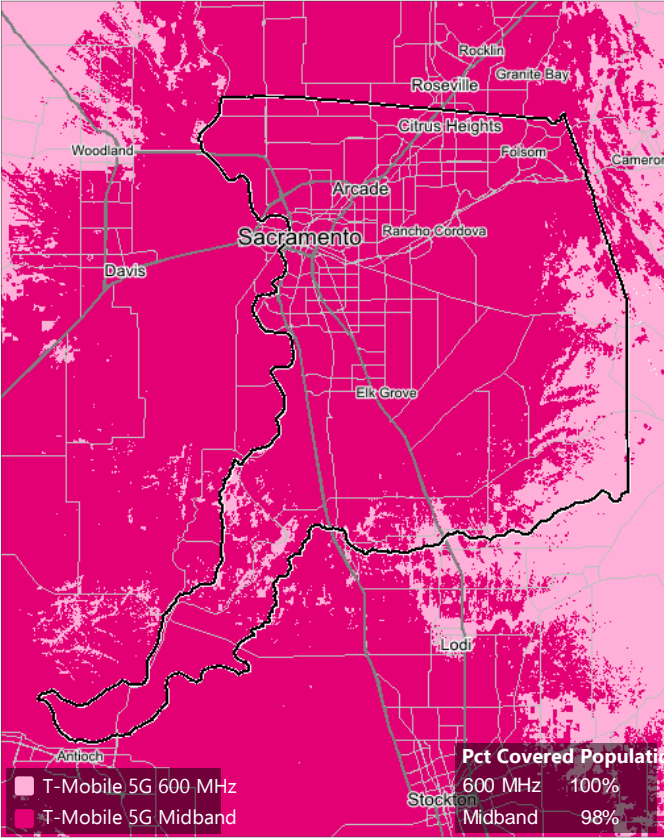


New T-Mobile

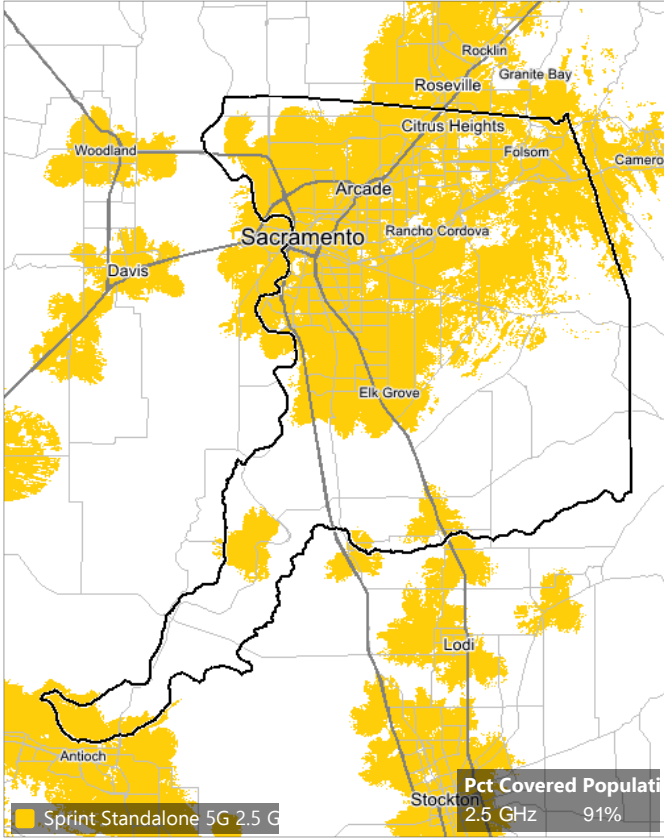


Projected 2024 5G Coverage: Sacramento County (06067)

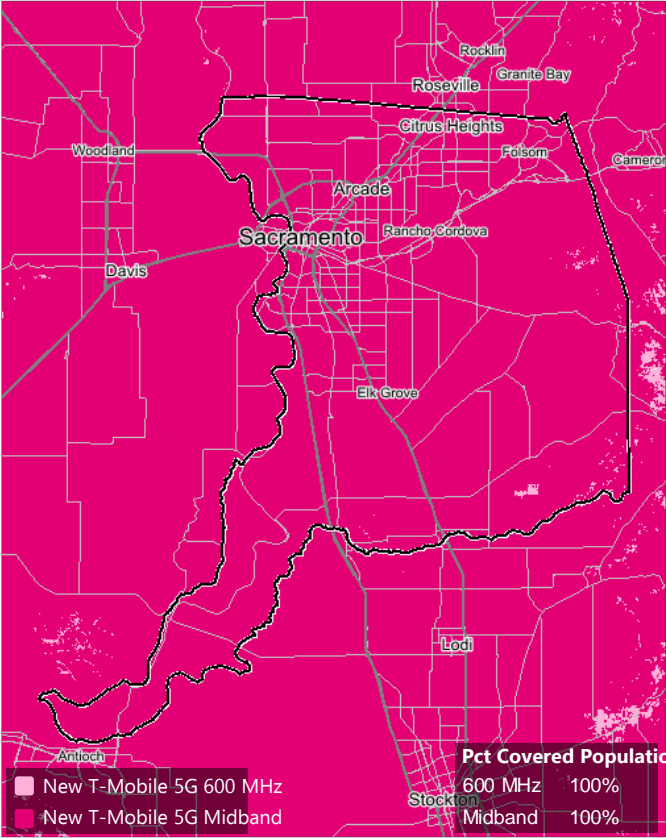
T-Mobile Standalone



Sprint Standalone

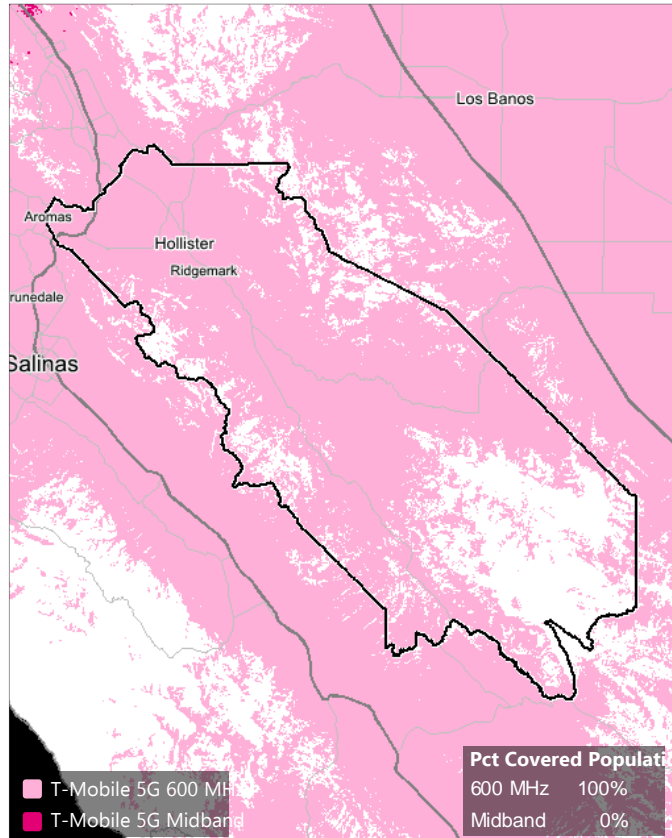


New T-Mobile

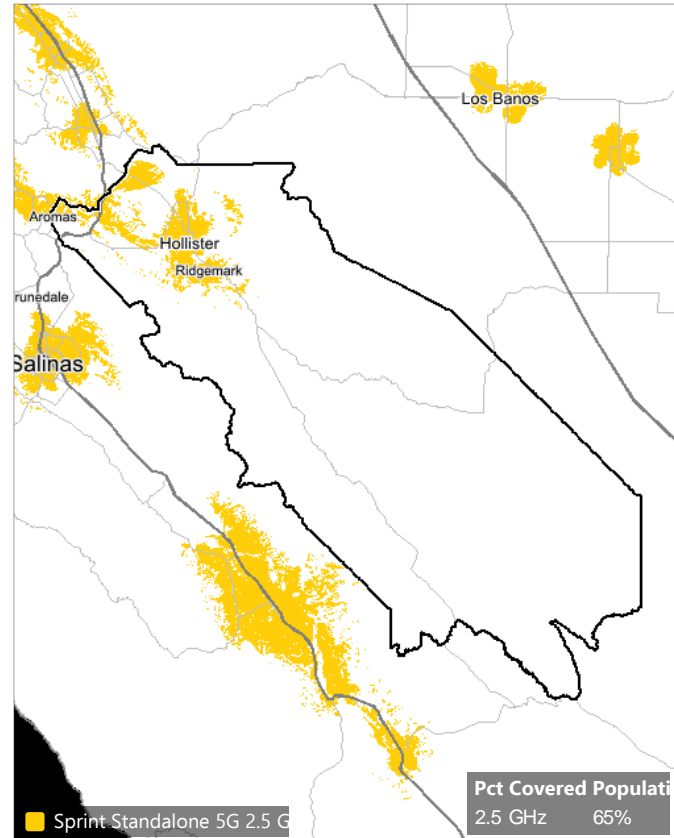


Projected 2021 5G Coverage: San Benito County (06069)

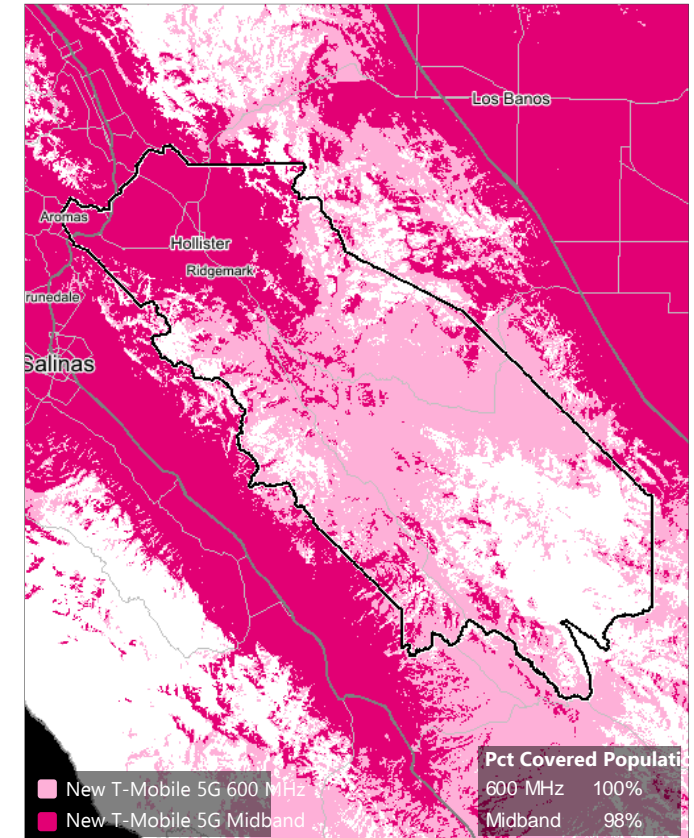
T-Mobile Standalone



Sprint Standalone

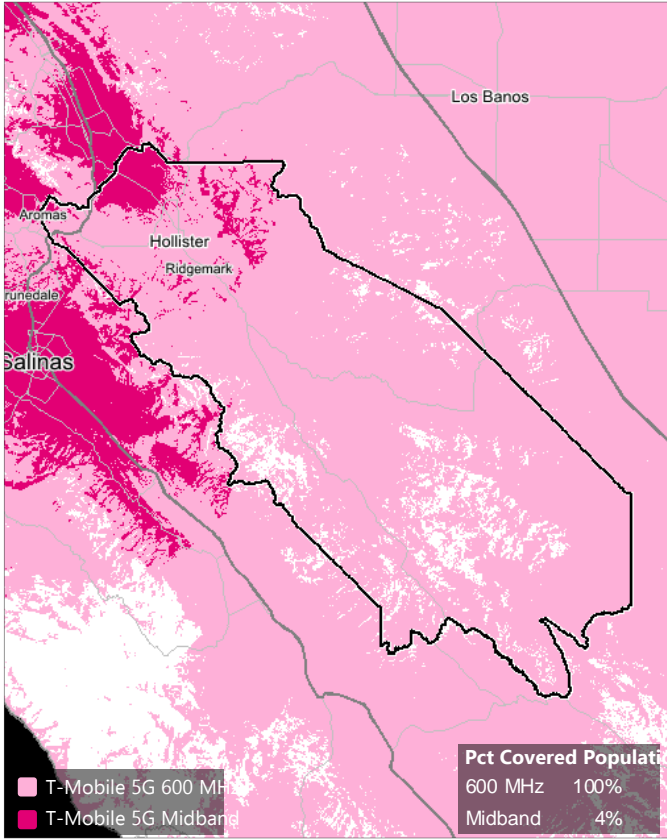


New T-Mobile

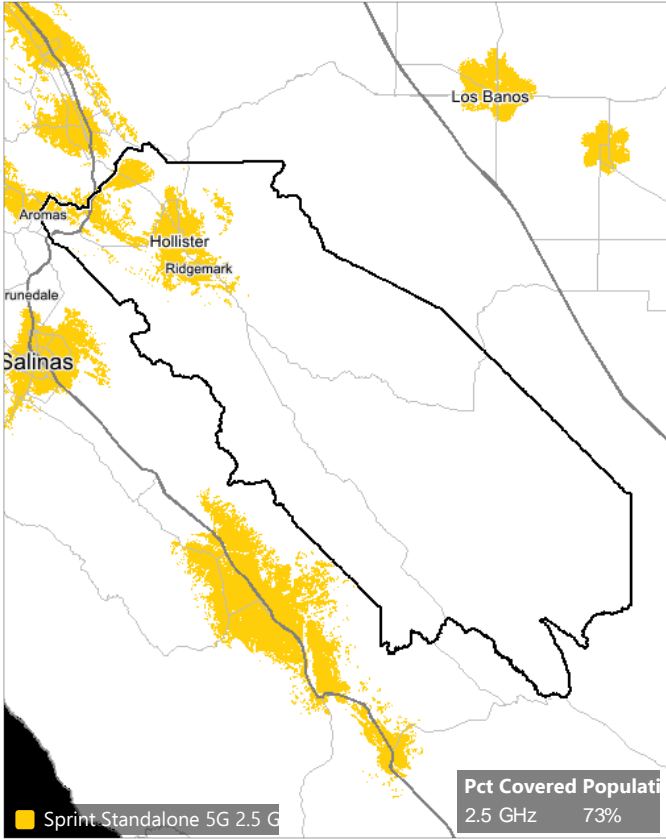


Projected 2024 5G Coverage: San Benito County (06069)

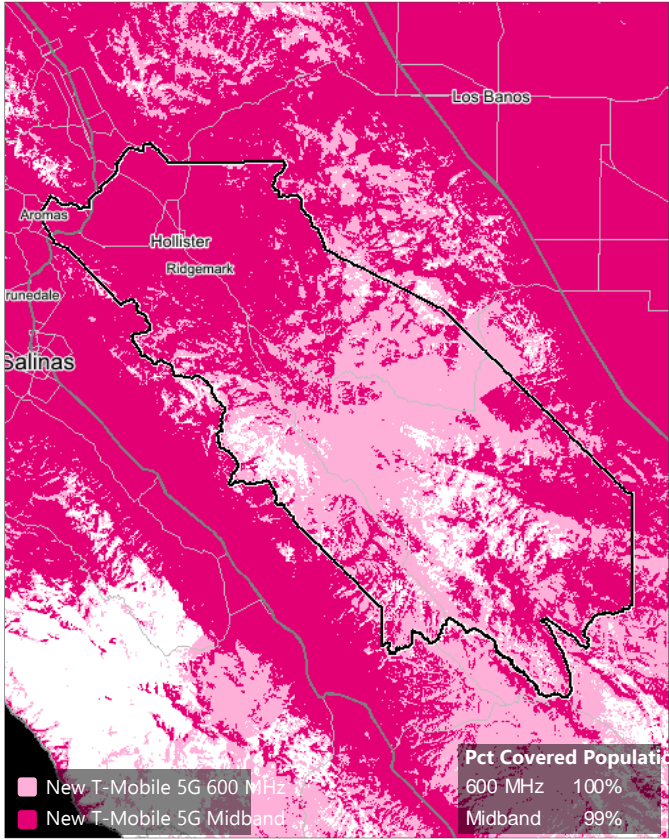
T-Mobile Standalone



Sprint Standalone

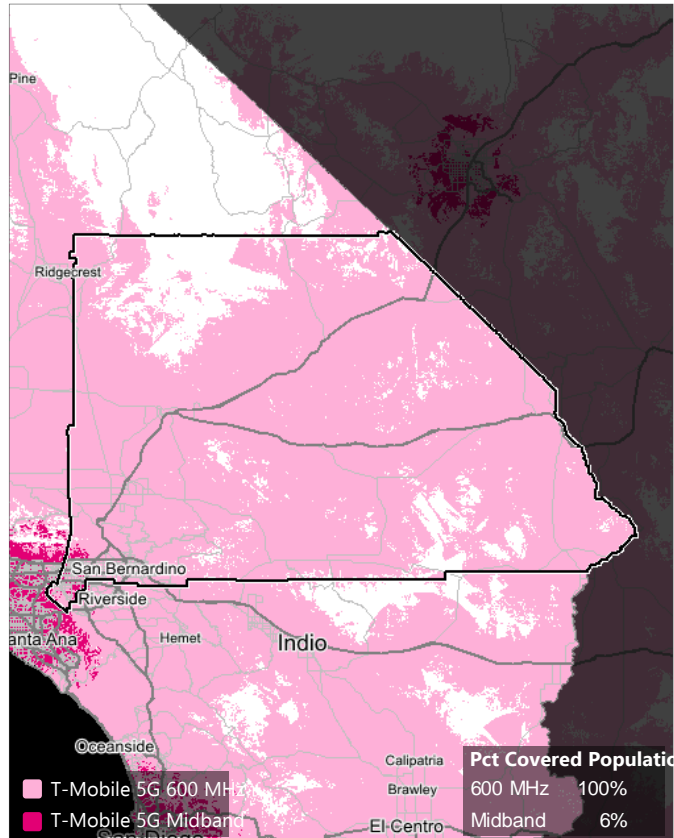


New T-Mobile

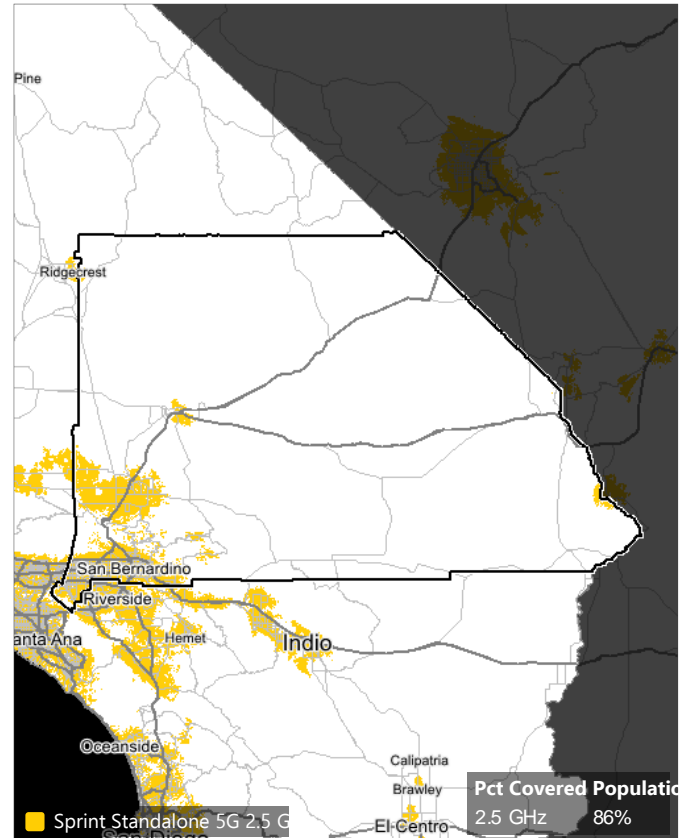


Projected 2021 5G Coverage: San Bernardino County (06071)

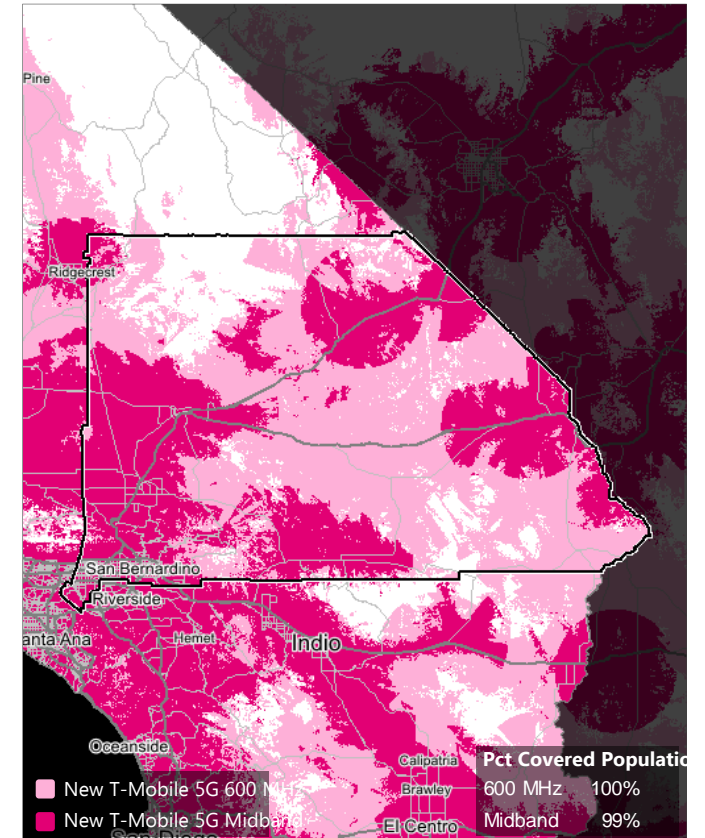
T-Mobile Standalone



Sprint Standalone

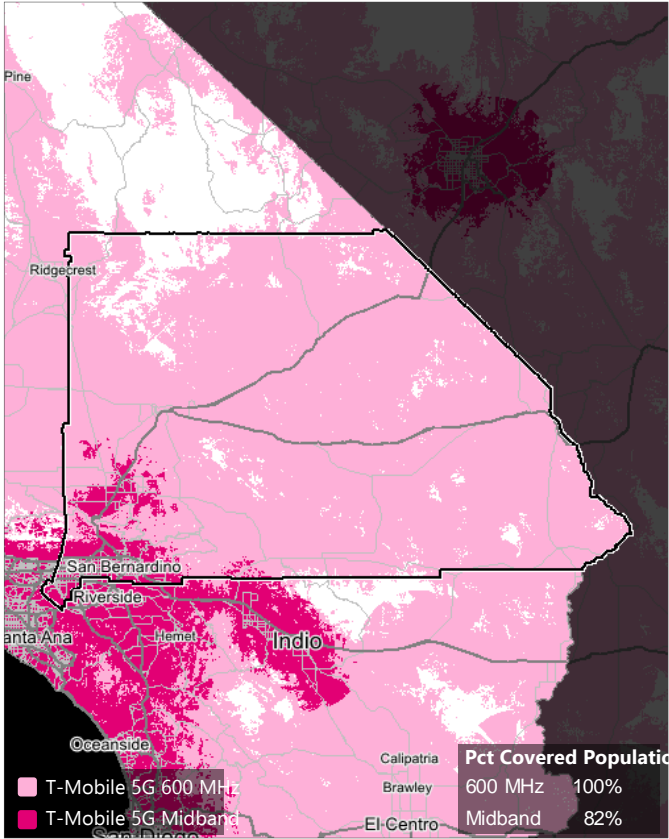


New T-Mobile

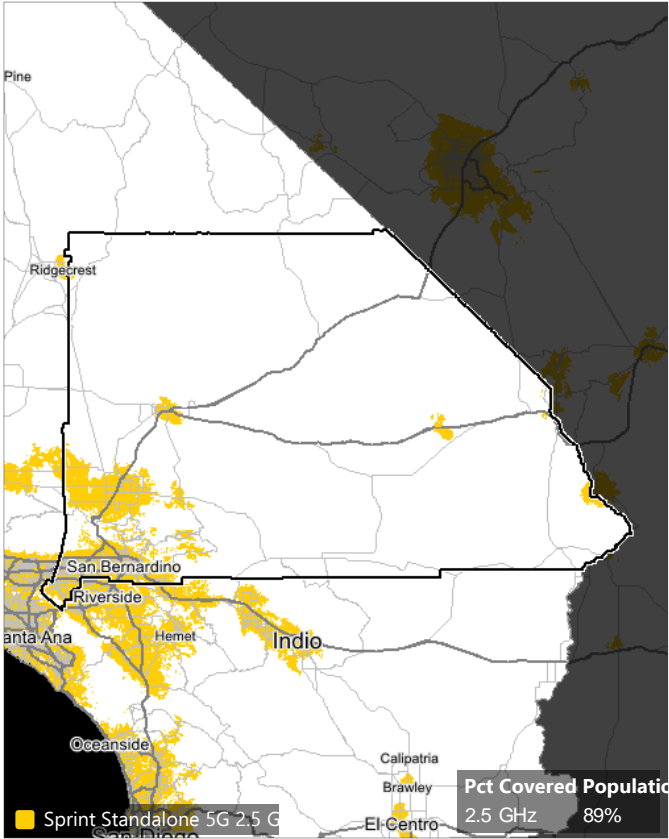


Projected 2024 5G Coverage: San Bernardino County (06071)

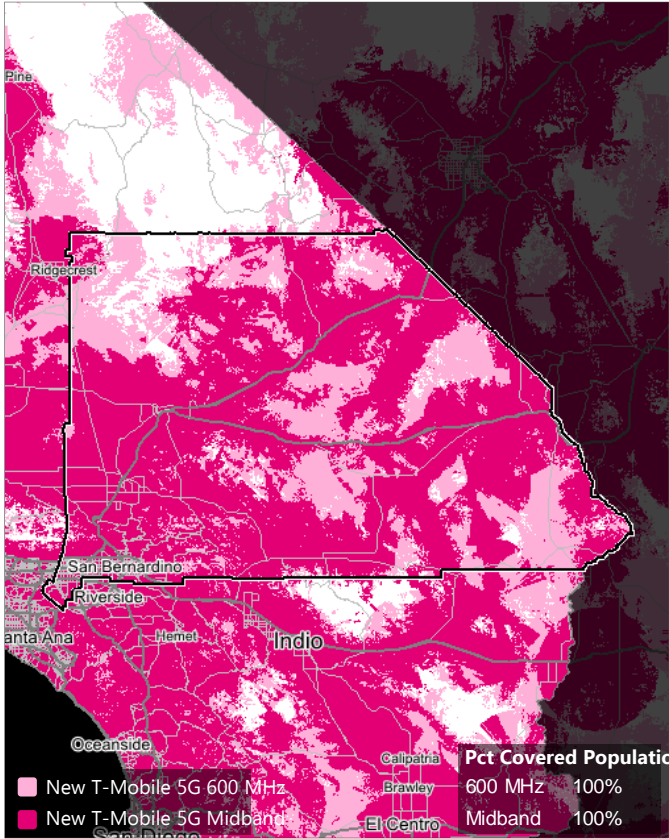
T-Mobile Standalone



Sprint Standalone

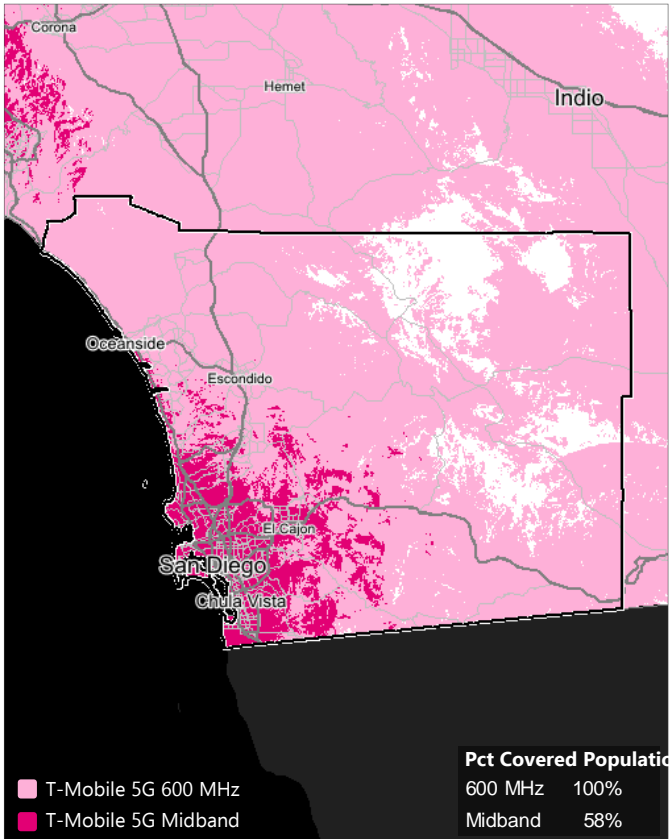


New T-Mobile

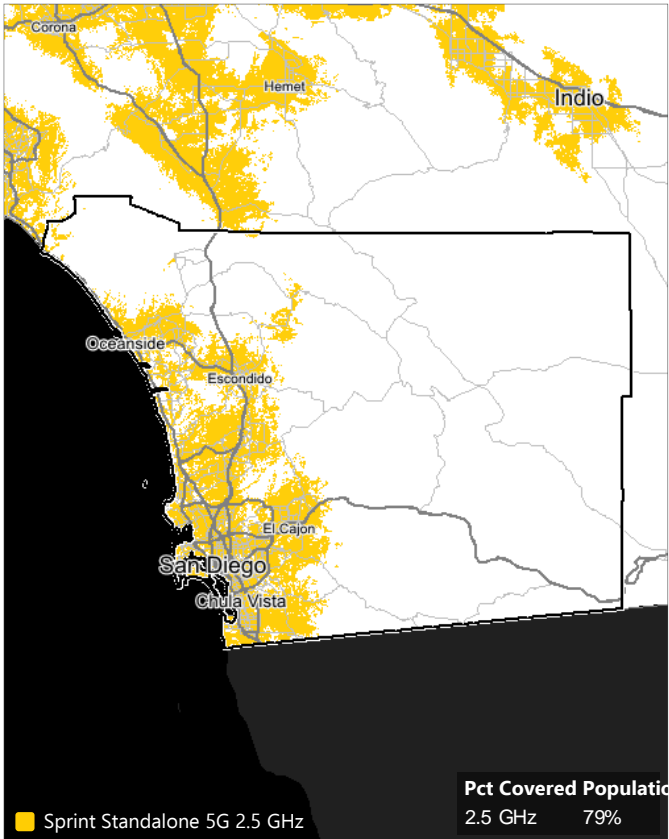


Projected 2021 5G Coverage: San Diego County (06073)

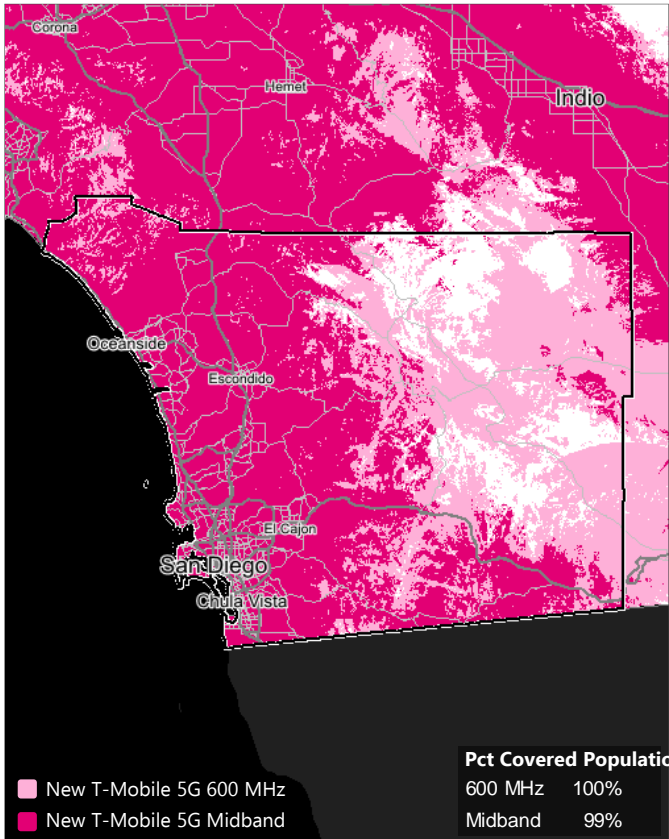
T-Mobile Standalone



Sprint Standalone

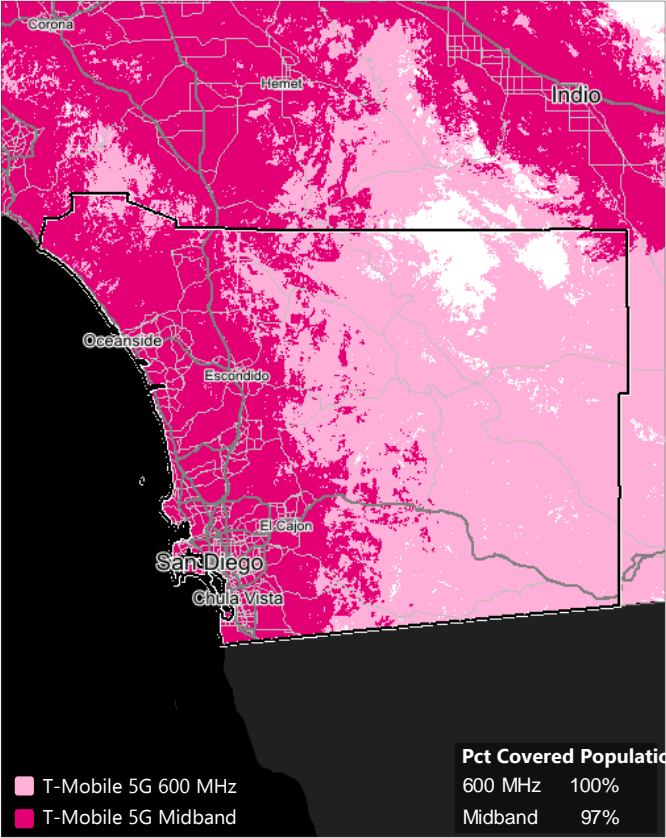


New T-Mobile

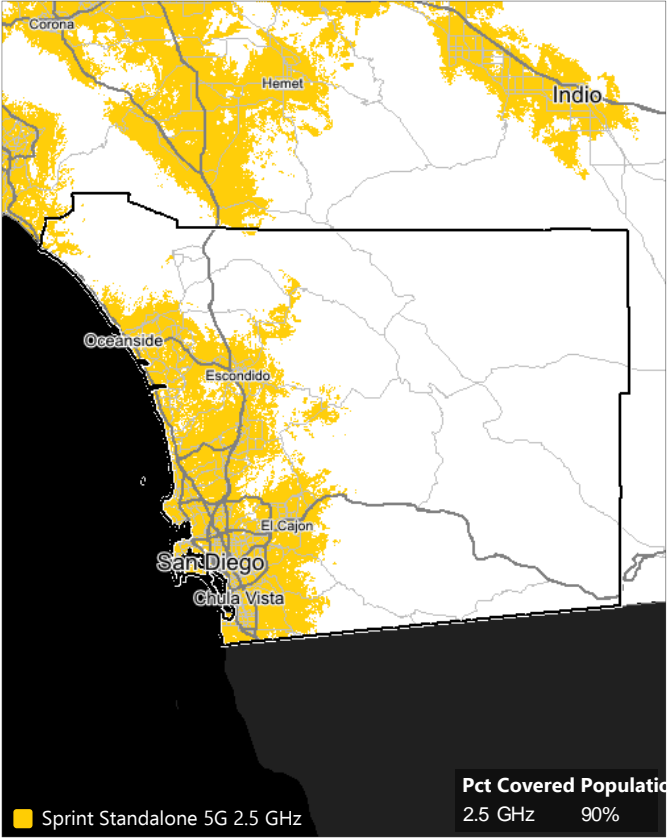


Projected 2024 5G Coverage: San Diego County (06073)

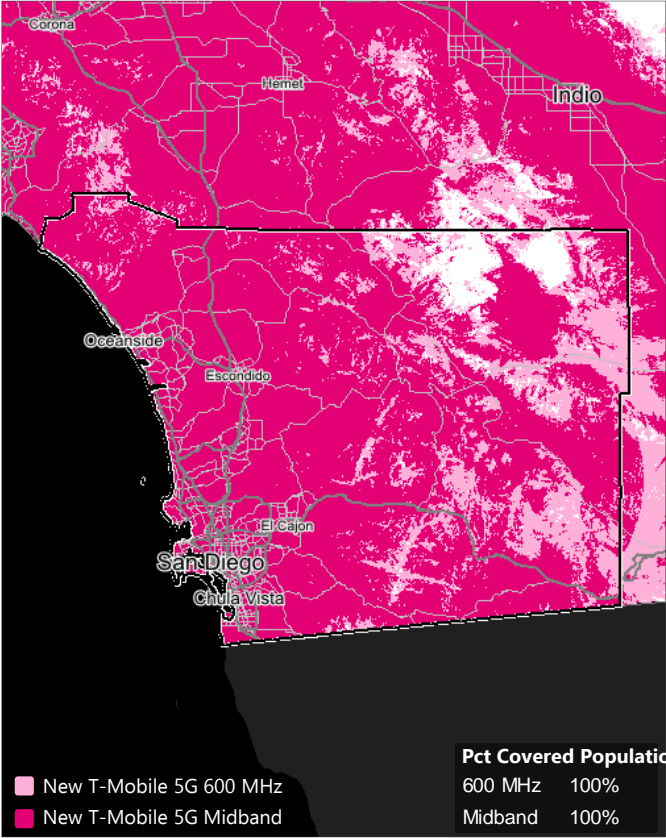
T-Mobile Standalone



Sprint Standalone

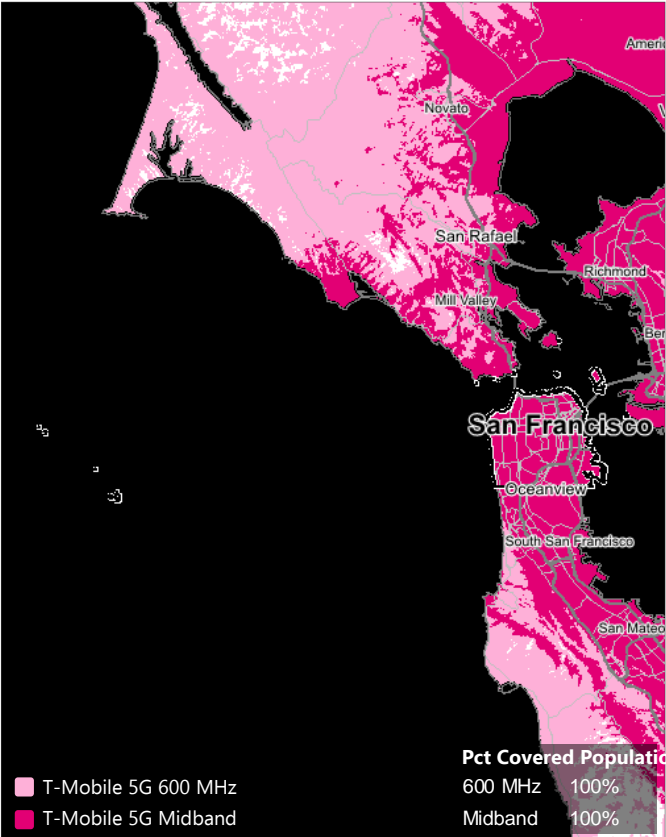


New T-Mobile

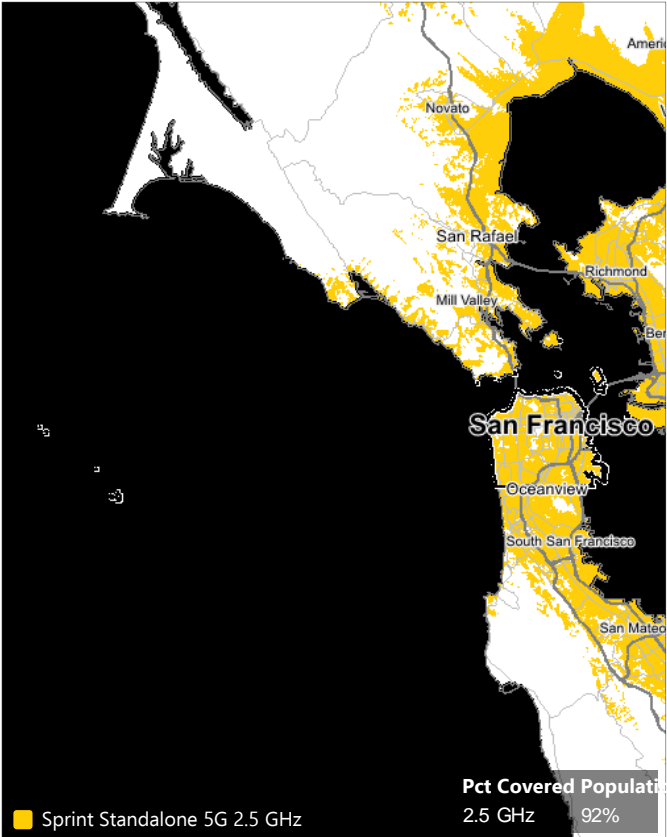


Projected 2021 5G Coverage: San Francisco County (06075)

T-Mobile Standalone



Sprint Standalone

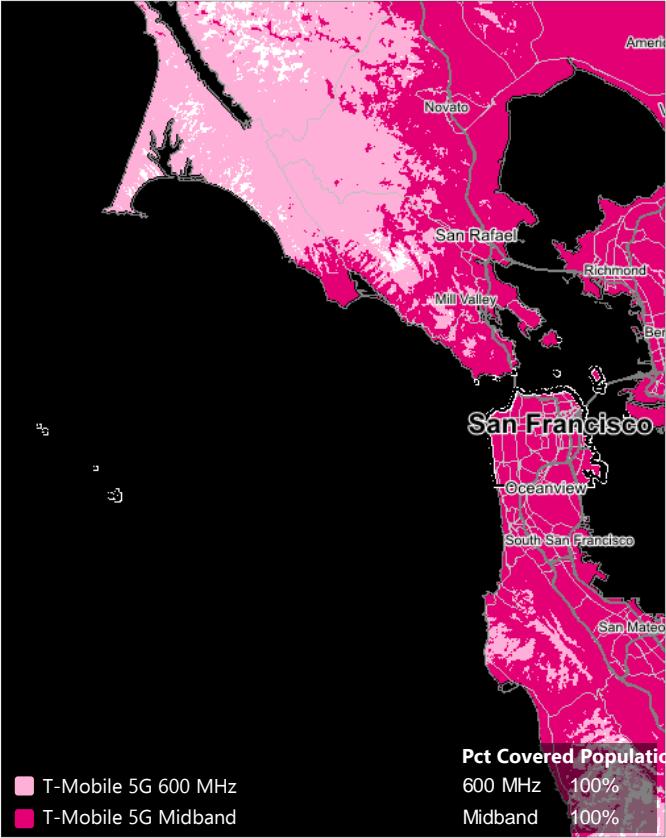


New T-Mobile

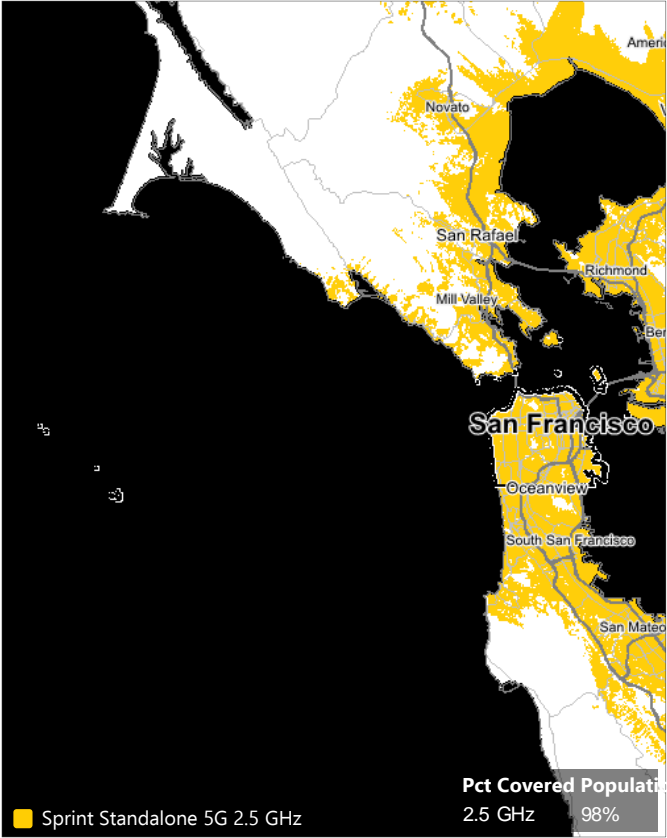


Projected 2024 5G Coverage: San Francisco County (06075)

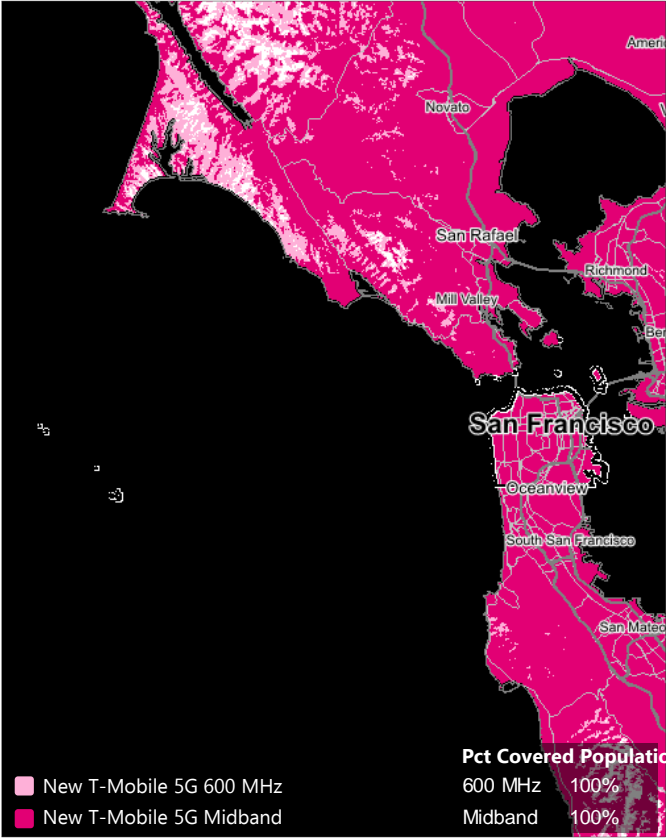
T-Mobile Standalone



Sprint Standalone

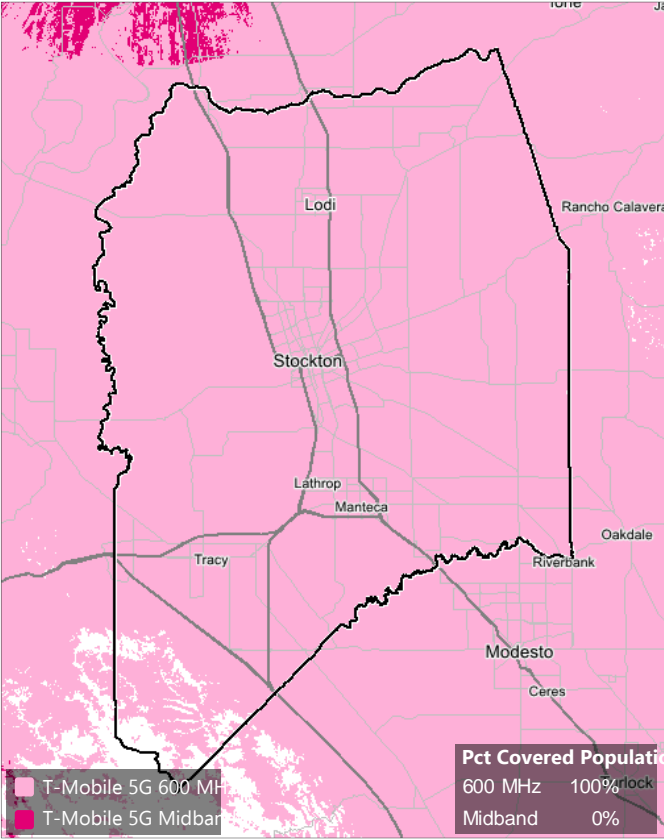


New T-Mobile

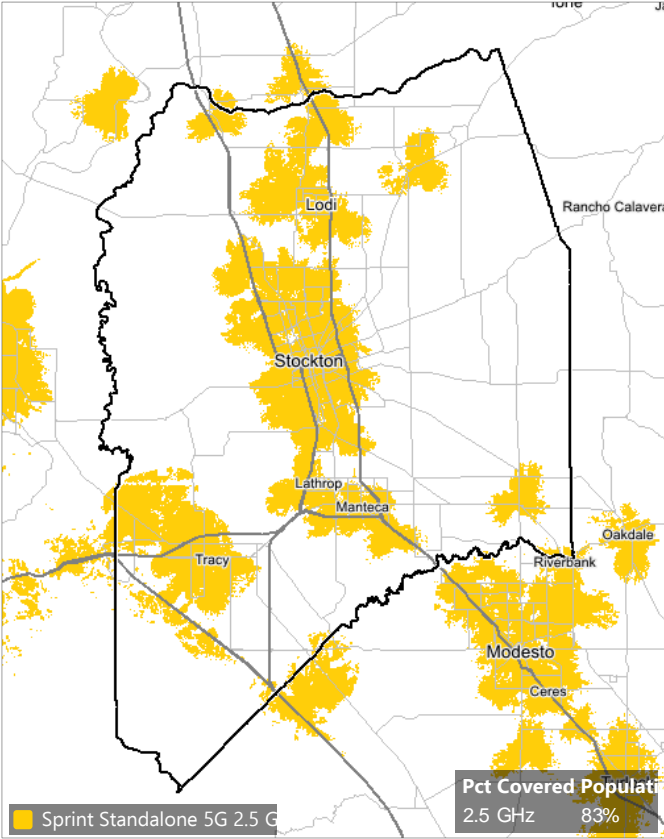


Projected 2021 5G Coverage: San Joaquin County (06077)

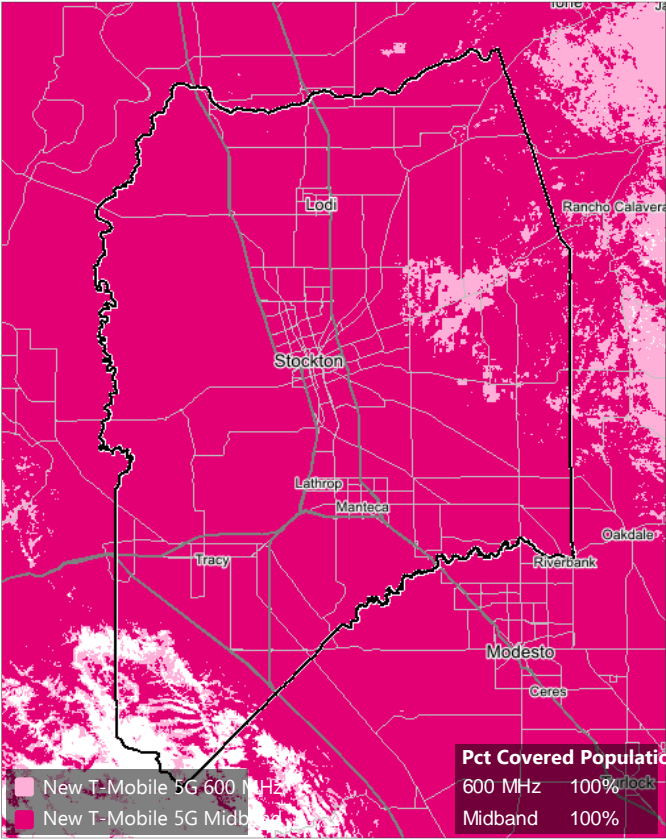
T-Mobile Standalone



Sprint Standalone

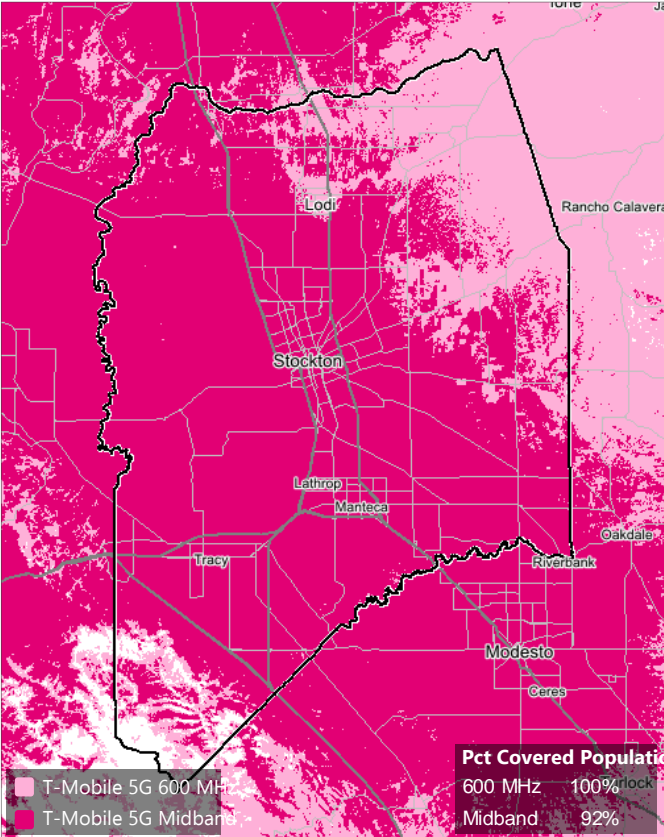


New T-Mobile

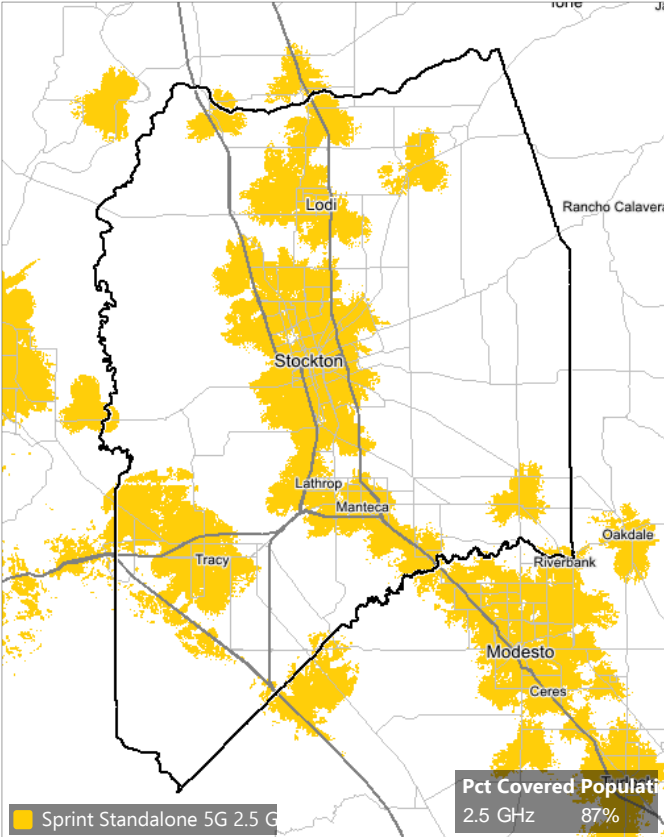


Projected 2024 5G Coverage: San Joaquin County (06077)

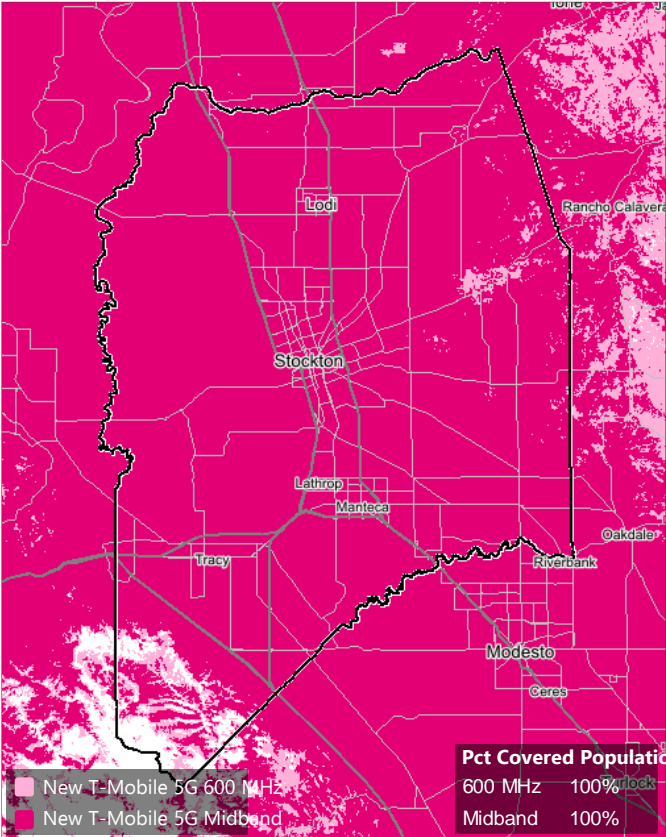
T-Mobile Standalone



Sprint Standalone

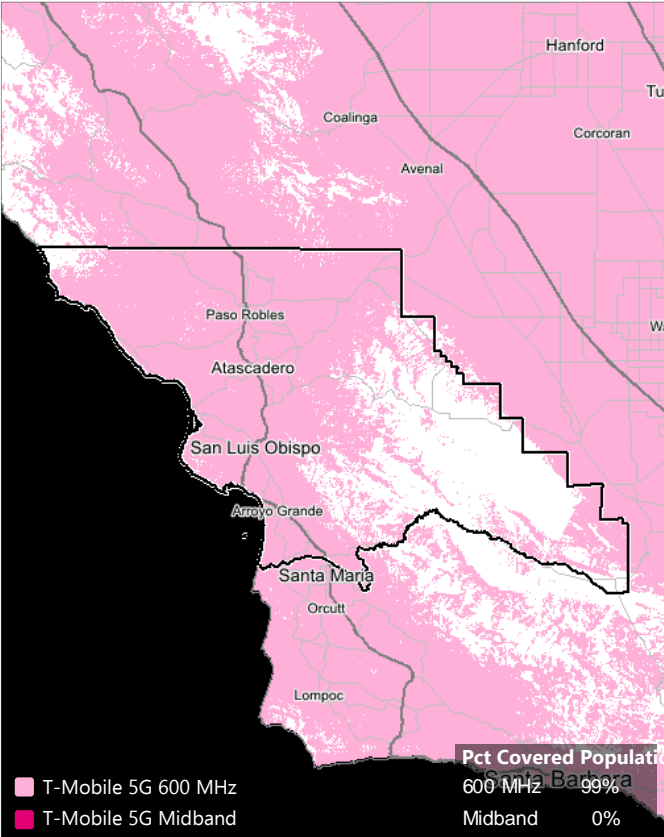


New T-Mobile

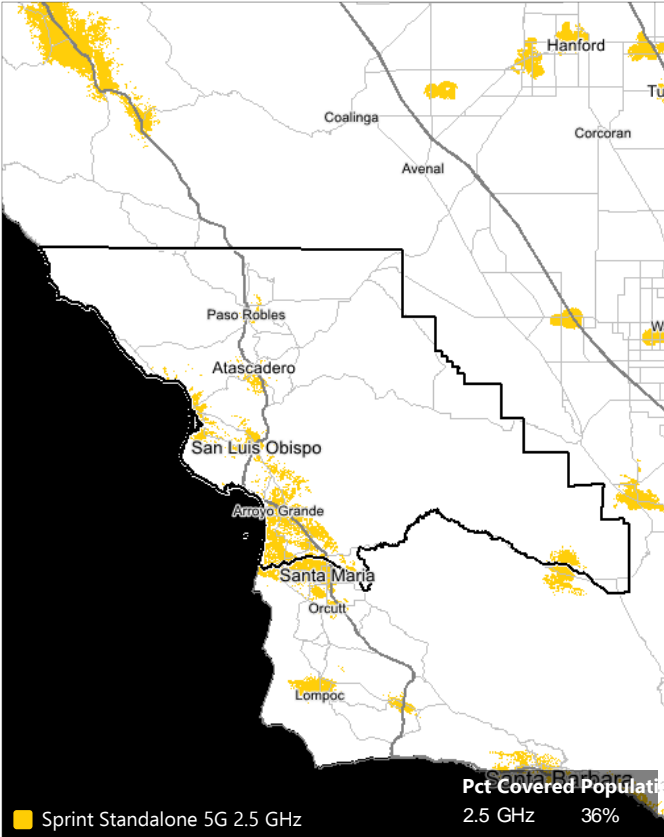


Projected 2021 5G Coverage: San Luis Obispo County (06079)

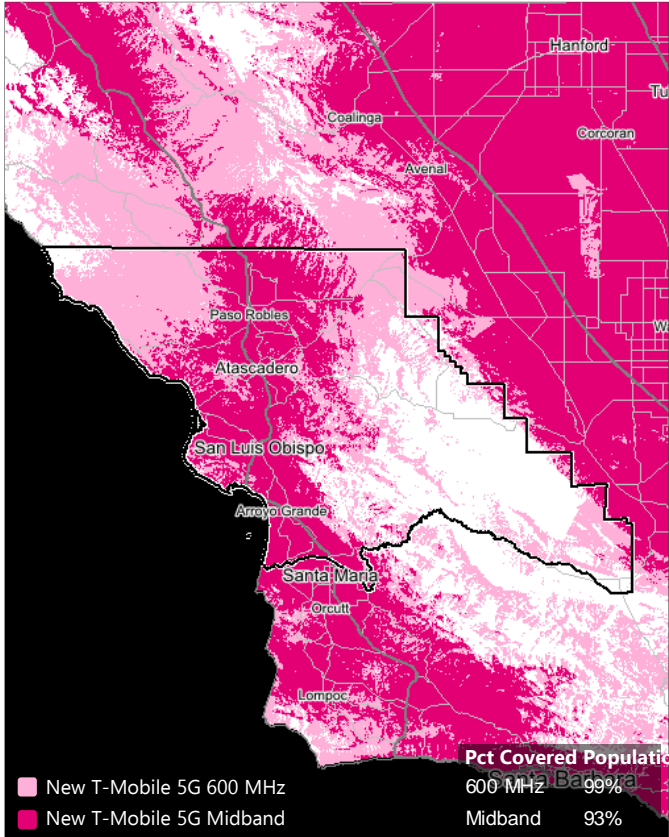
T-Mobile Standalone



Sprint Standalone

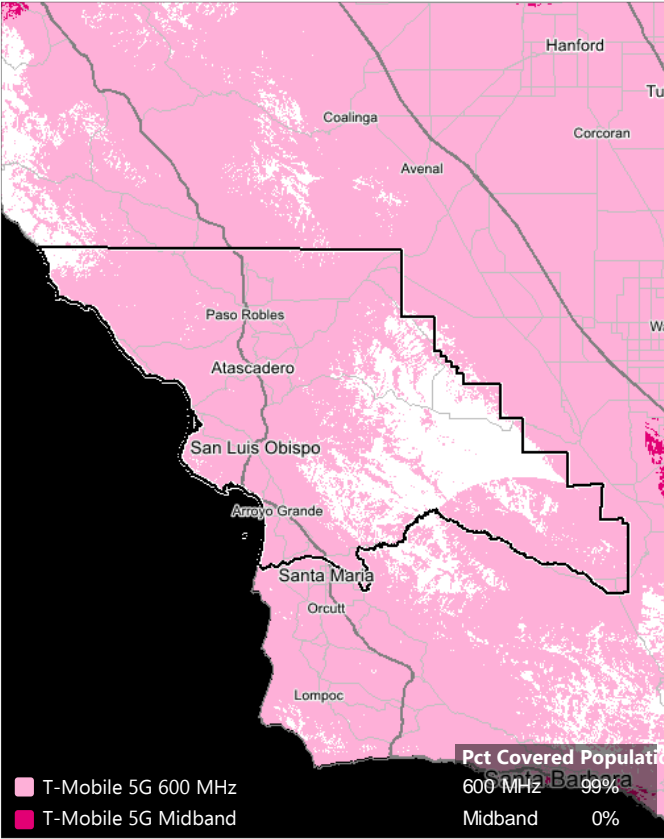


New T-Mobile

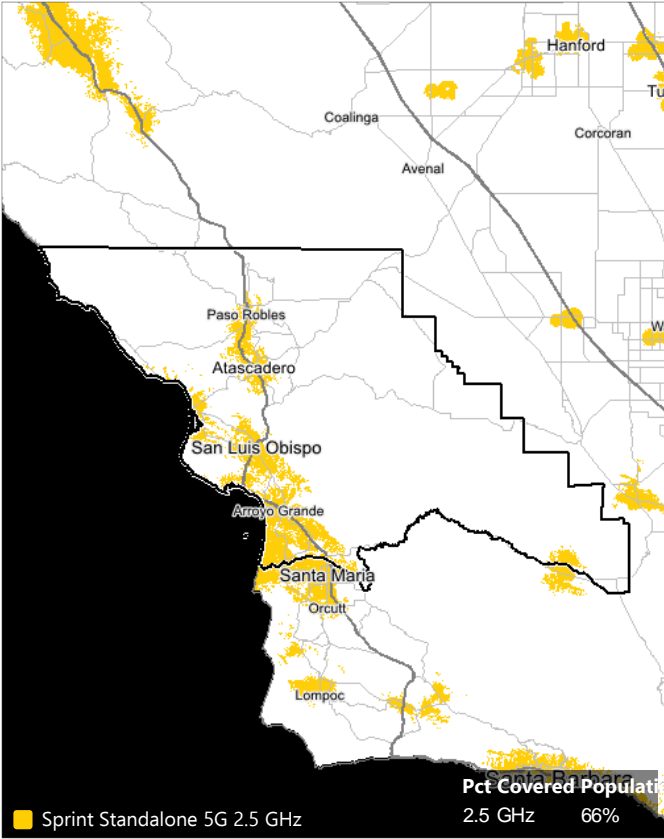


Projected 2024 5G Coverage: San Luis Obispo County (06079)

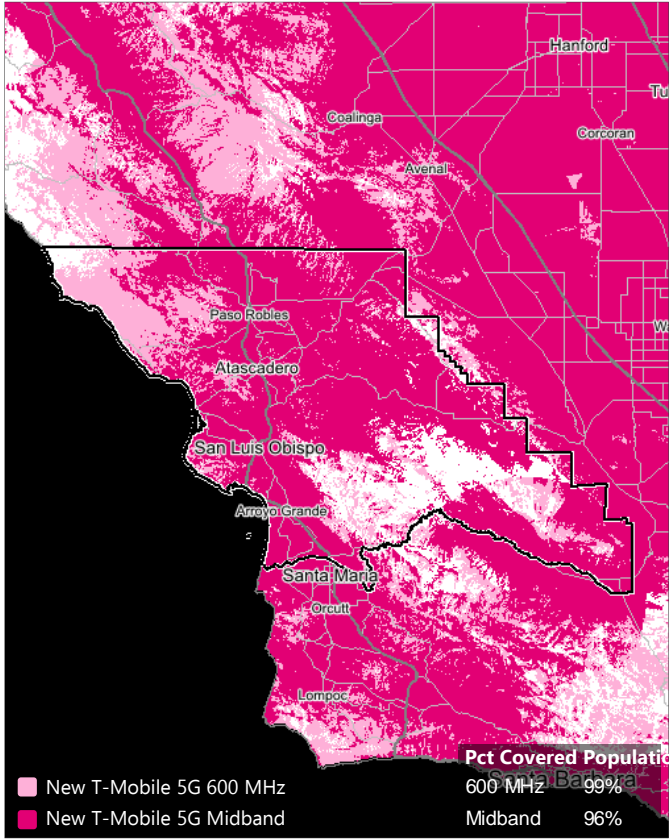
T-Mobile Standalone



Sprint Standalone

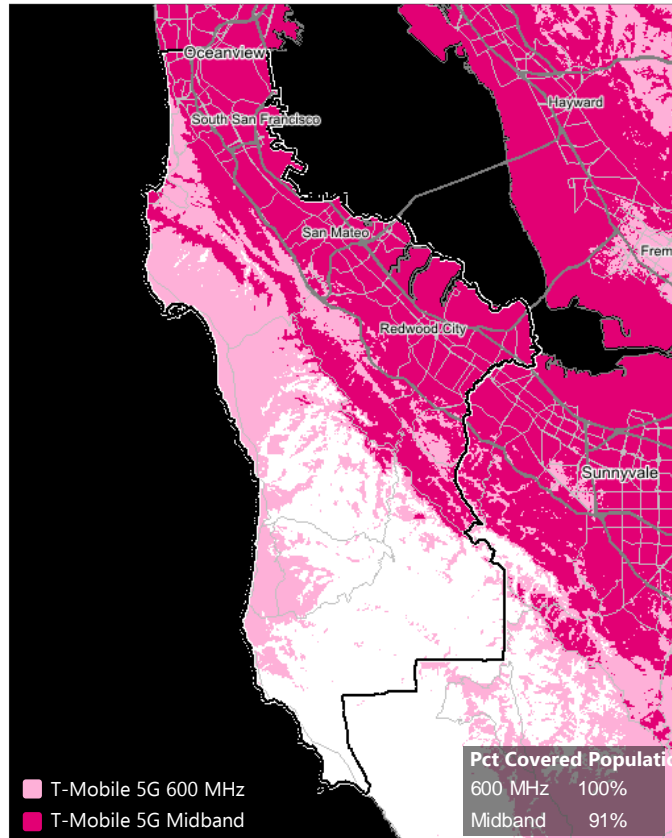


New T-Mobile

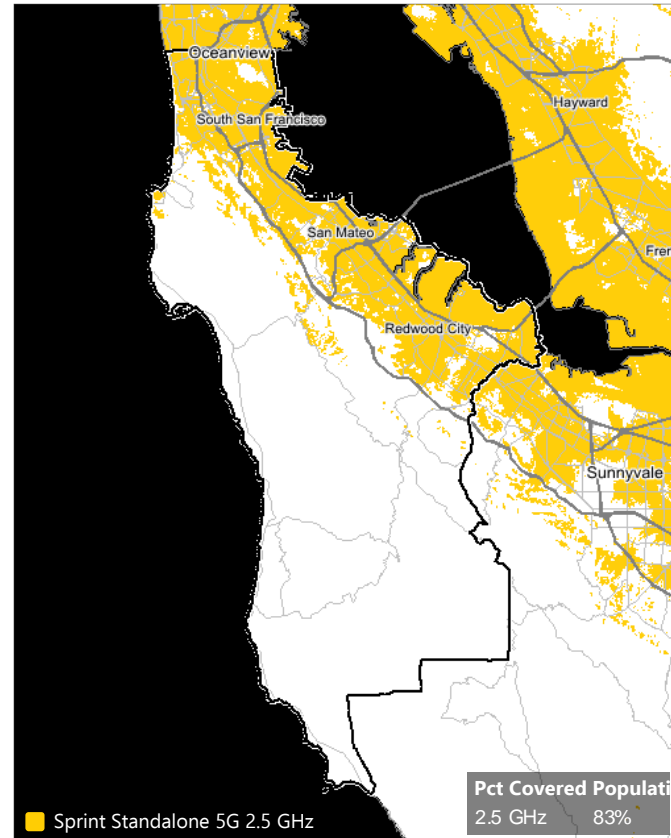


Projected 2021 5G Coverage: San Mateo County (06081)

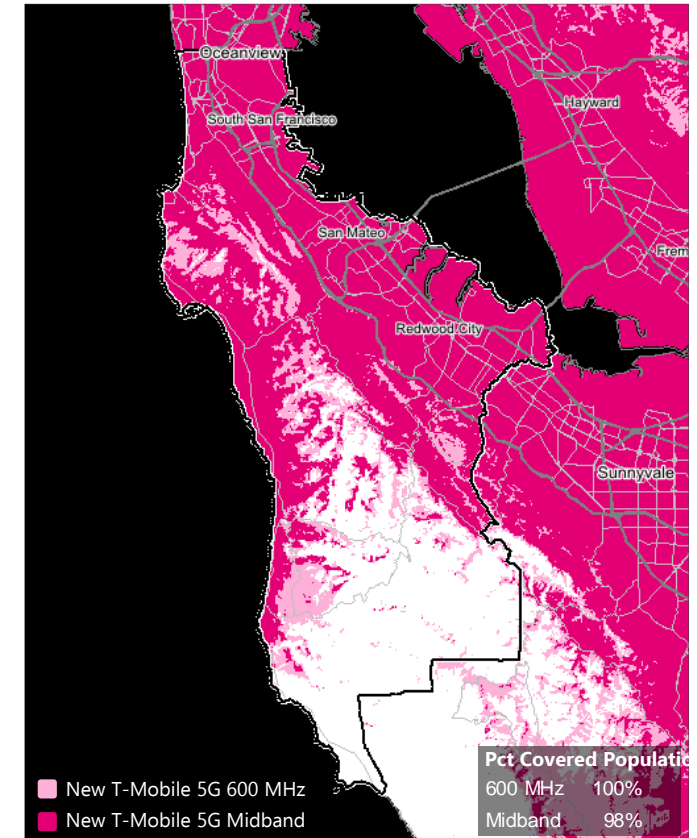
T-Mobile Standalone



Sprint Standalone

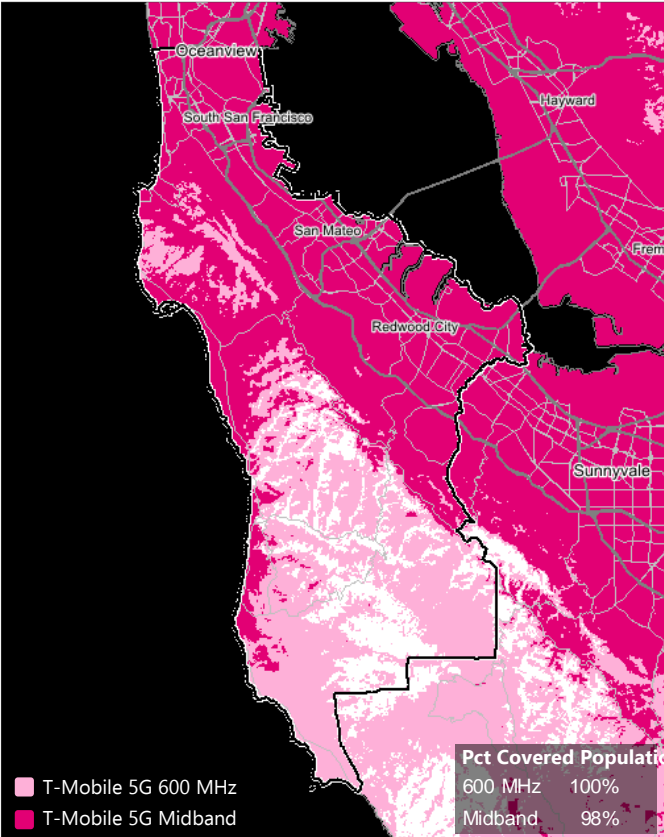


New T-Mobile

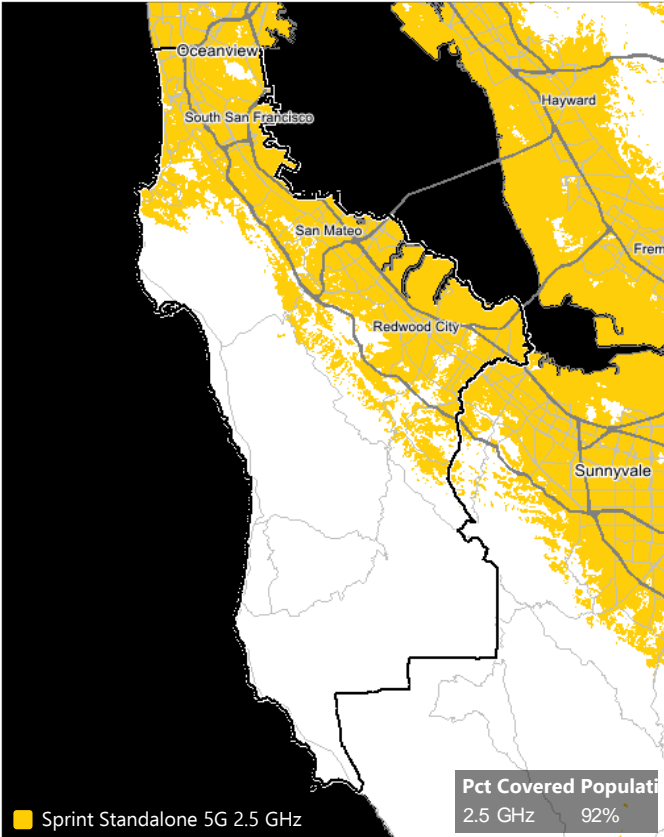


Projected 2024 5G Coverage: San Mateo County (06081)

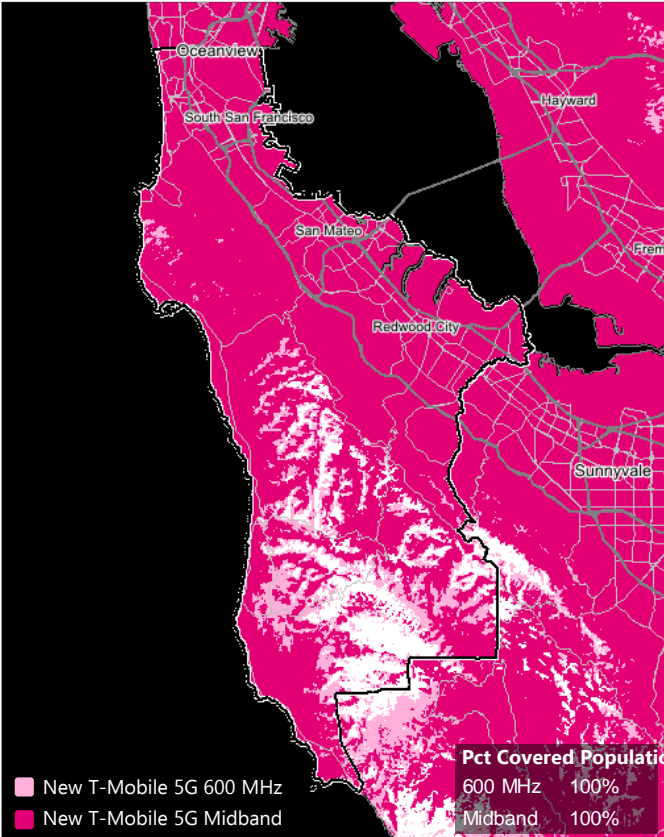
T-Mobile Standalone



Sprint Standalone

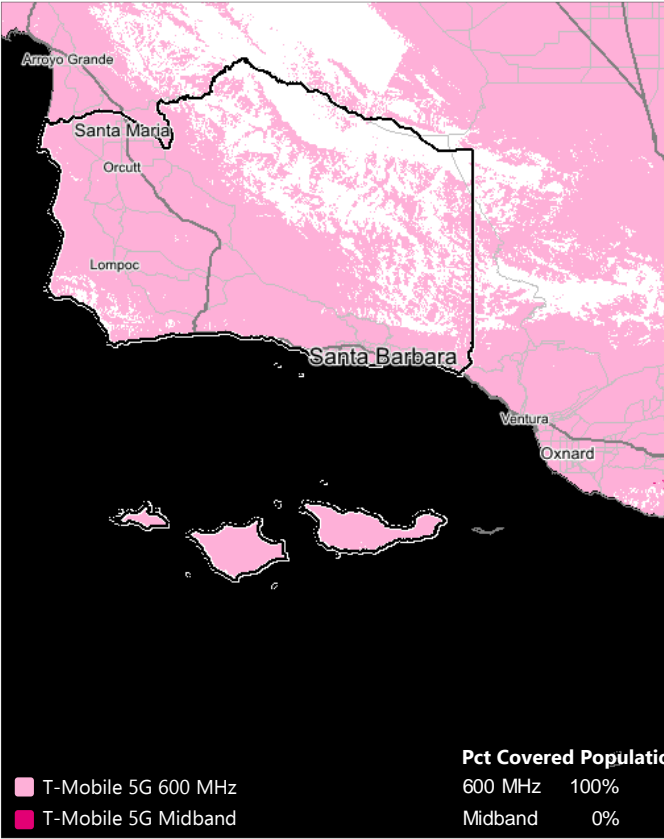


New T-Mobile

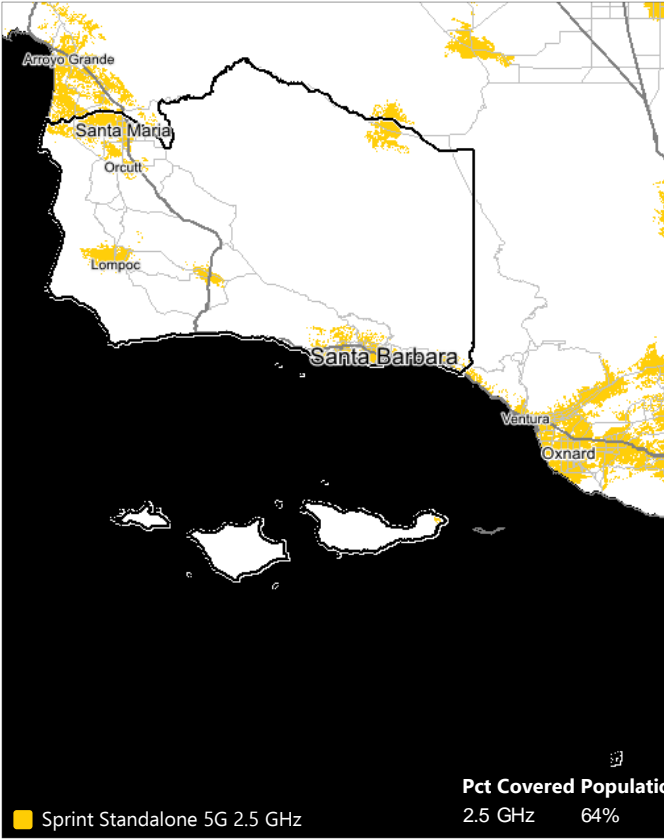


Projected 2021 5G Coverage: Santa Barbara County (06083)

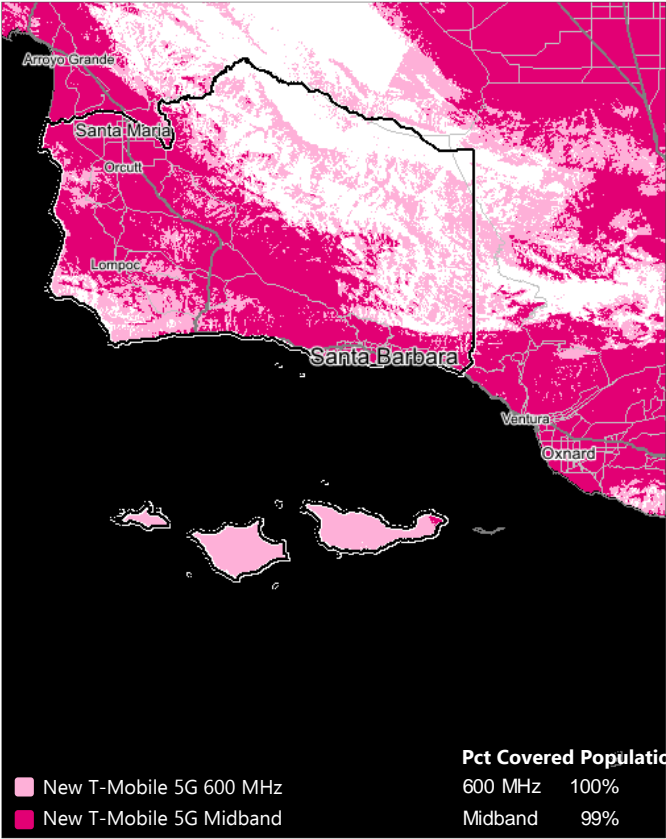
T-Mobile Standalone



Sprint Standalone

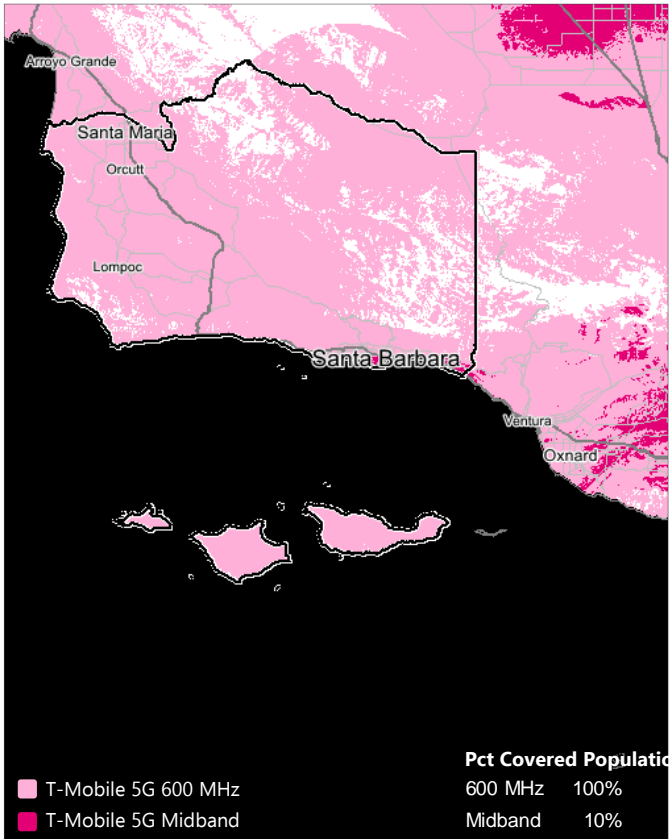


New T-Mobile

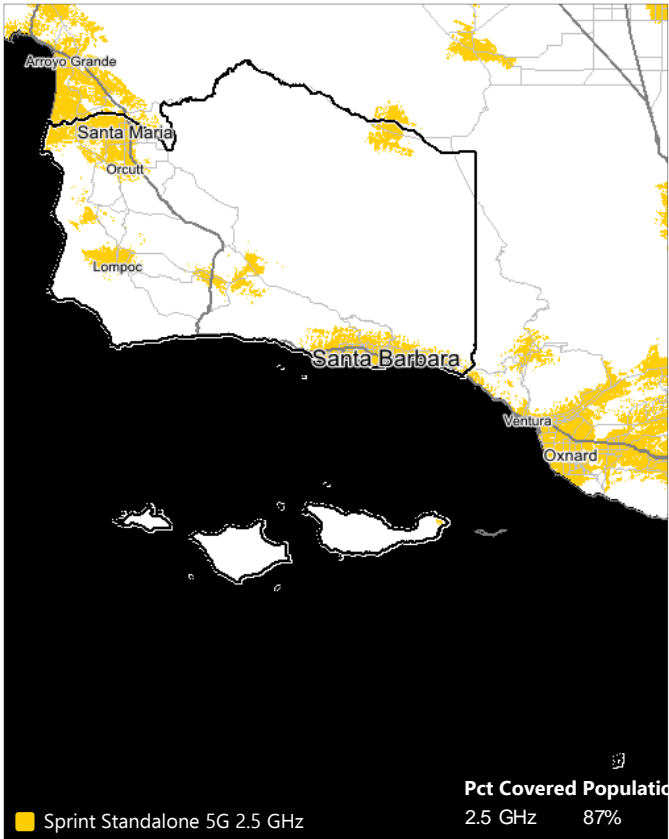


Projected 2024 5G Coverage: Santa Barbara County (06083)

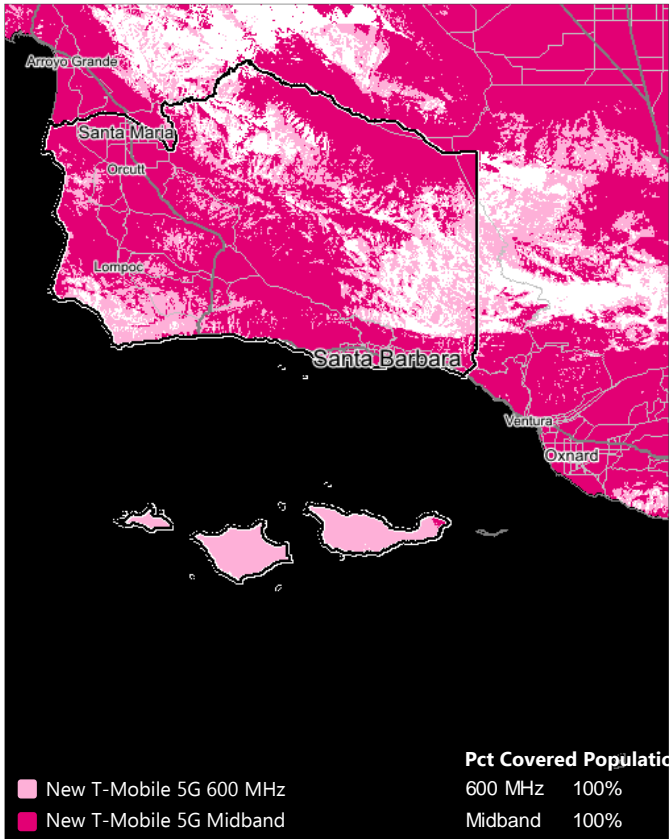
T-Mobile Standalone



Sprint Standalone

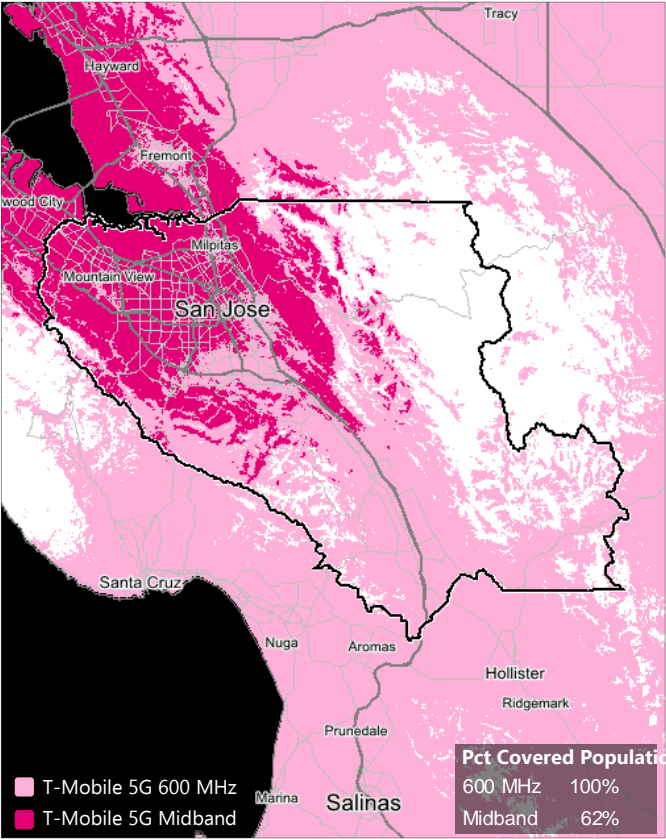


New T-Mobile

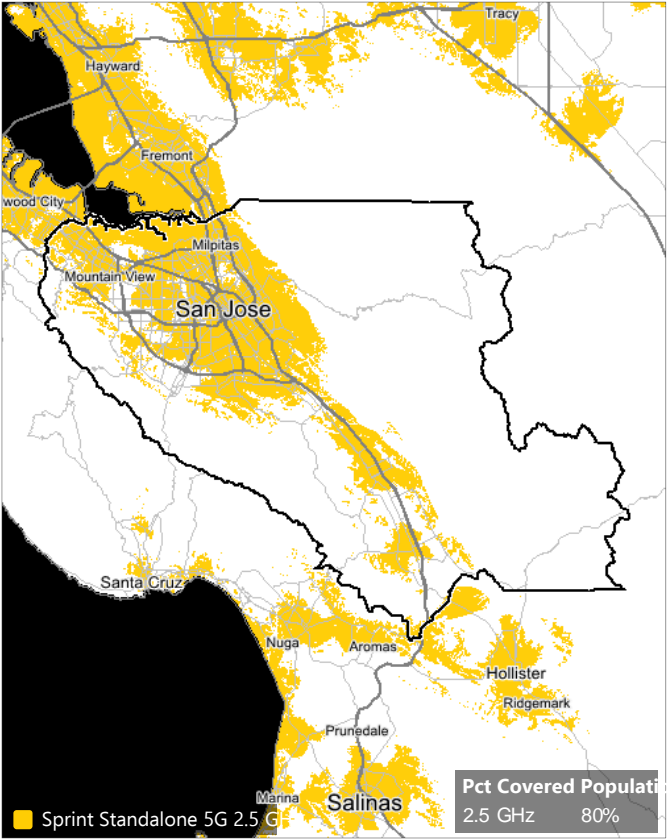


Projected 2021 5G Coverage: Santa Clara County (06085)

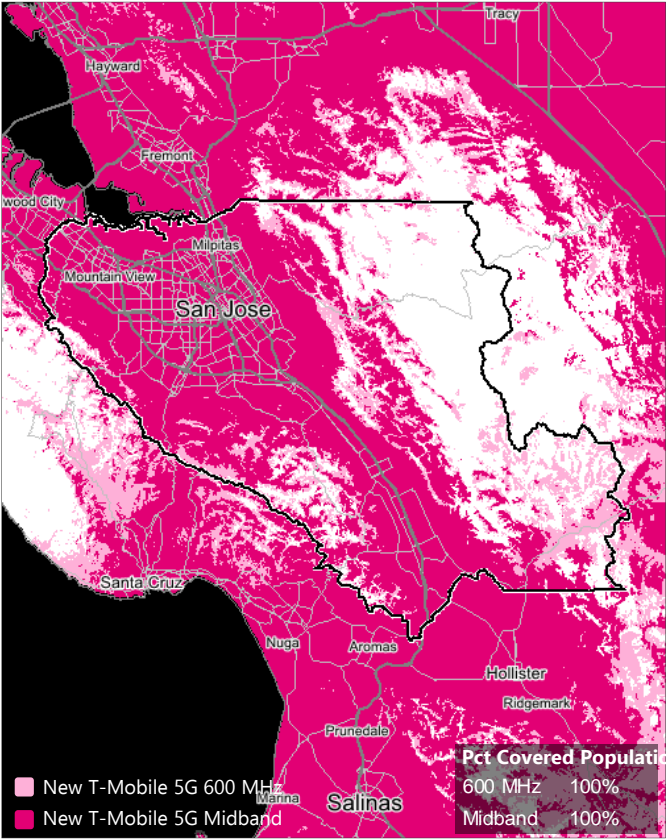
T-Mobile Standalone



Sprint Standalone

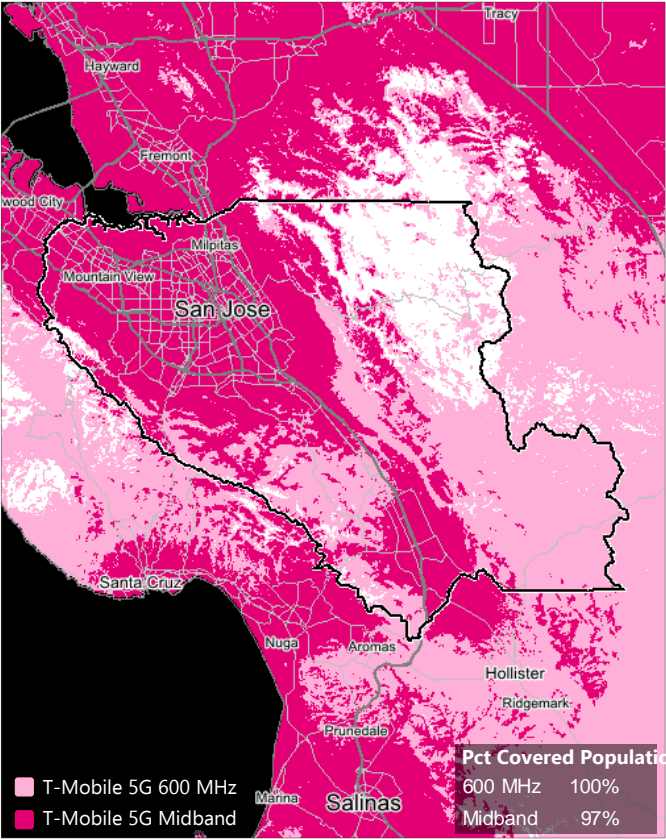


New T-Mobile

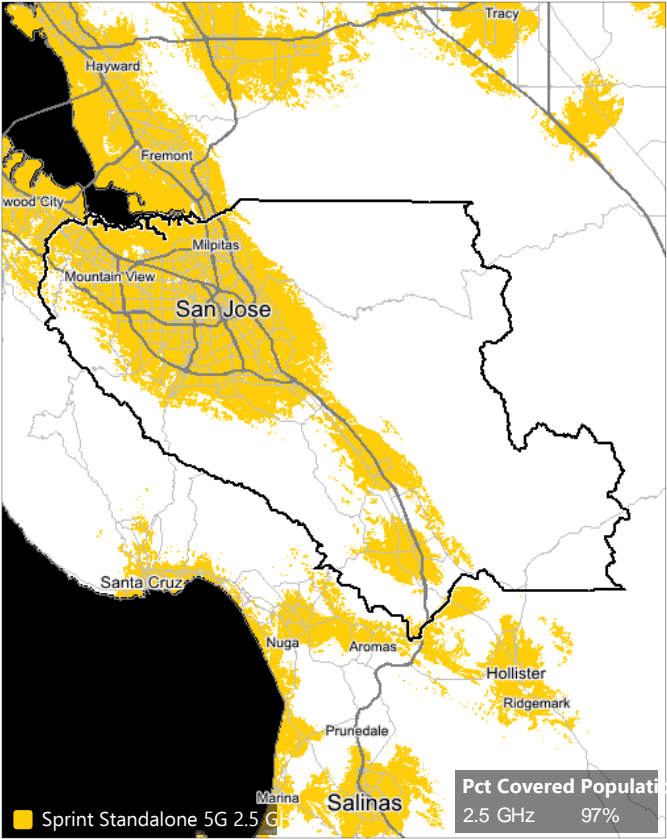


Projected 2024 5G Coverage: Santa Clara County (06085)

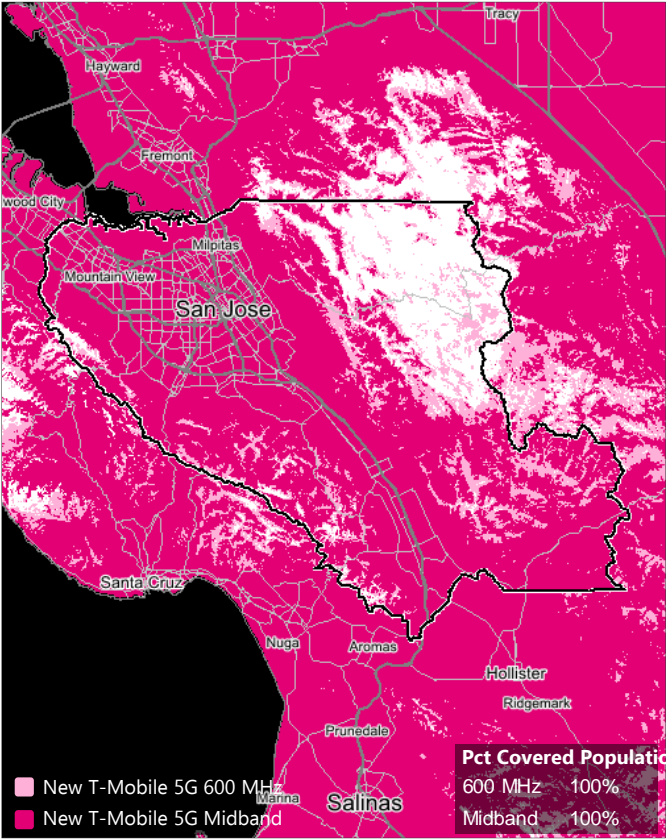
T-Mobile Standalone



Sprint Standalone

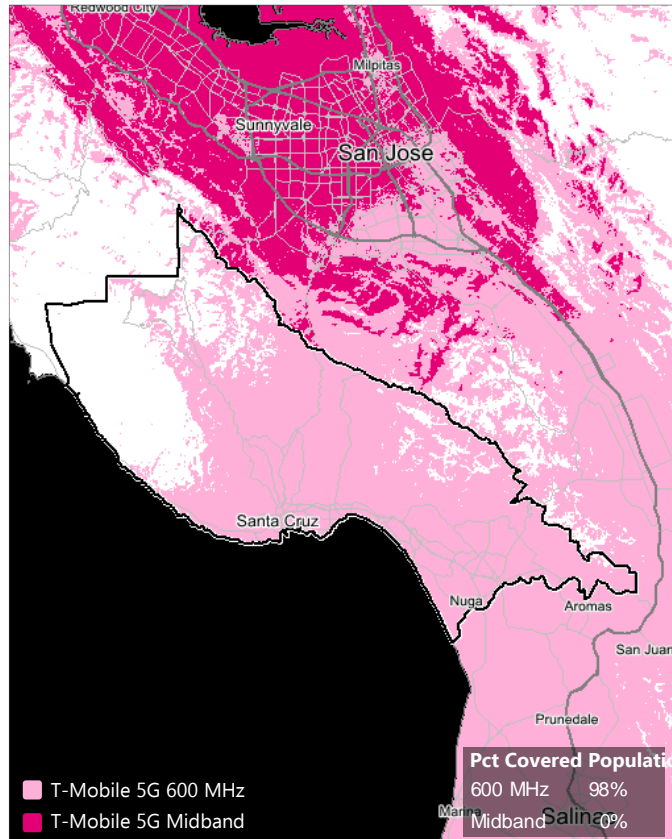


New T-Mobile

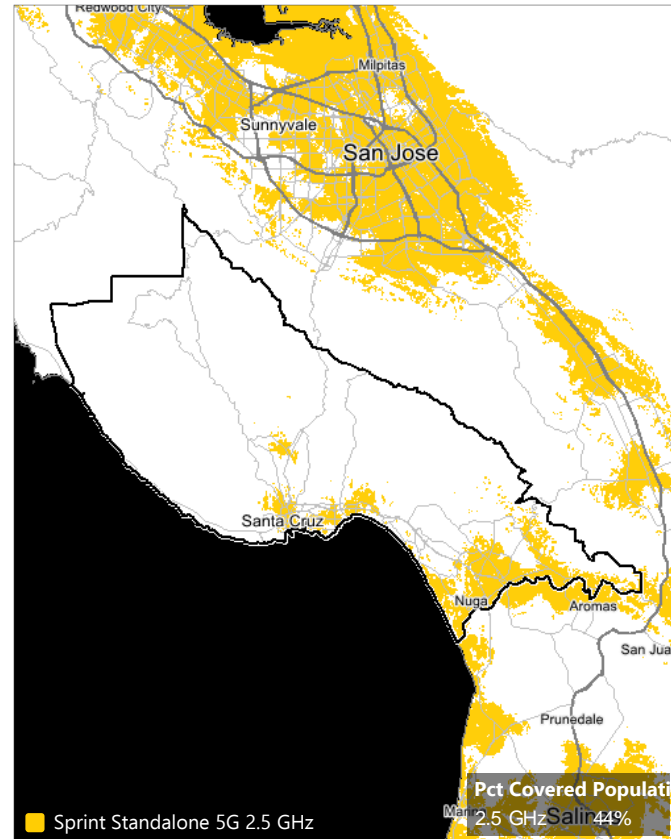


Projected 2021 5G Coverage: Santa Cruz County (06087)

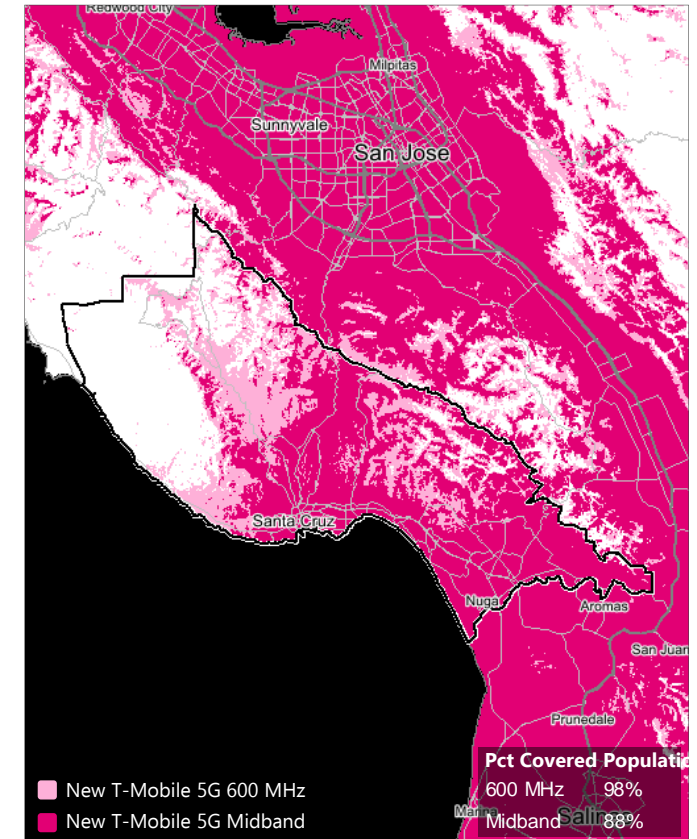
T-Mobile Standalone



Sprint Standalone

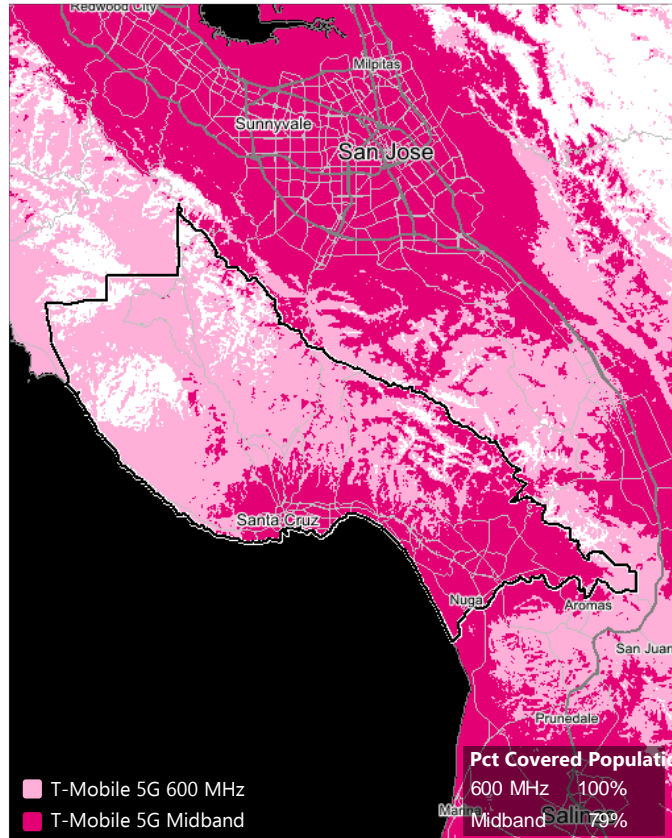


New T-Mobile

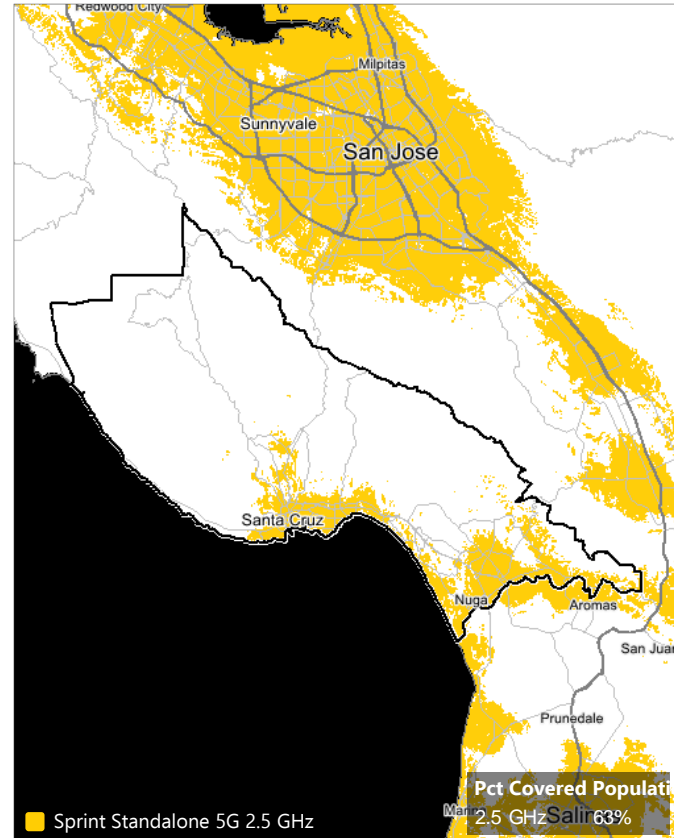


Projected 2024 5G Coverage: Santa Cruz County (06087)

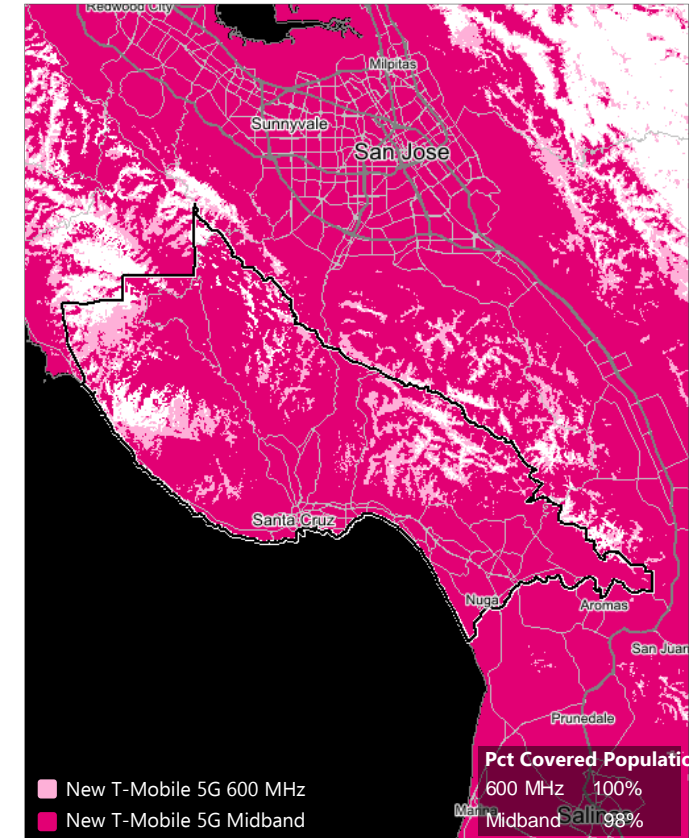
T-Mobile Standalone



Sprint Standalone

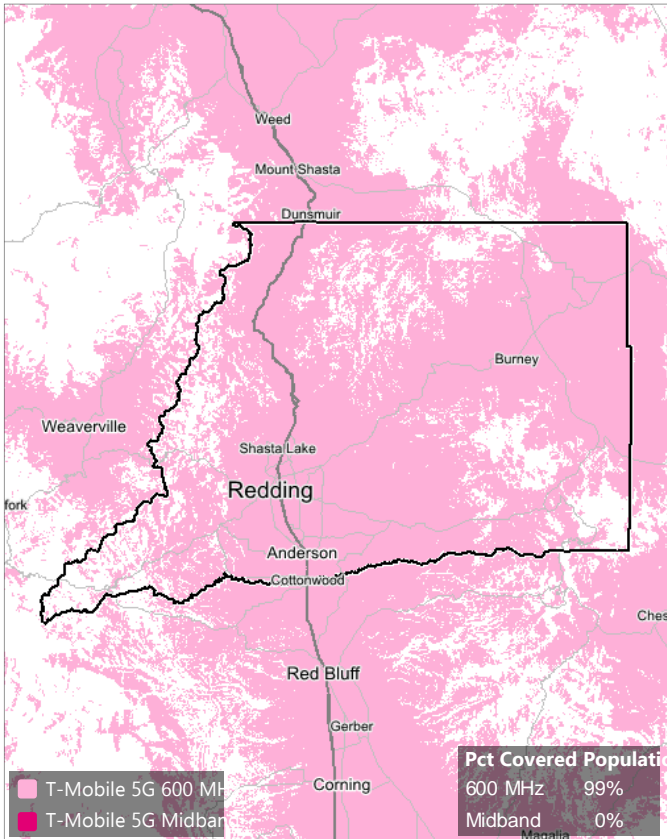


New T-Mobile

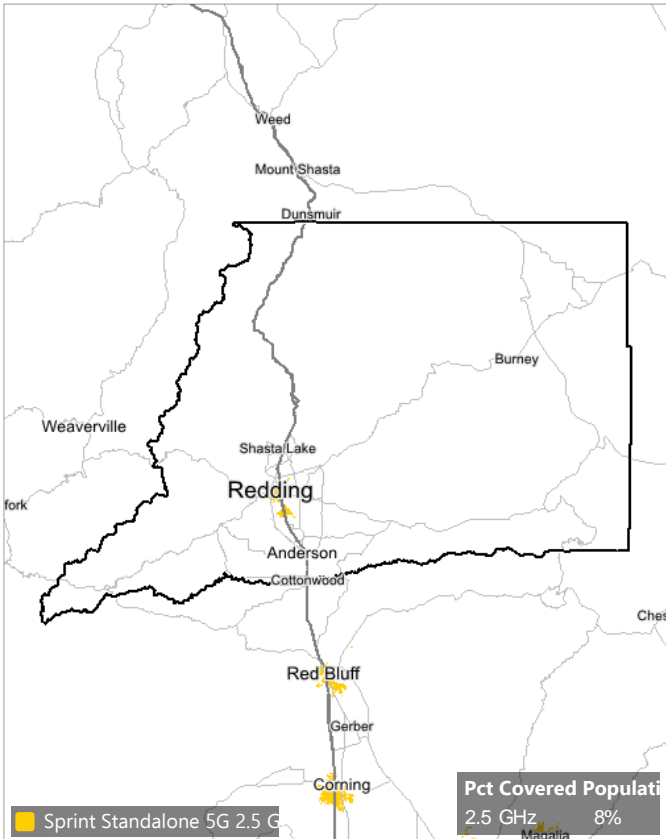


Projected 2021 5G Coverage: Shasta County (06089)

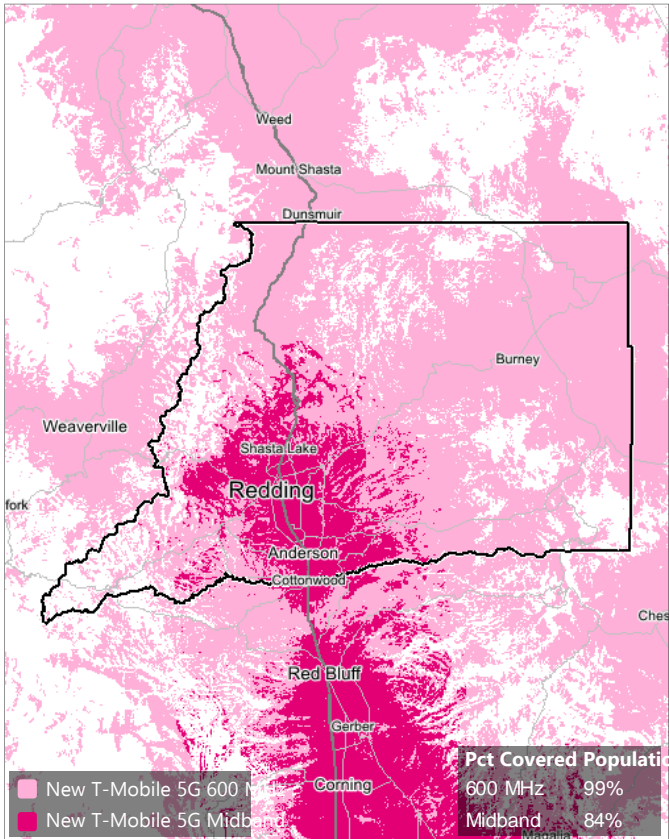
T-Mobile Standalone



Sprint Standalone

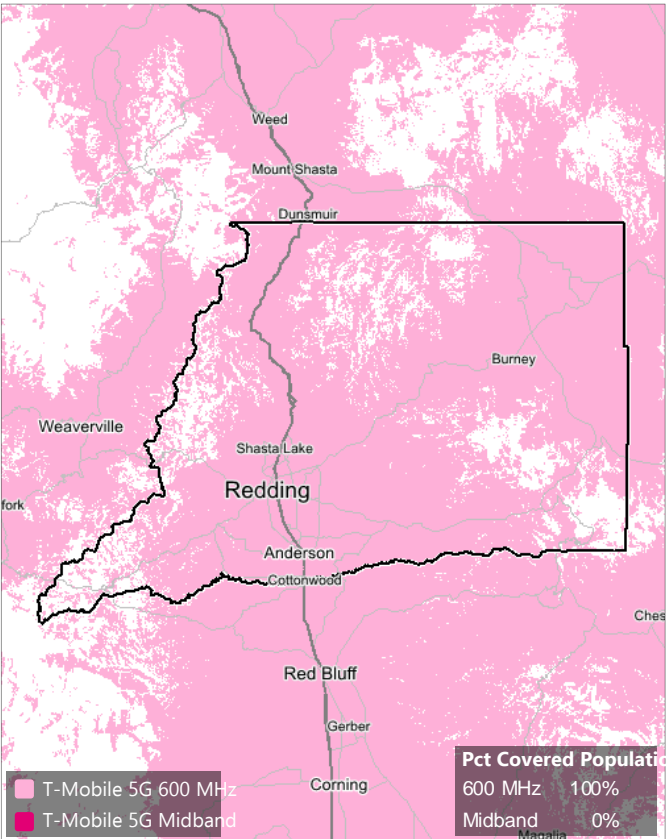


New T-Mobile

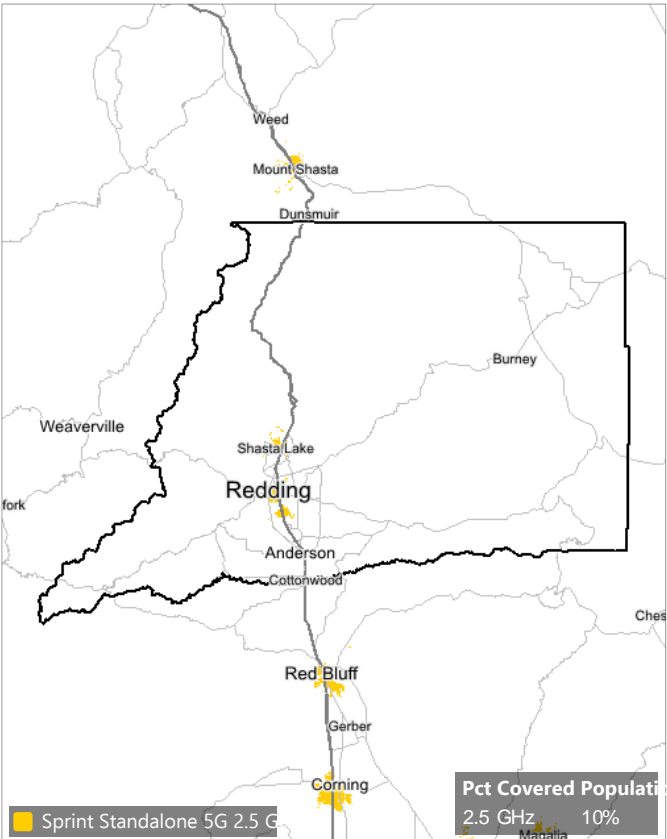


Projected 2024 5G Coverage: Shasta County (06089)

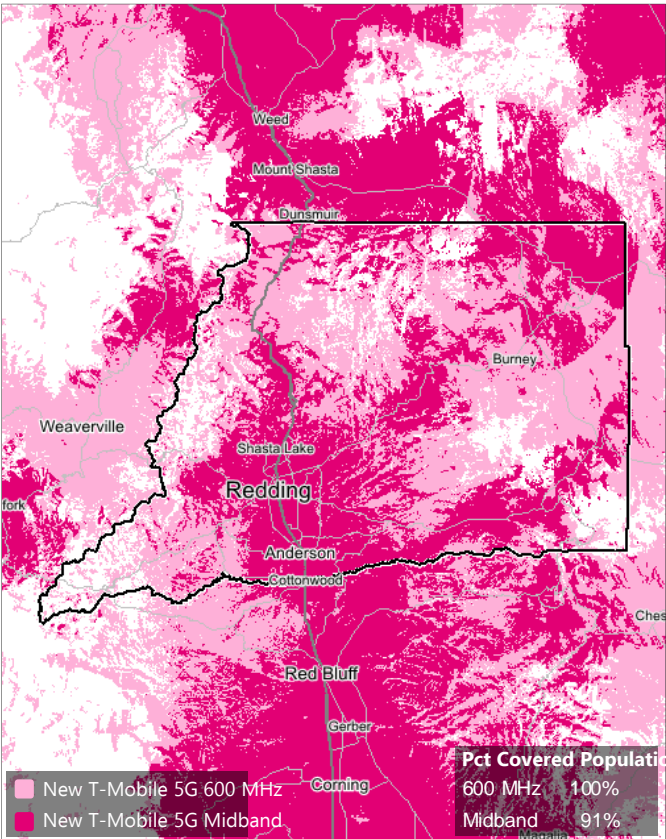
T-Mobile Standalone



Sprint Standalone

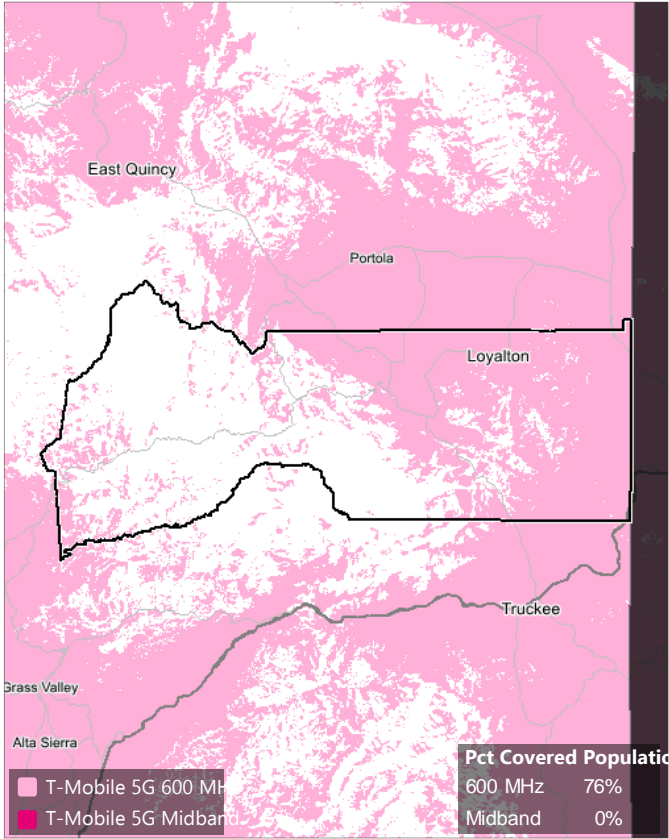


New T-Mobile

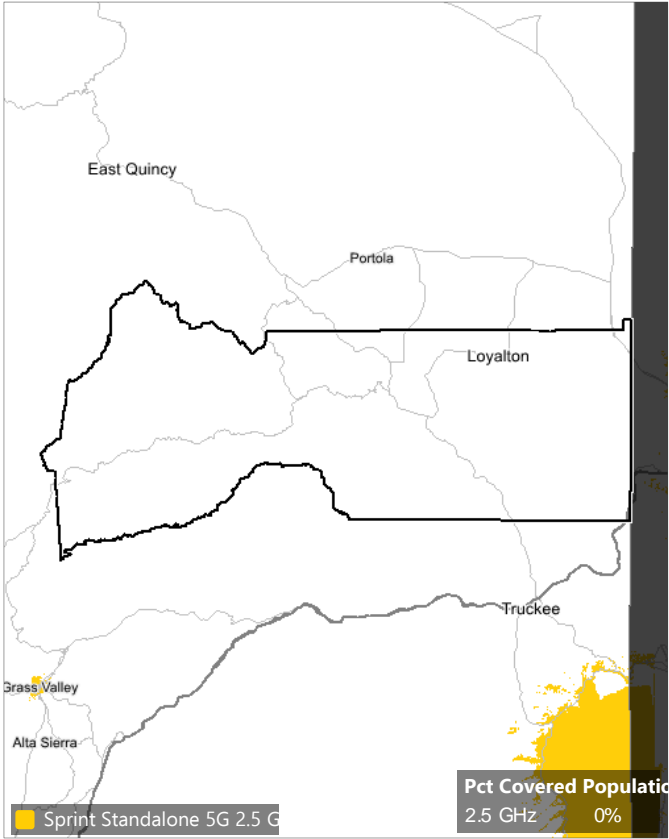


Projected 2021 5G Coverage: Sierra County (06091)

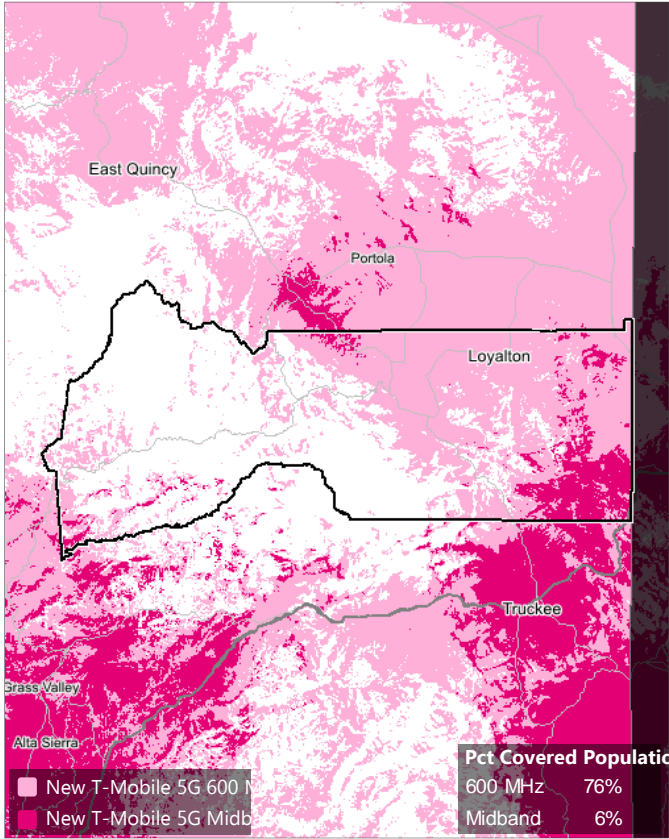
T-Mobile Standalone



Sprint Standalone

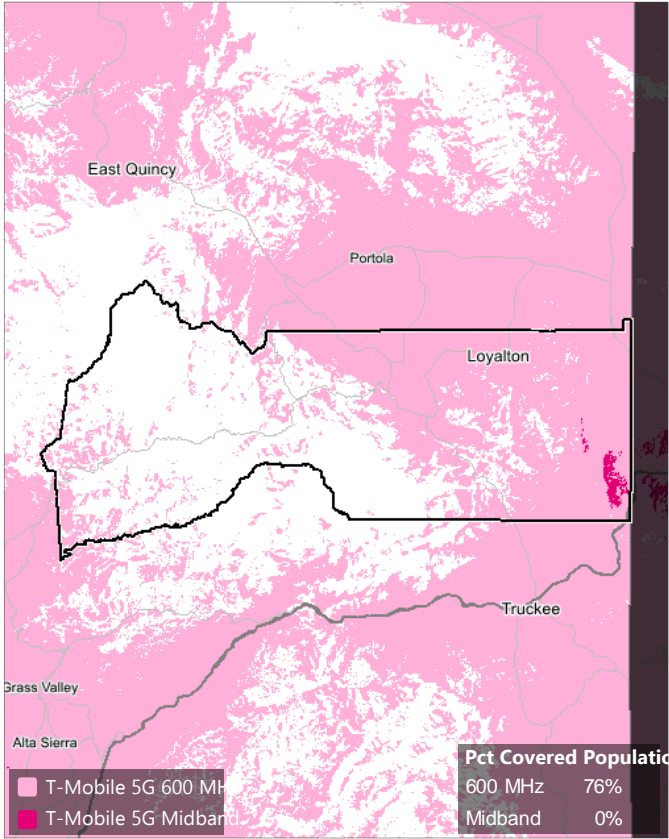


New T-Mobile

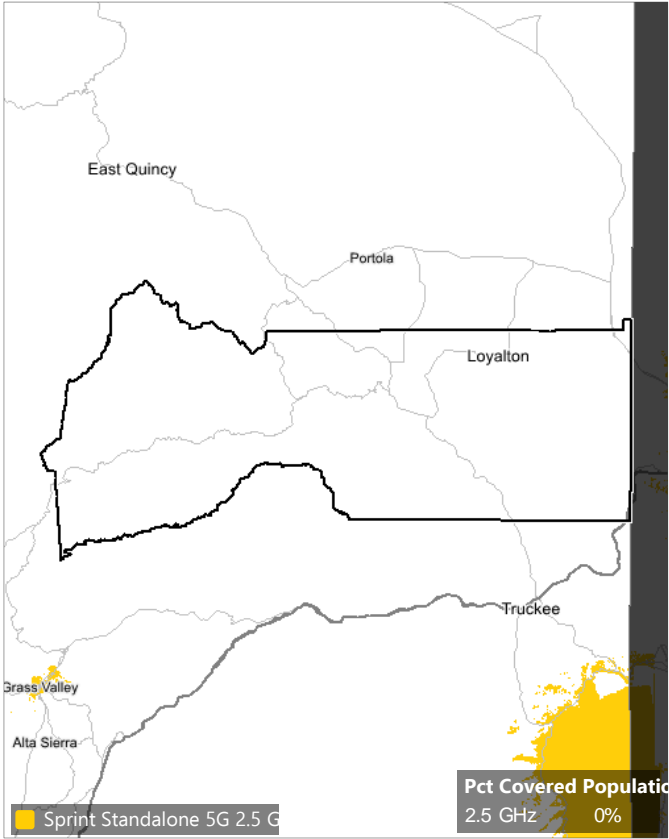


Projected 2024 5G Coverage: Sierra County (06091)

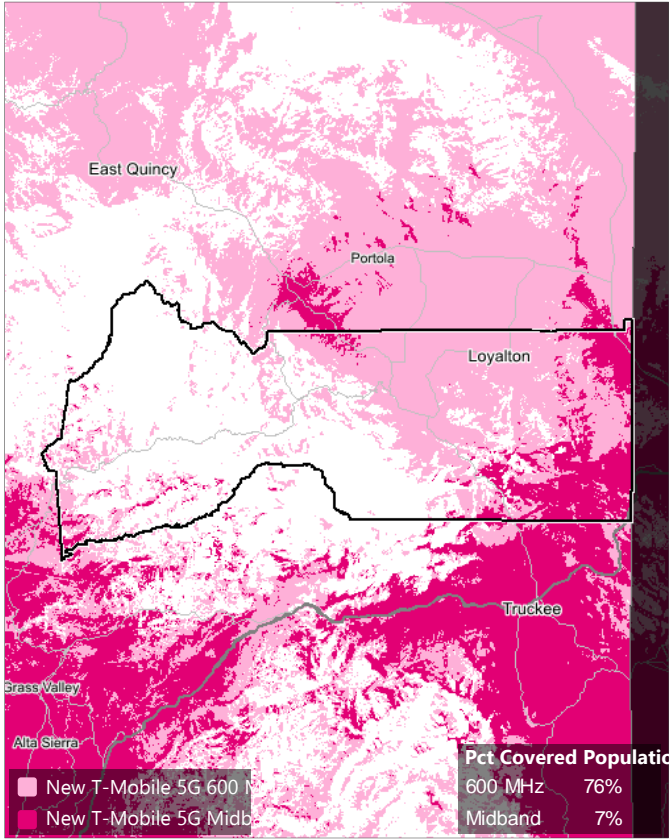
T-Mobile Standalone



Sprint Standalone

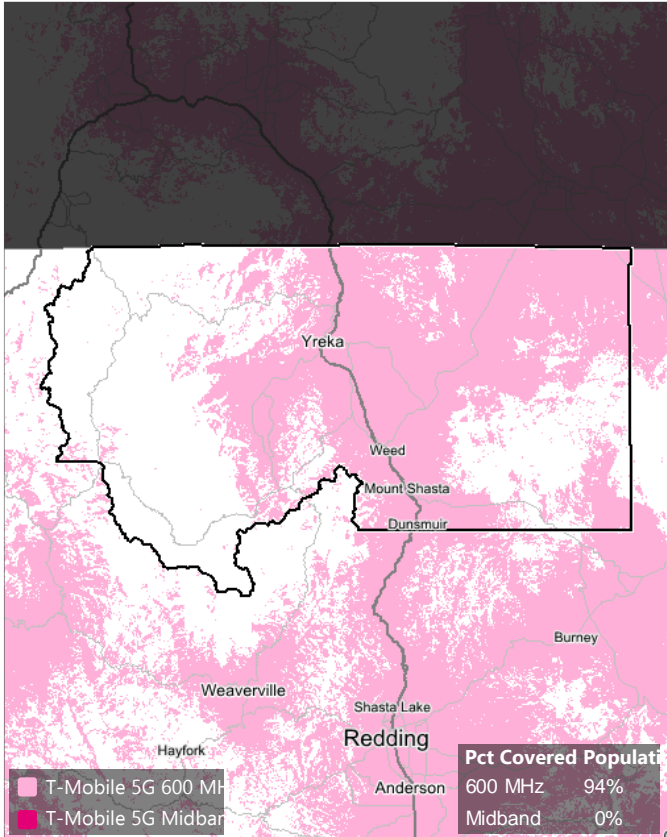


New T-Mobile

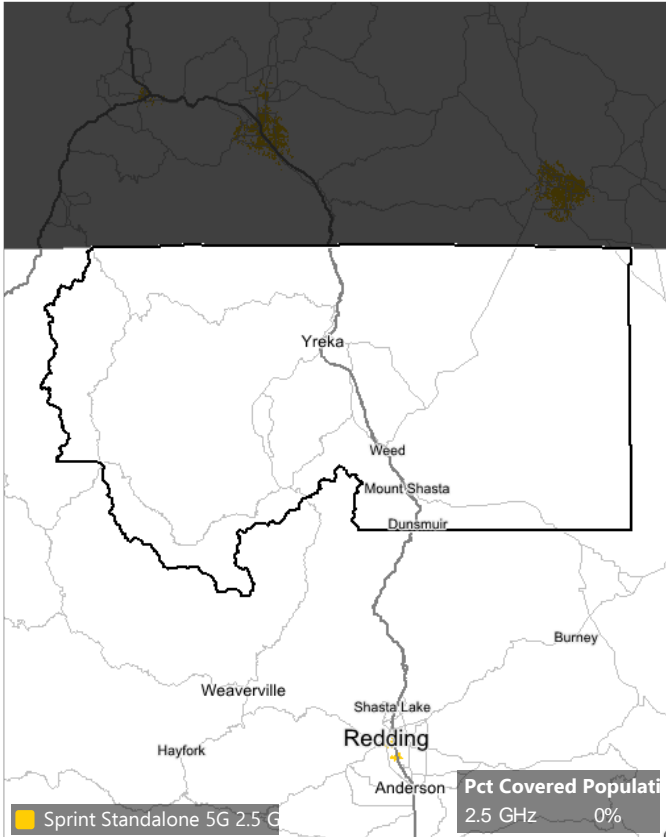


Projected 2021 5G Coverage: Siskiyou County (06093)

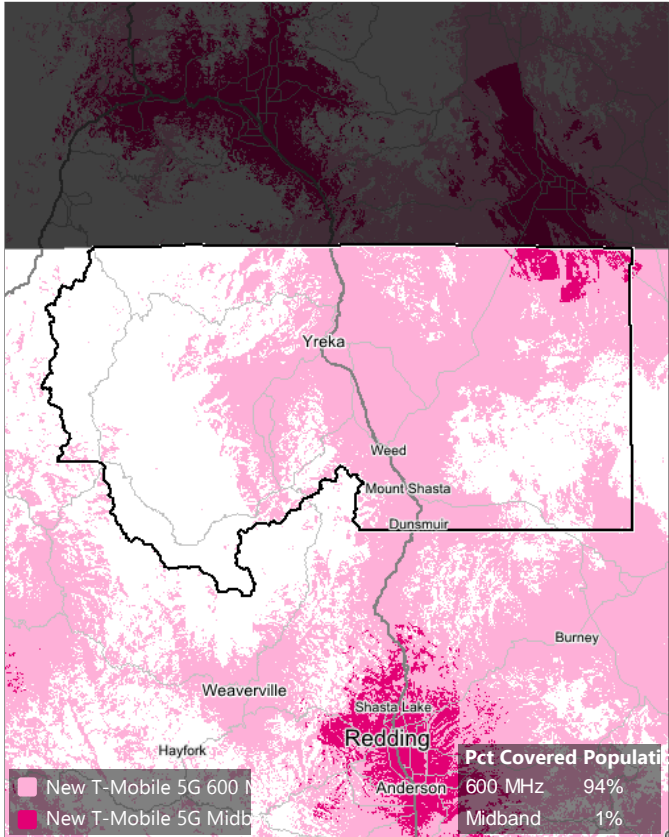
T-Mobile Standalone



Sprint Standalone

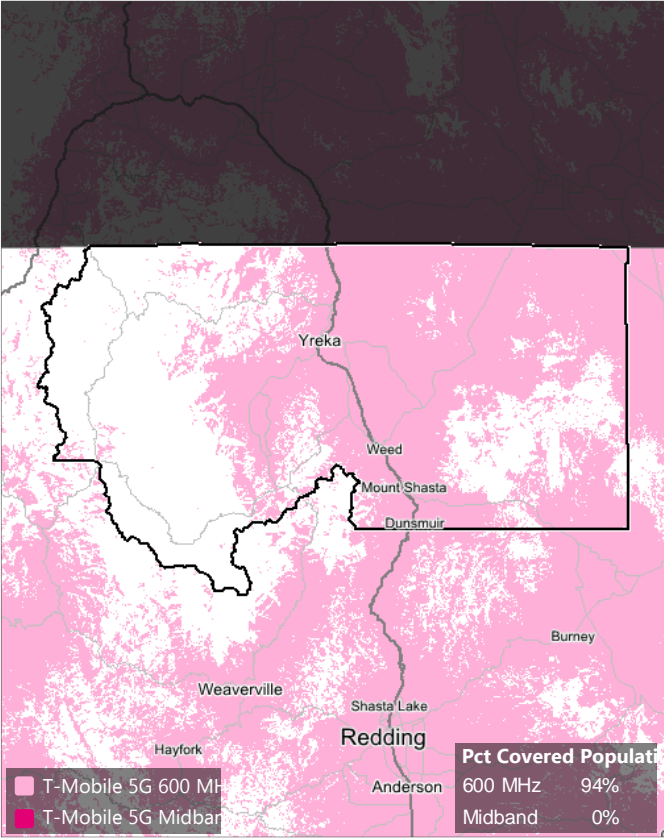


New T-Mobile

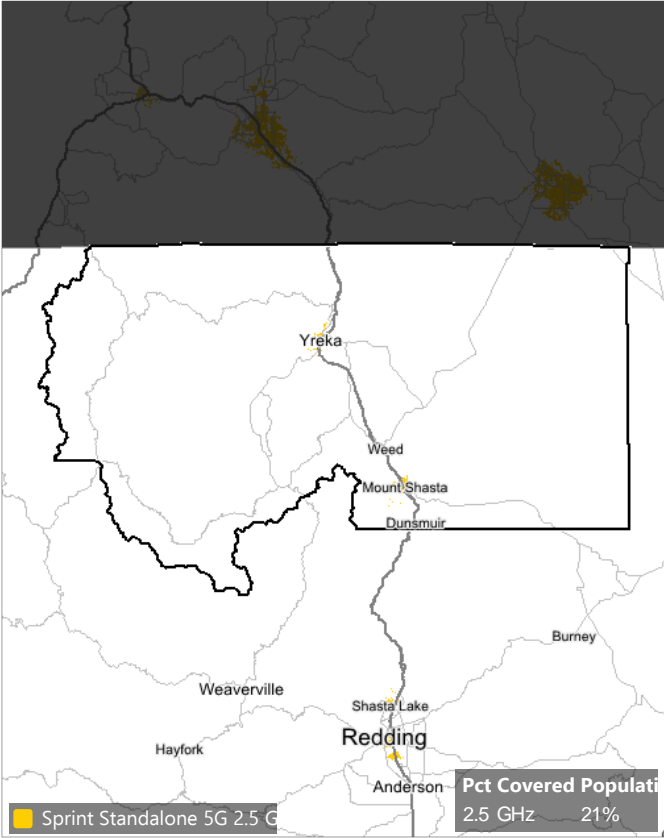


Projected 2024 5G Coverage: Siskiyou County (06093)

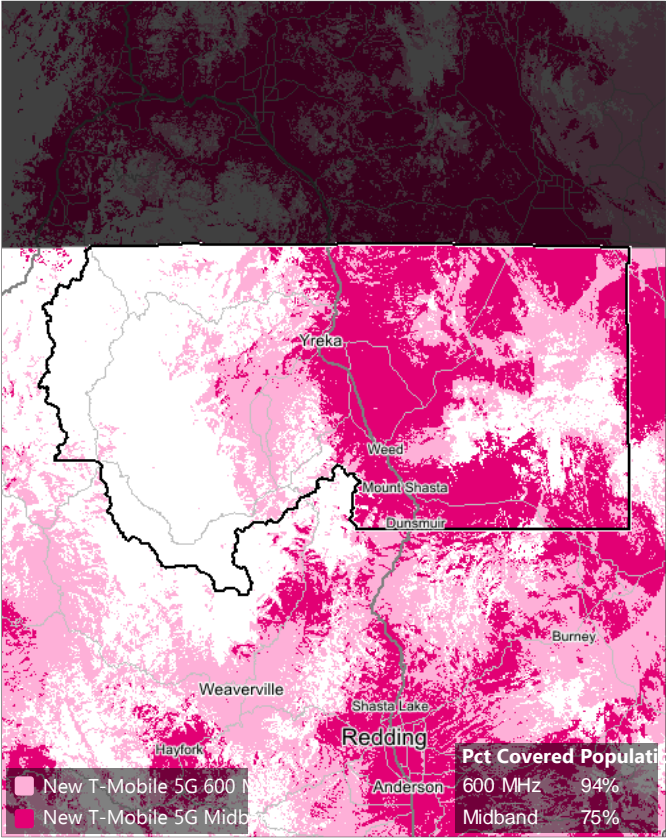
T-Mobile Standalone



Sprint Standalone

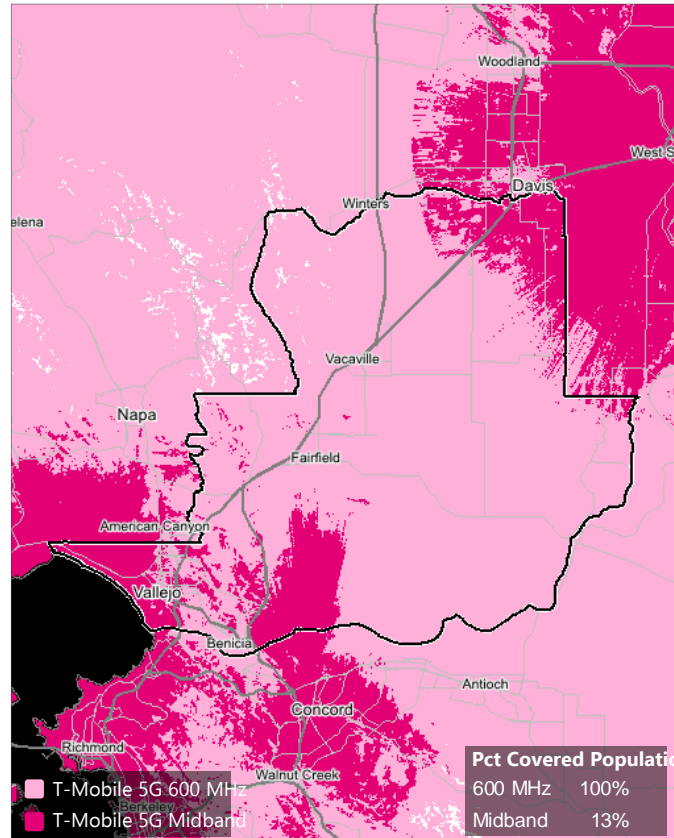


New T-Mobile

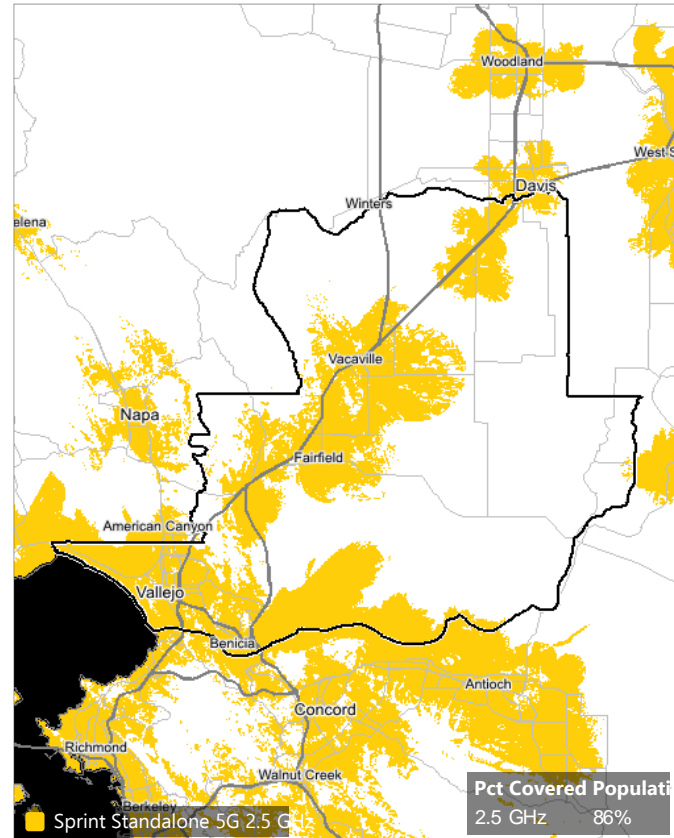


Projected 2021 5G Coverage: Solano County (06095)

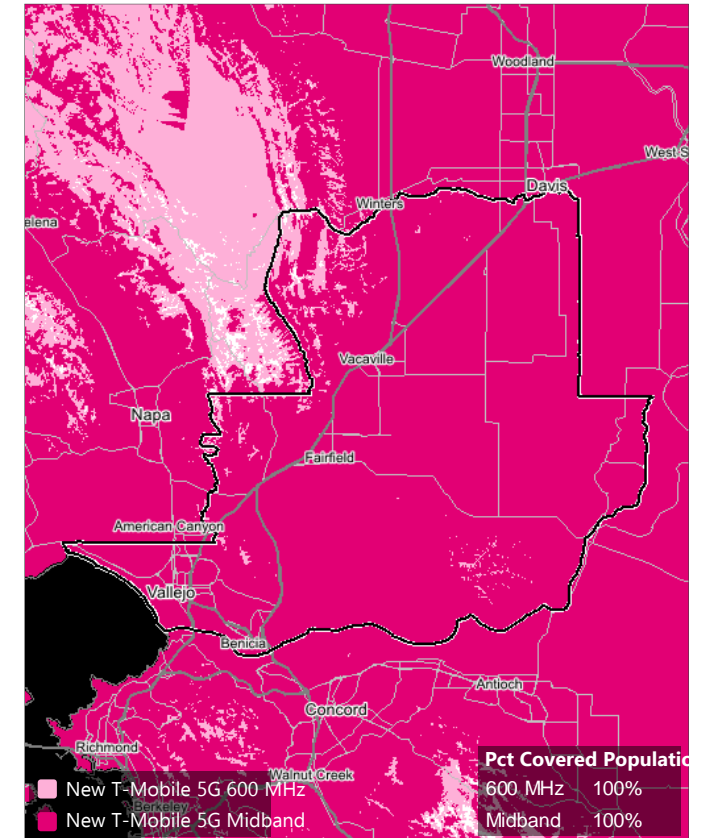
T-Mobile Standalone



Sprint Standalone

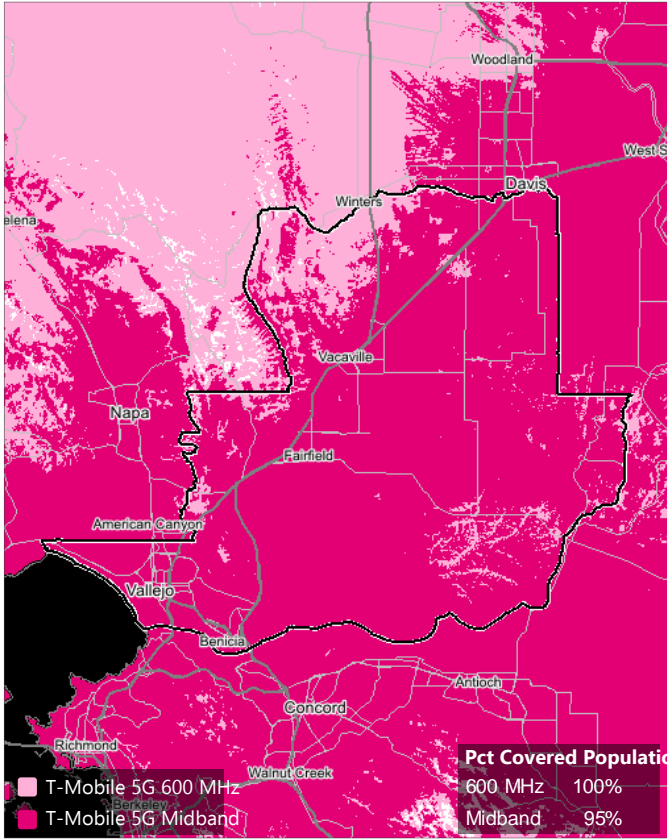


New T-Mobile

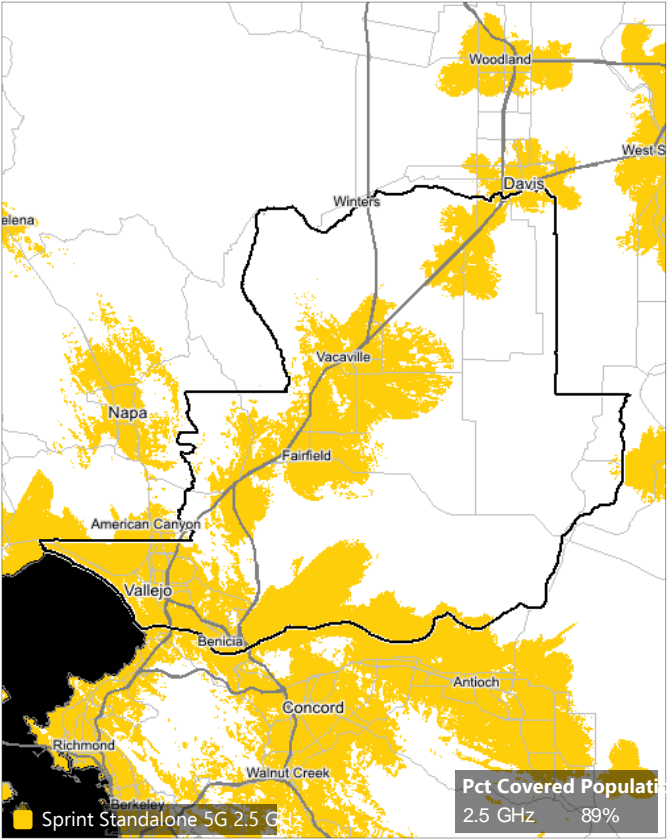


Projected 2024 5G Coverage: Solano County (06095)

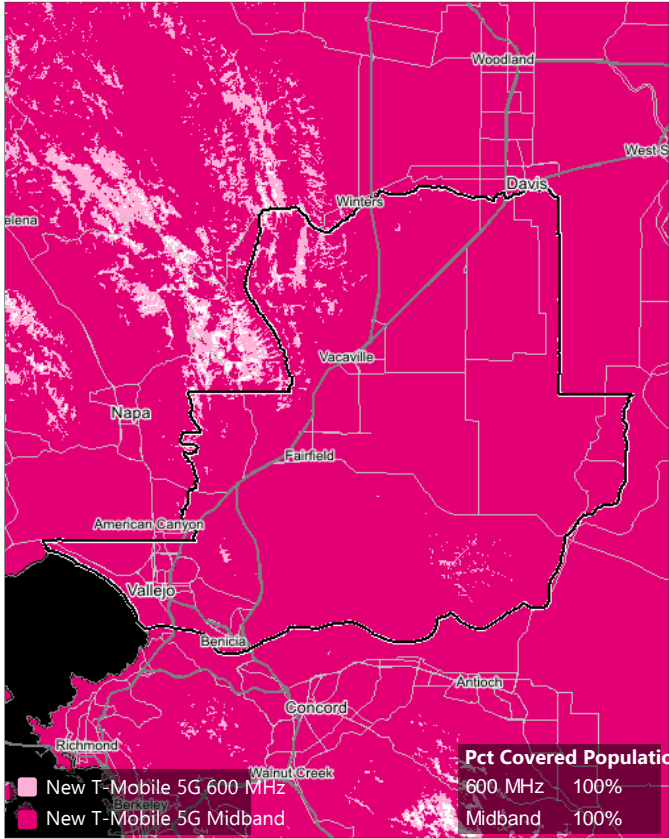
T-Mobile Standalone



Sprint Standalone

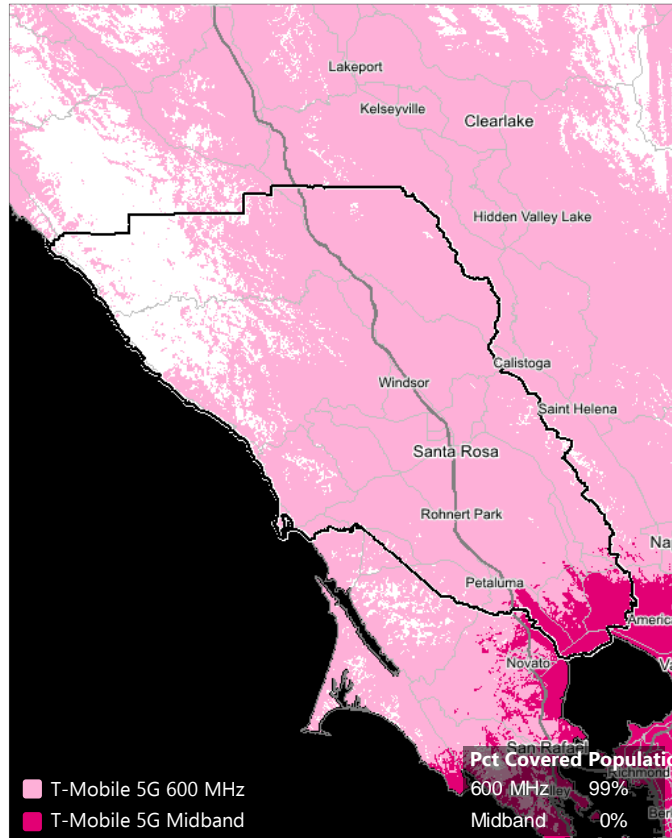


New T-Mobile

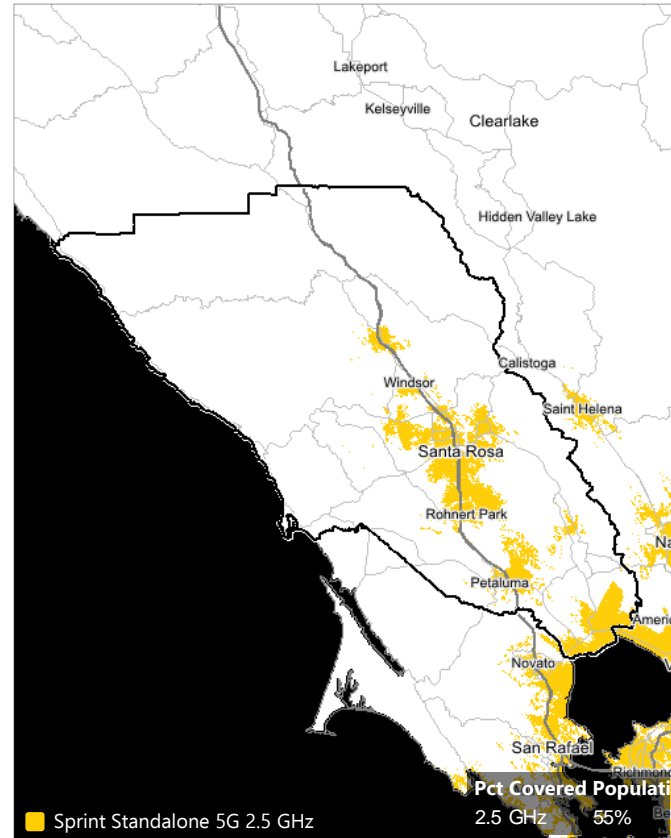


Projected 2021 5G Coverage: Sonoma County (06097)

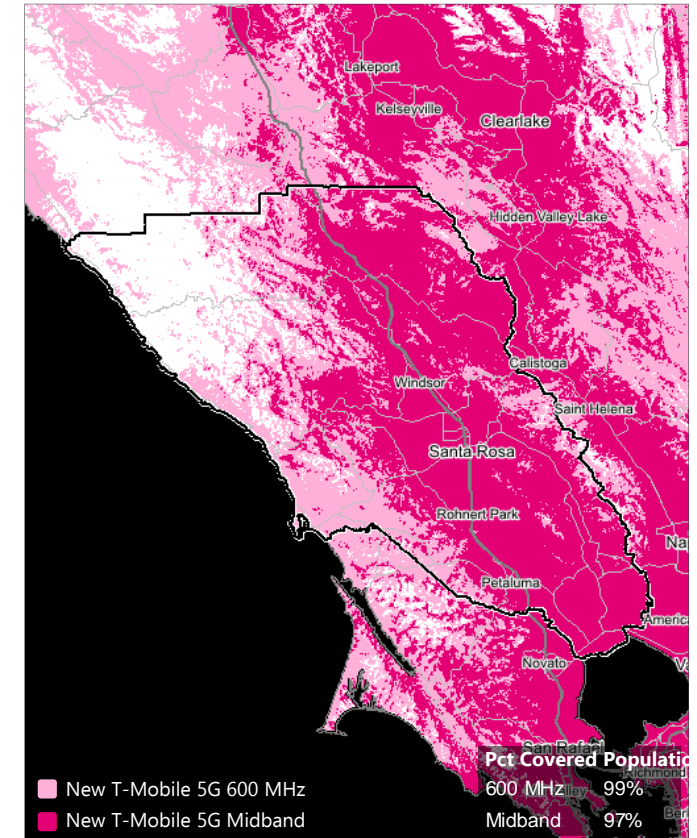
T-Mobile Standalone



Sprint Standalone

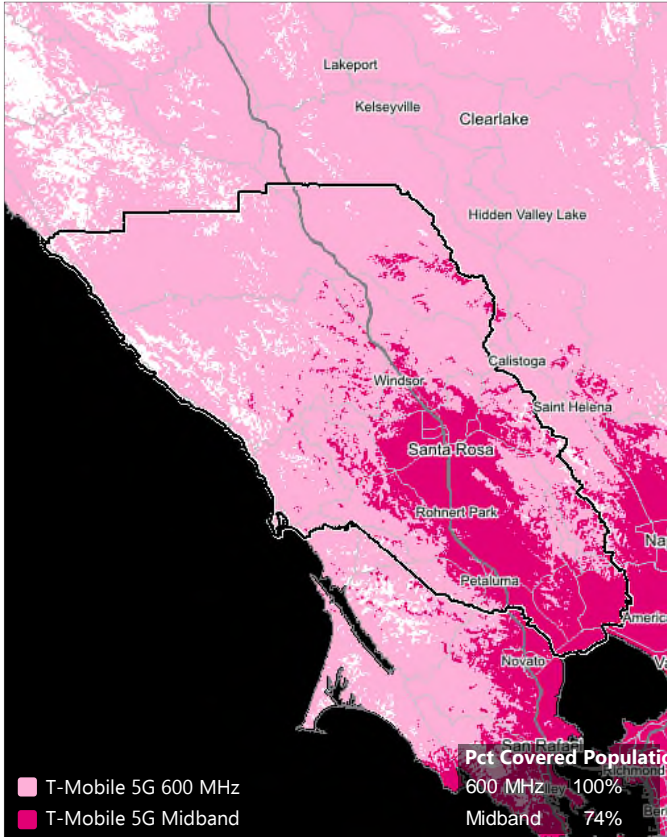


New T-Mobile

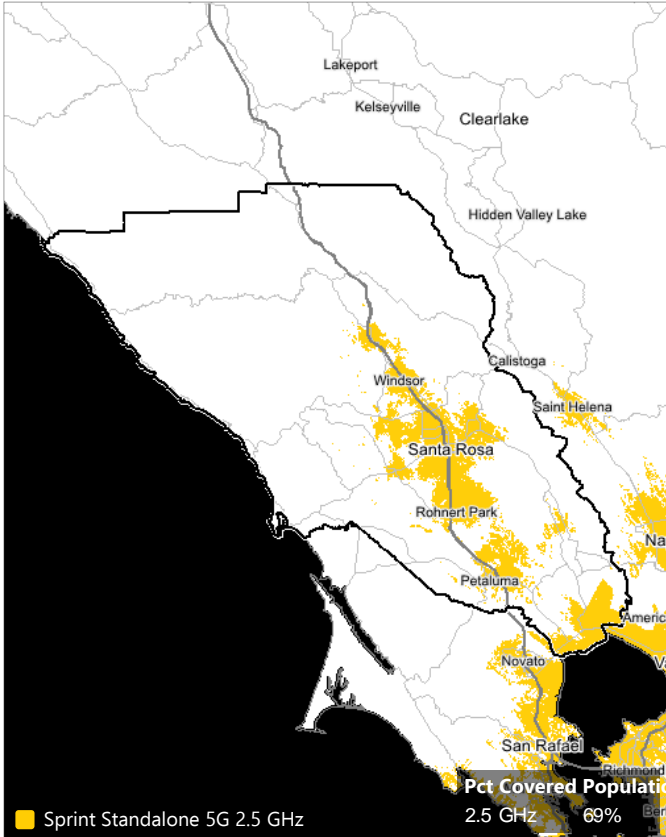


Projected 2024 5G Coverage: Sonoma County (06097)

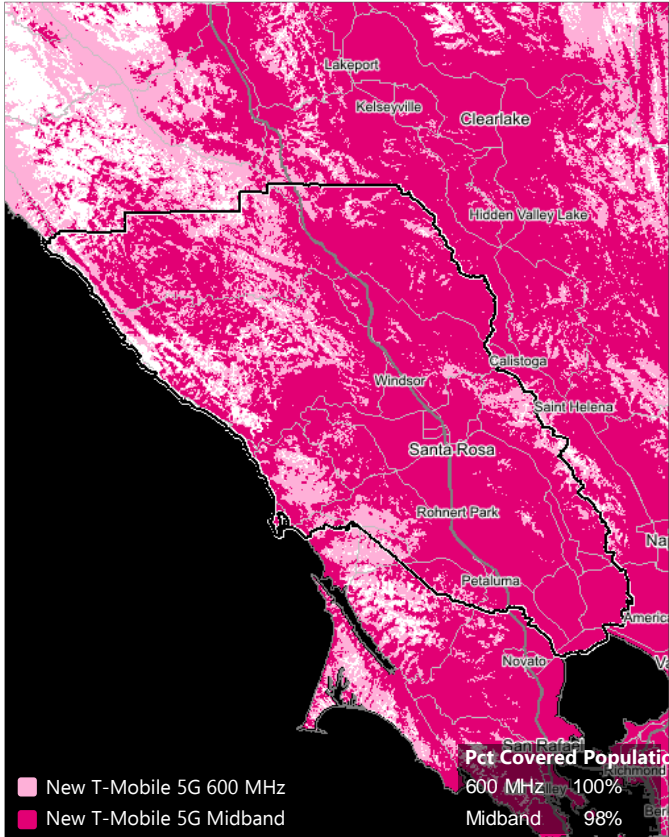
T-Mobile Standalone



Sprint Standalone

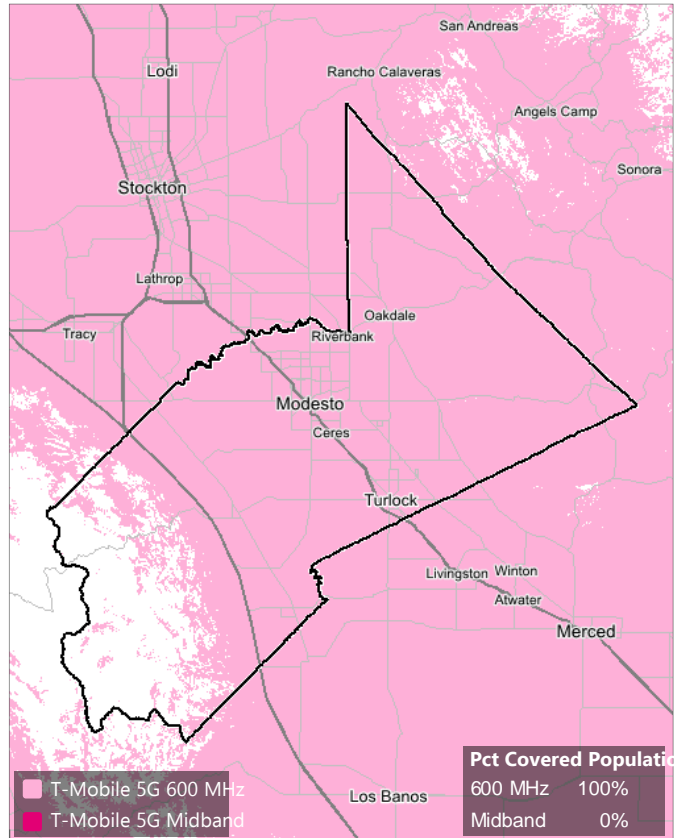


New T-Mobile

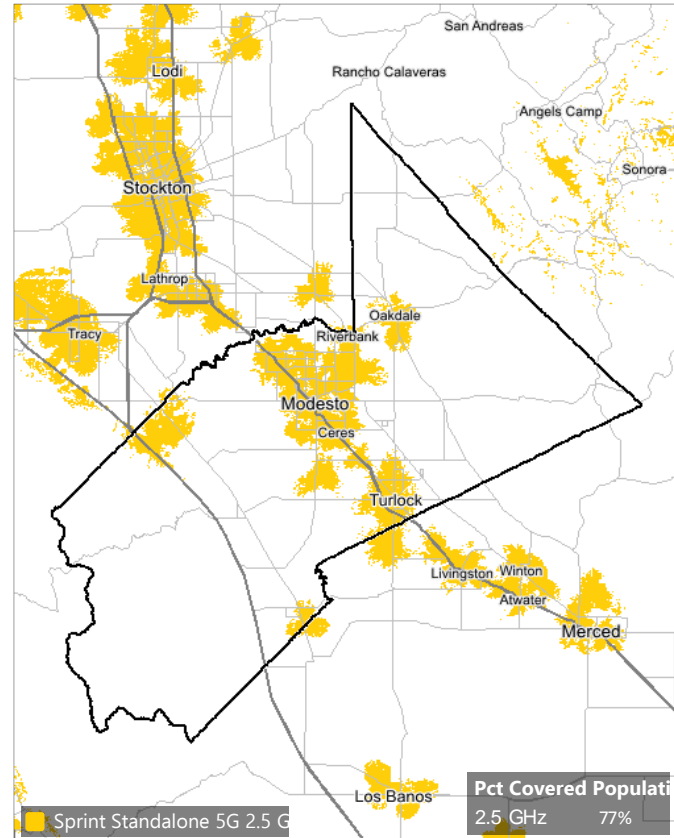


Projected 2021 5G Coverage: Stanislaus County (06099)

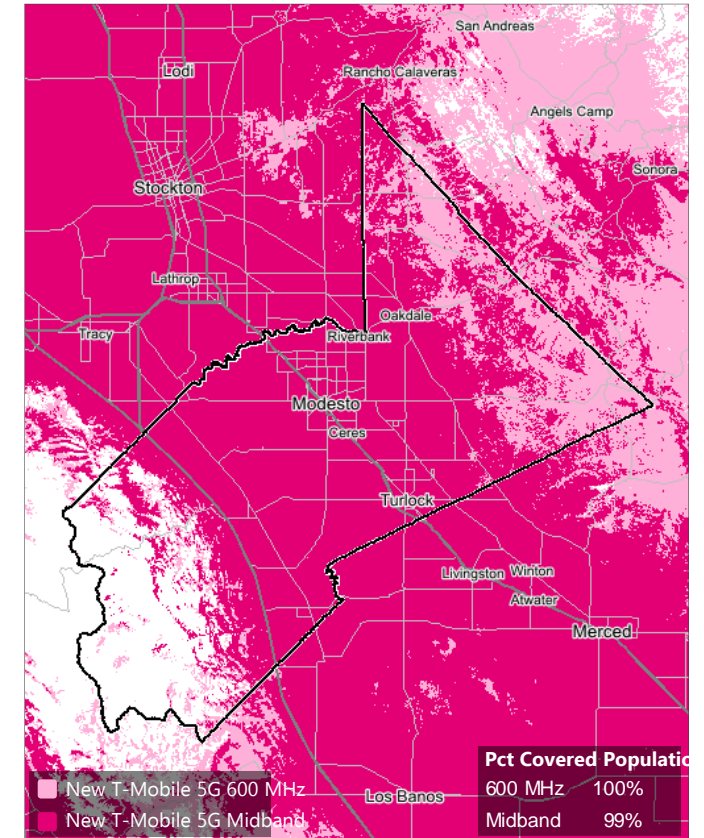
T-Mobile Standalone



Sprint Standalone

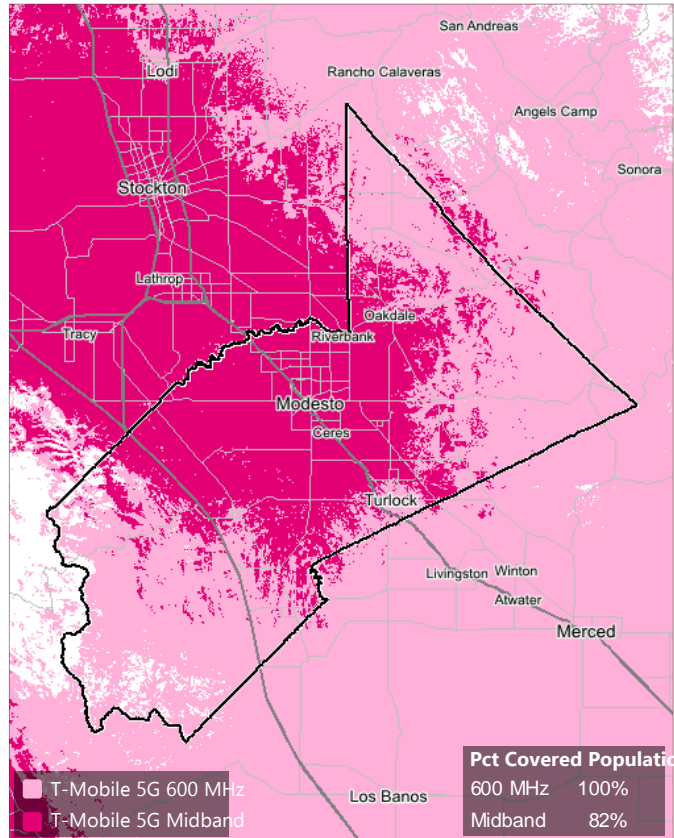


New T-Mobile

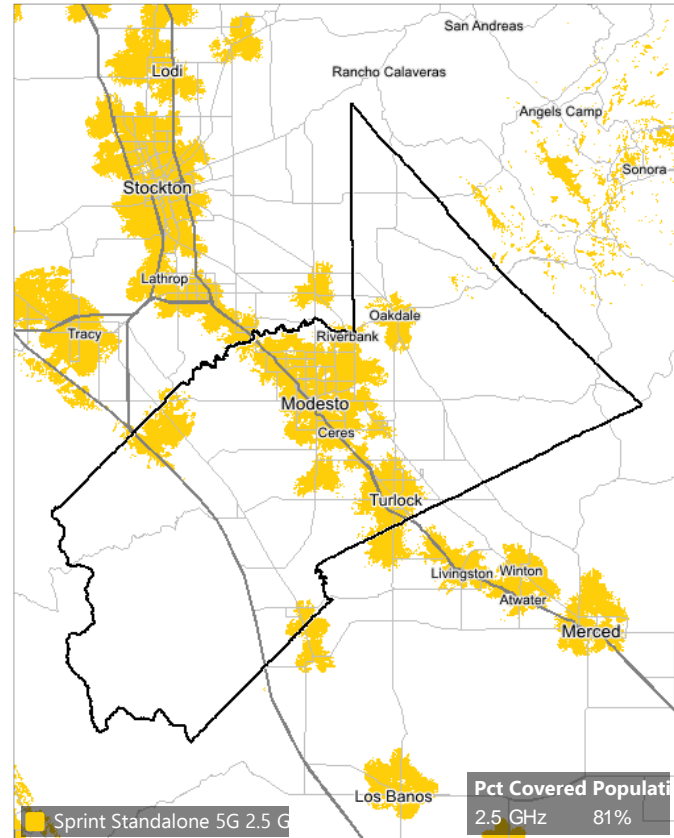


Projected 2024 5G Coverage: Stanislaus County (06099)

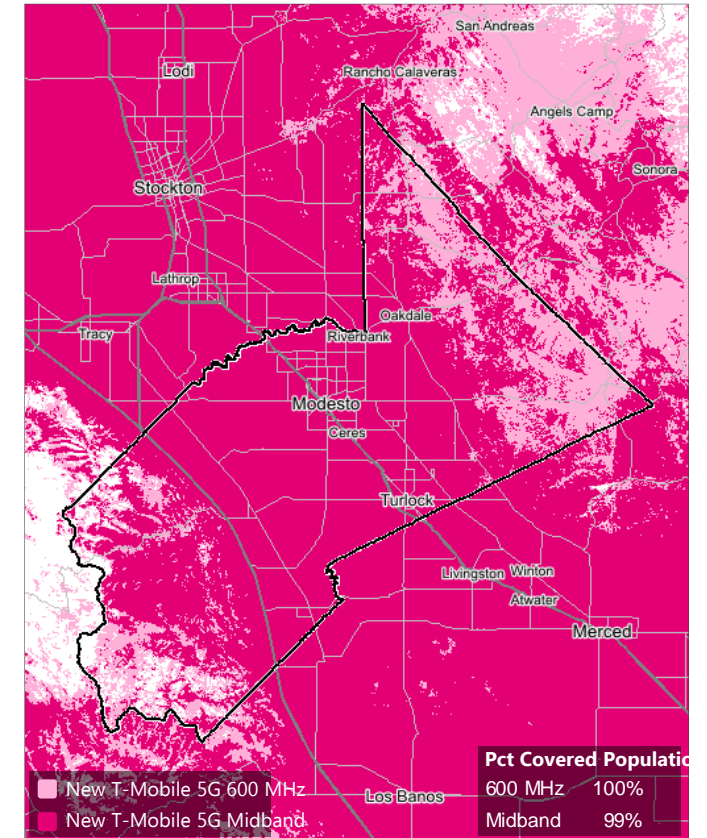
T-Mobile Standalone



Sprint Standalone

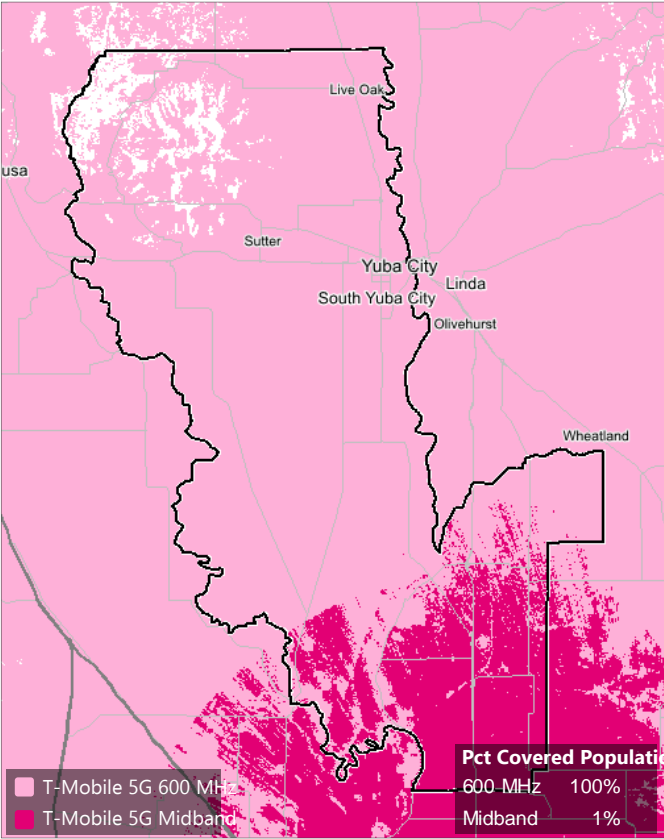


New T-Mobile

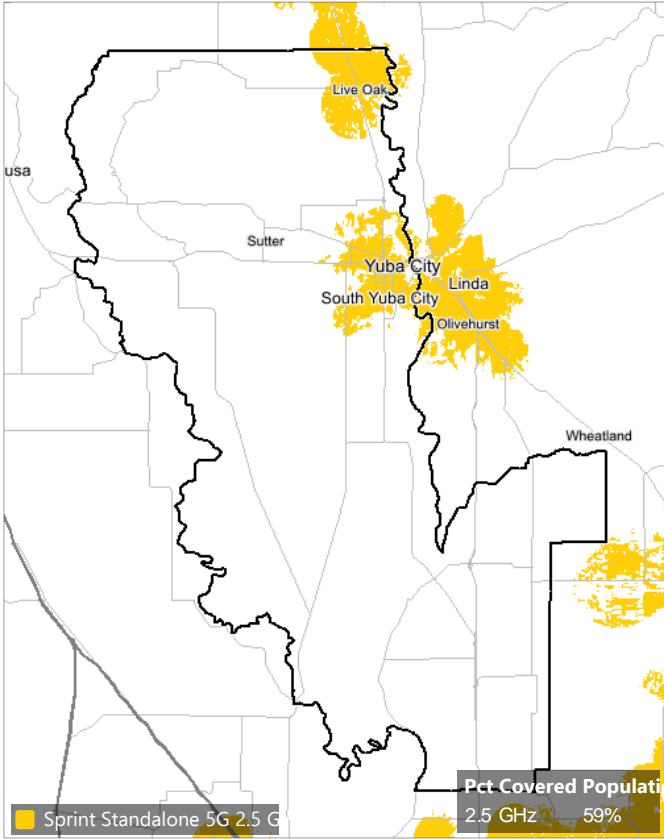


Projected 2021 5G Coverage: Sutter County (06101)

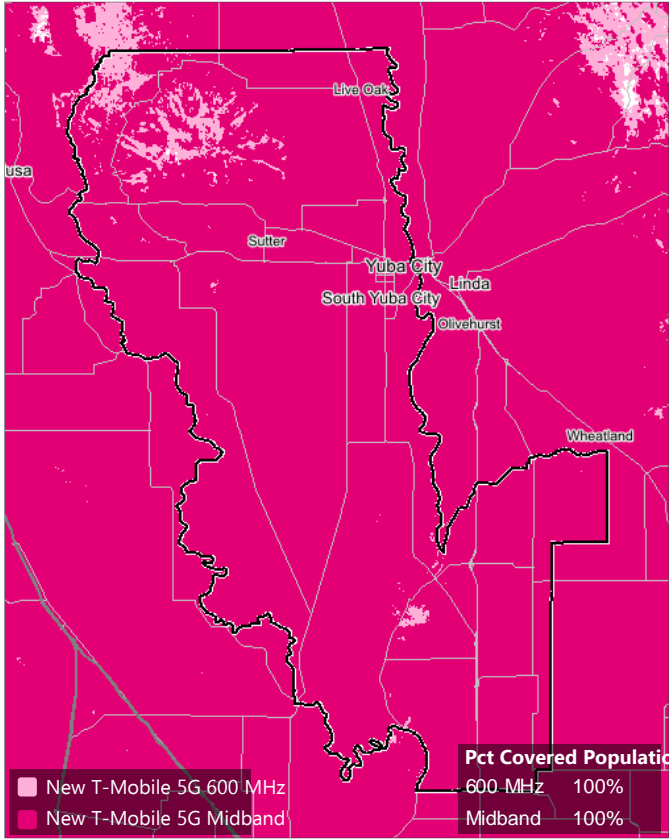
T-Mobile Standalone



Sprint Standalone

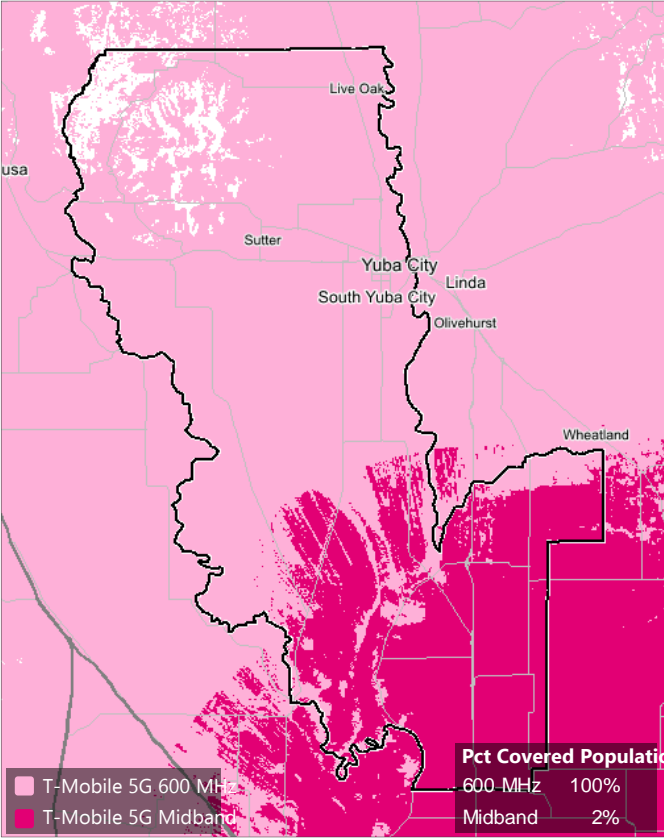


New T-Mobile

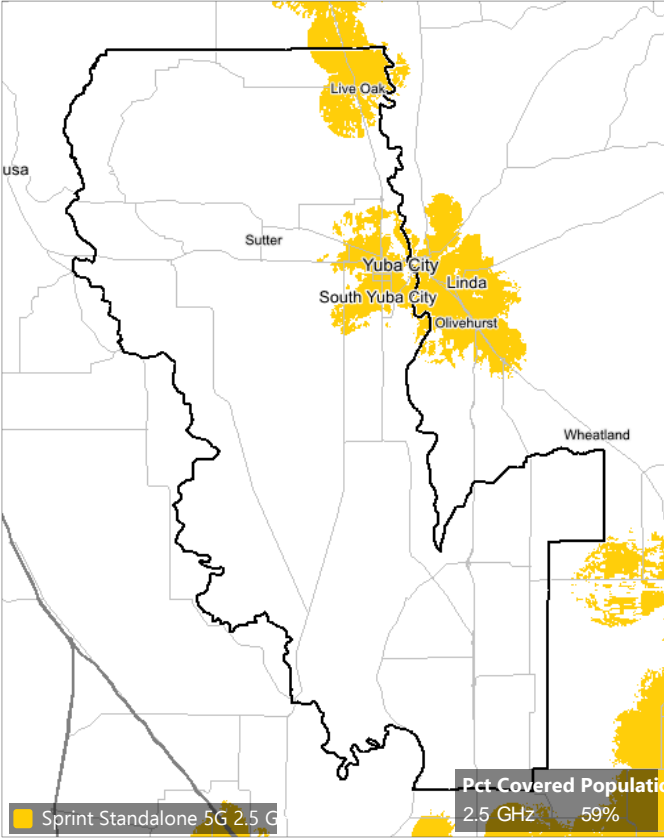


Projected 2024 5G Coverage: Sutter County (06101)

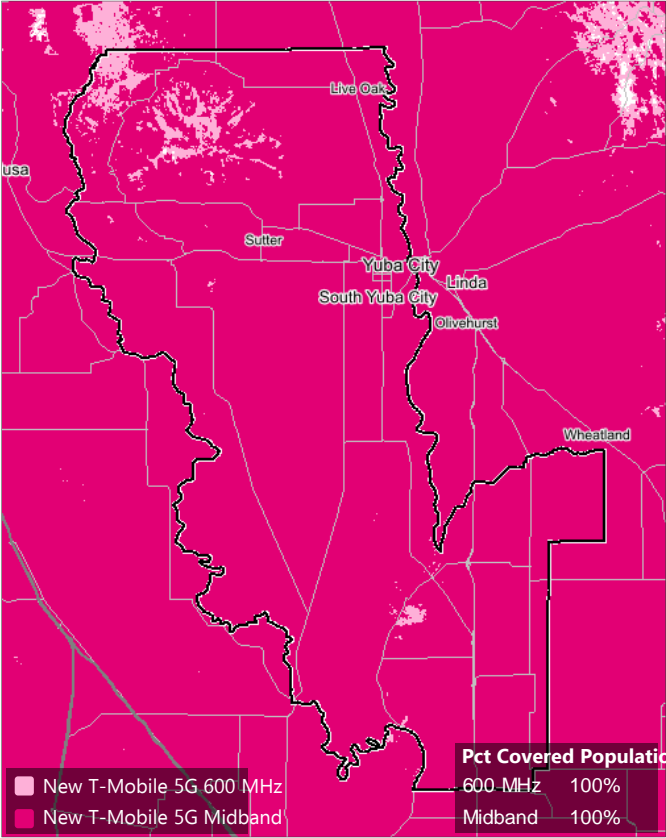
T-Mobile Standalone



Sprint Standalone

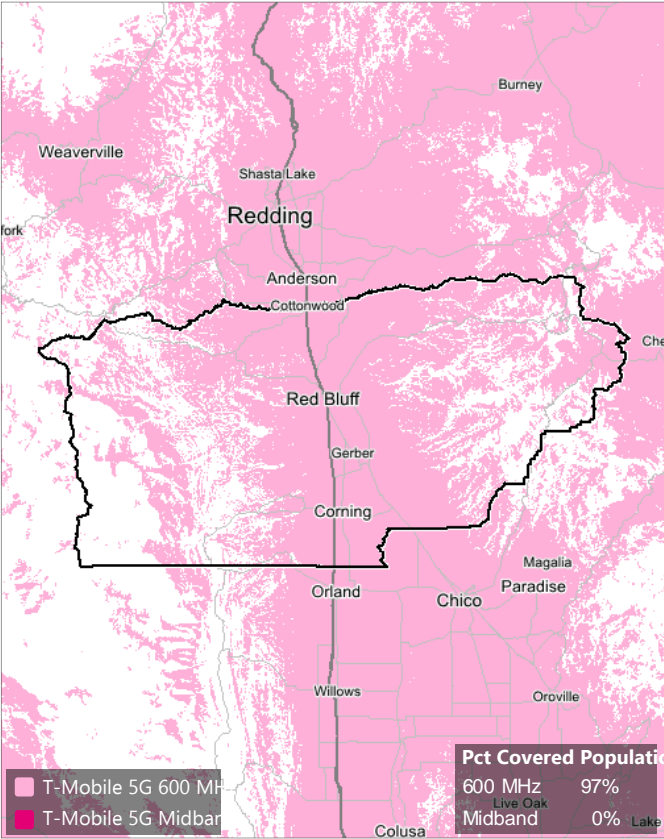


New T-Mobile

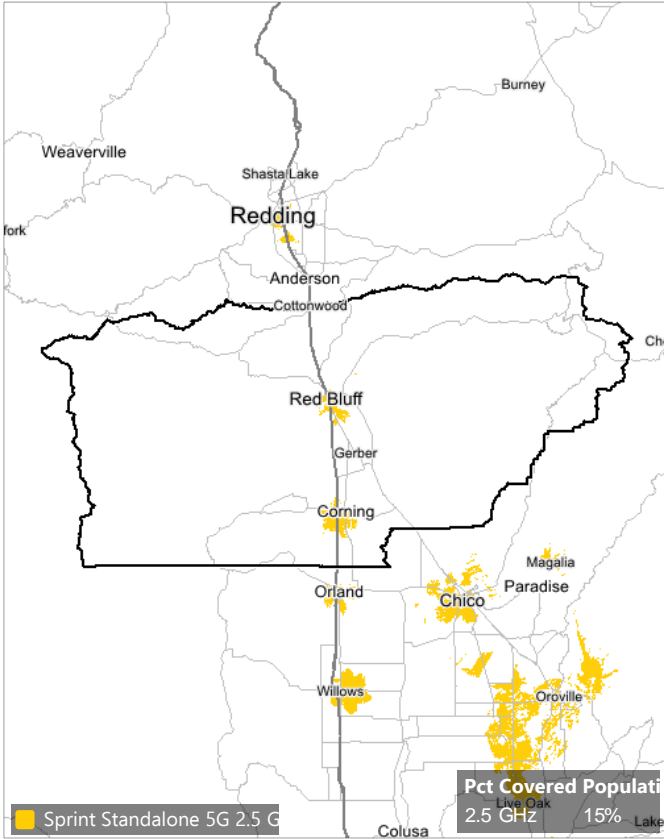


Projected 2021 5G Coverage: Tehama County (06103)

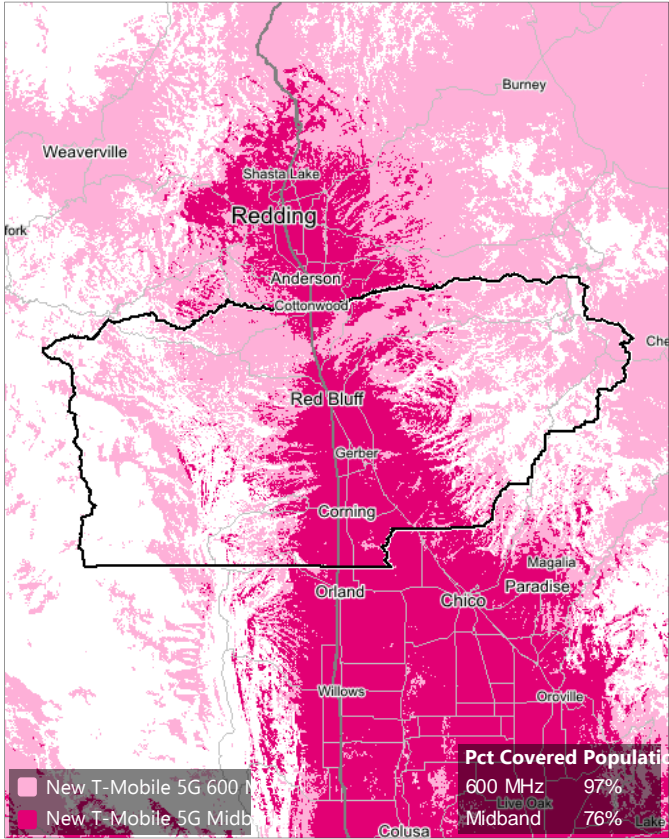
T-Mobile Standalone



Sprint Standalone

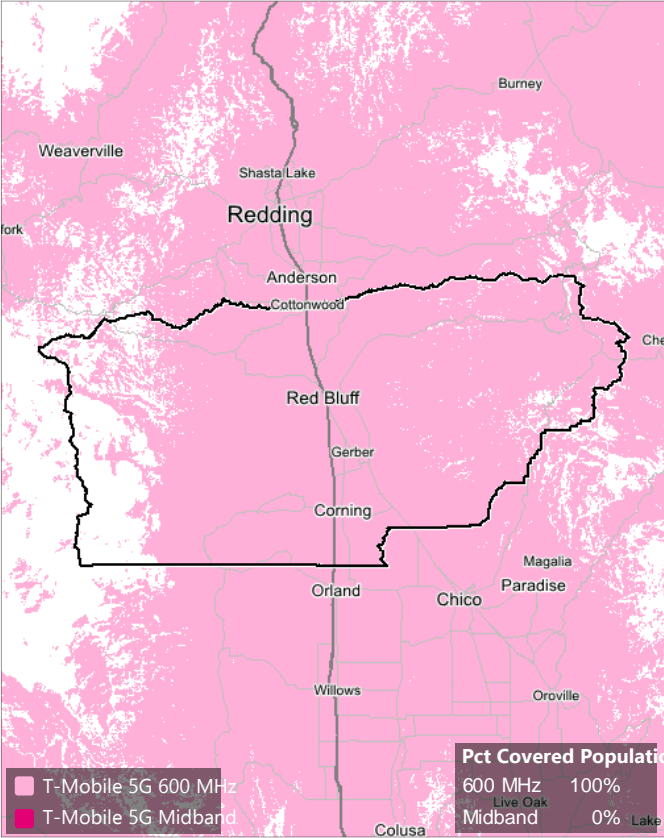


New T-Mobile

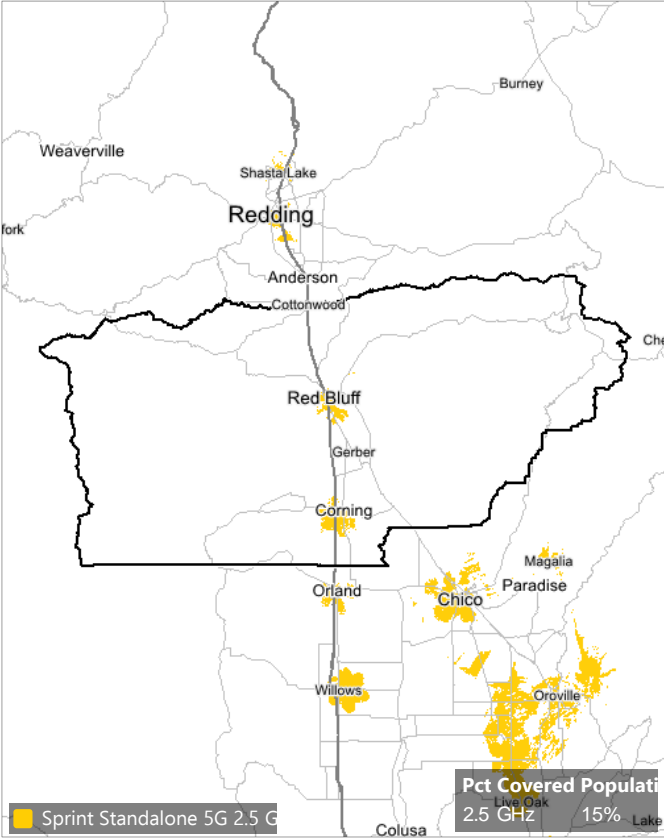


Projected 2024 5G Coverage: Tehama County (06103)

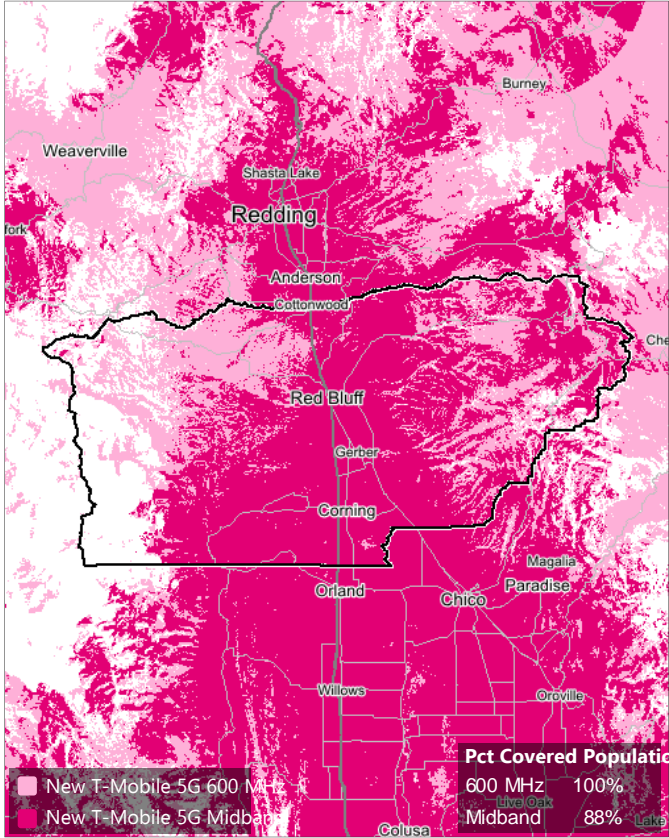
T-Mobile Standalone



Sprint Standalone

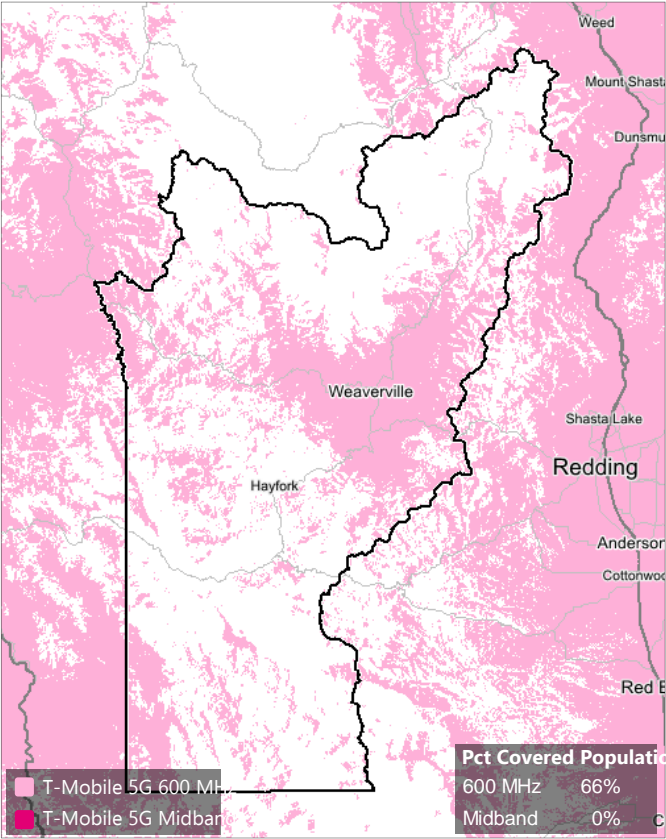


New T-Mobile

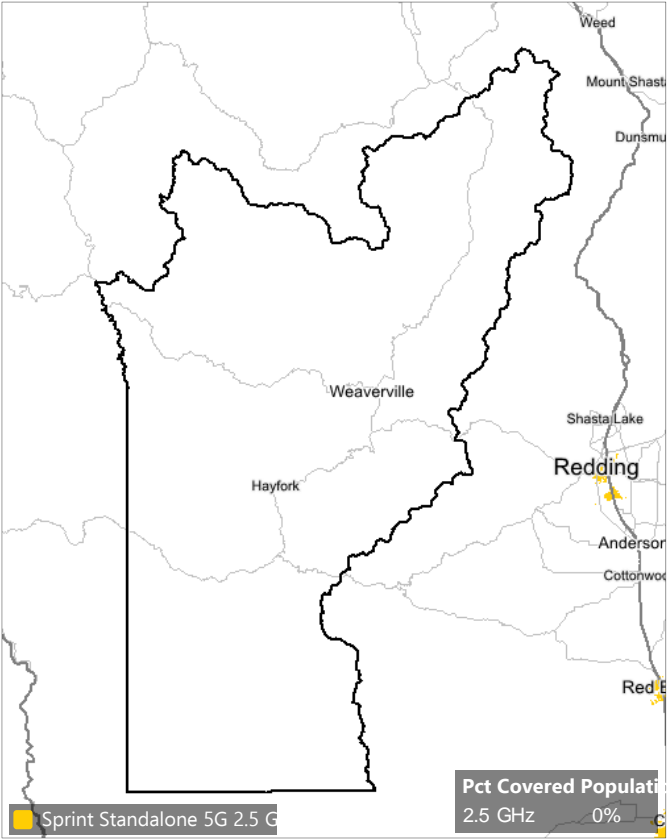


Projected 2021 5G Coverage: Trinity County (06105)

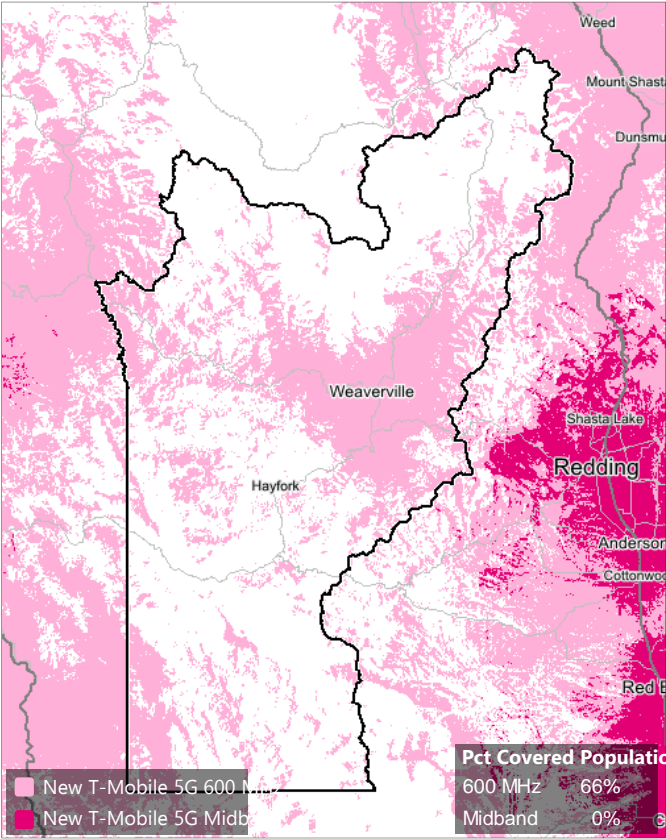
T-Mobile Standalone



Sprint Standalone

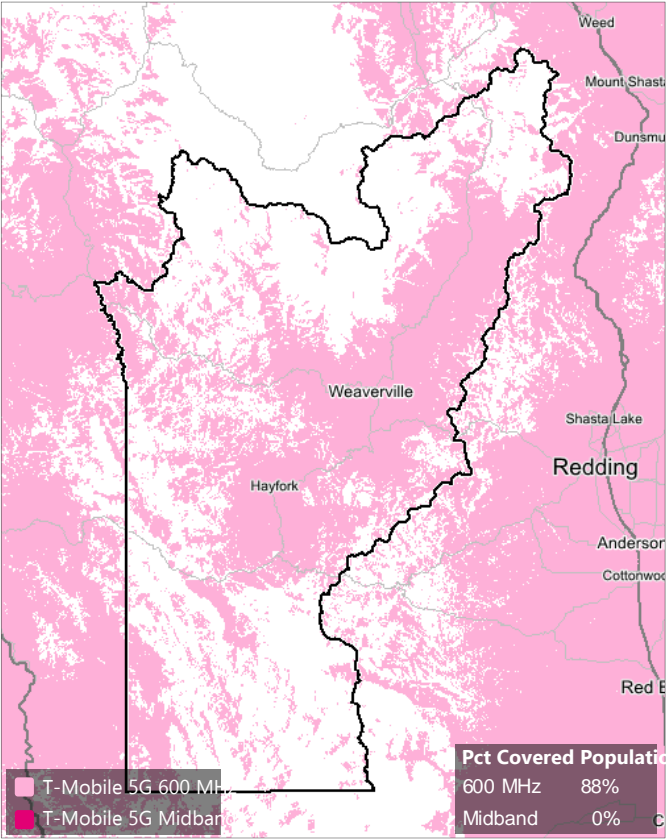


New T-Mobile

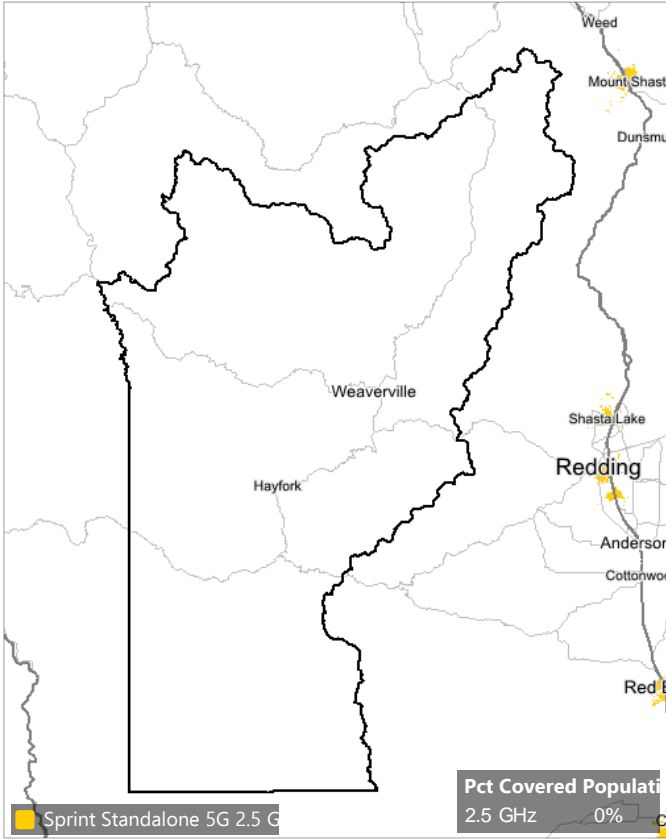


Projected 2024 5G Coverage: Trinity County (06105)

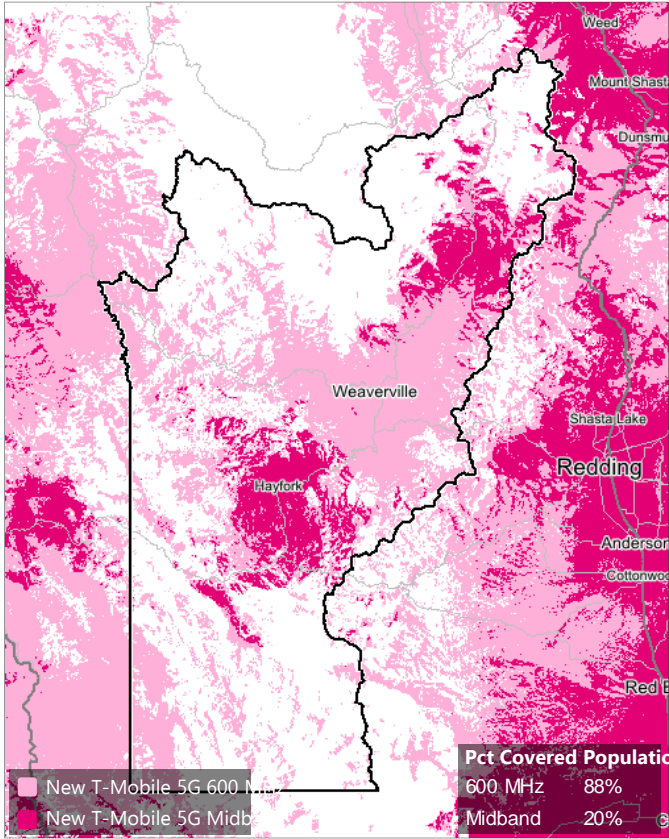
T-Mobile Standalone



Sprint Standalone

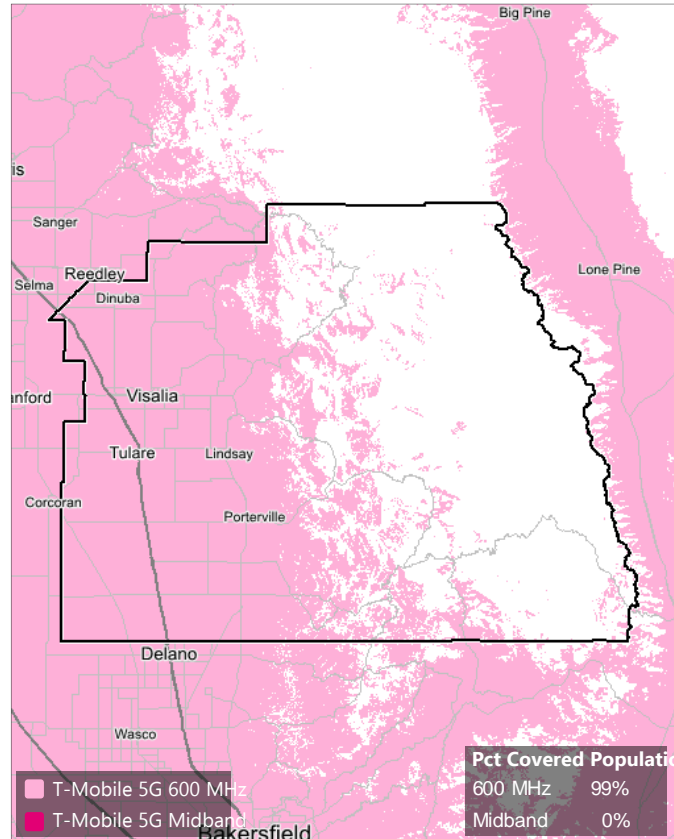


New T-Mobile

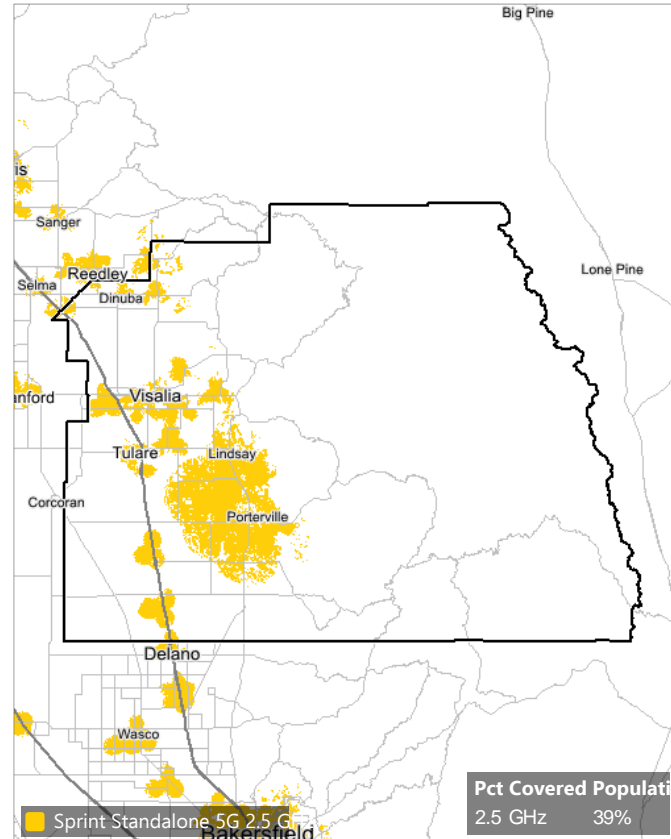


Projected 2021 5G Coverage: Tulare County (06107)

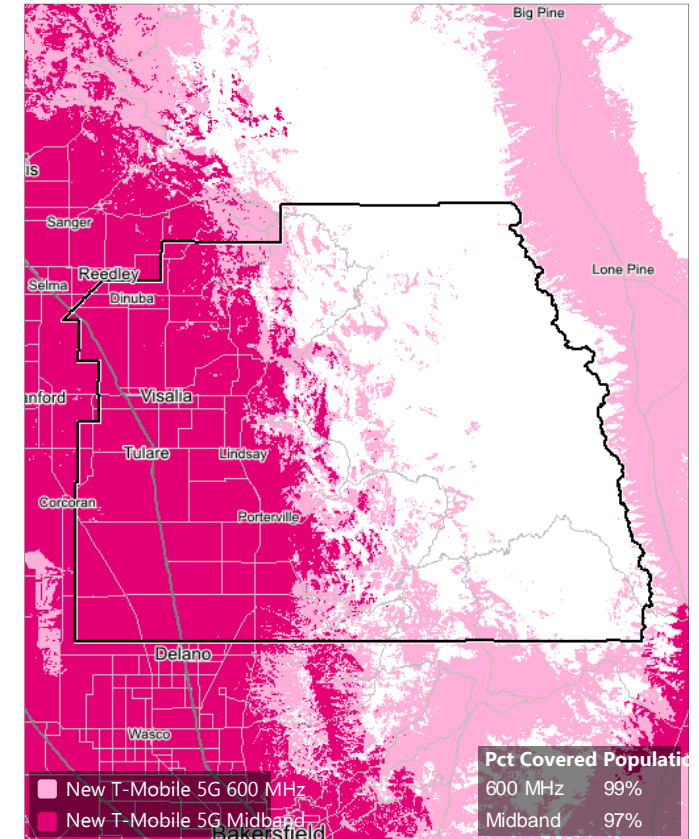
T-Mobile Standalone



Sprint Standalone

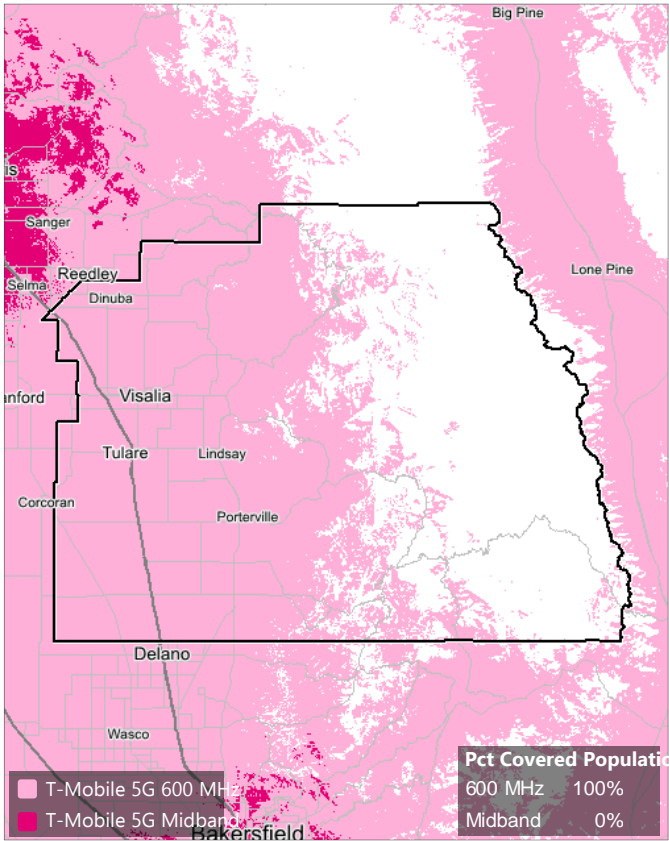


New T-Mobile

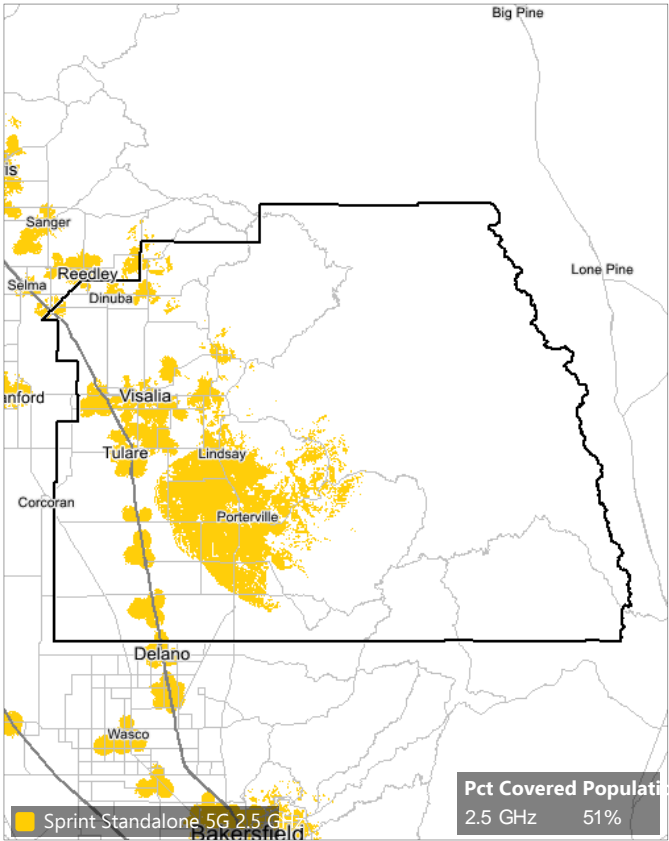


Projected 2024 5G Coverage: Tulare County (06107)

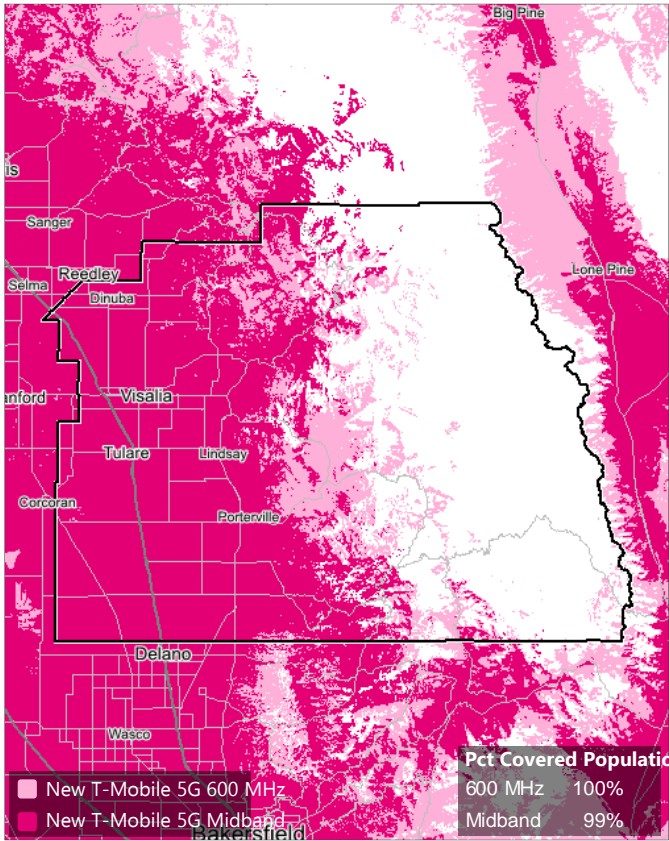
T-Mobile Standalone



Sprint Standalone

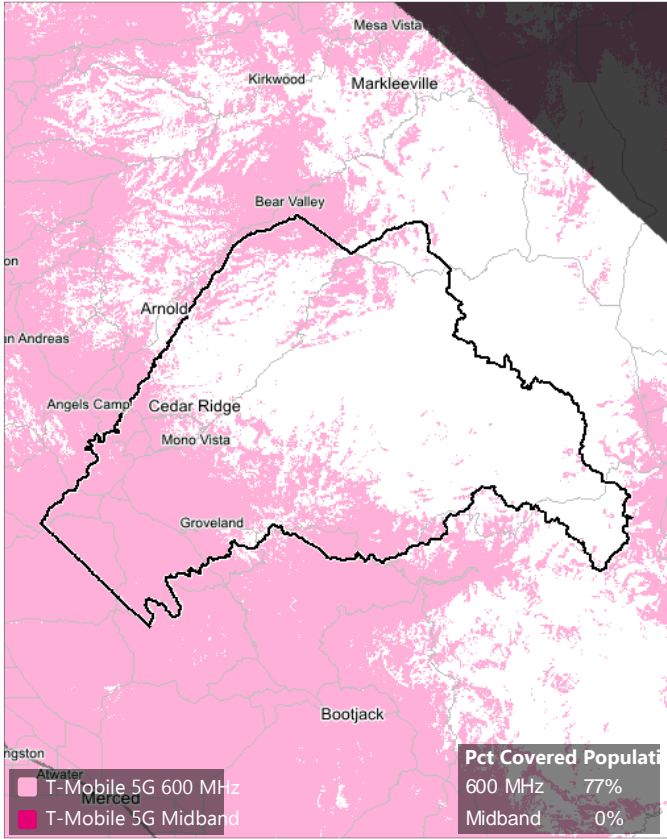


New T-Mobile

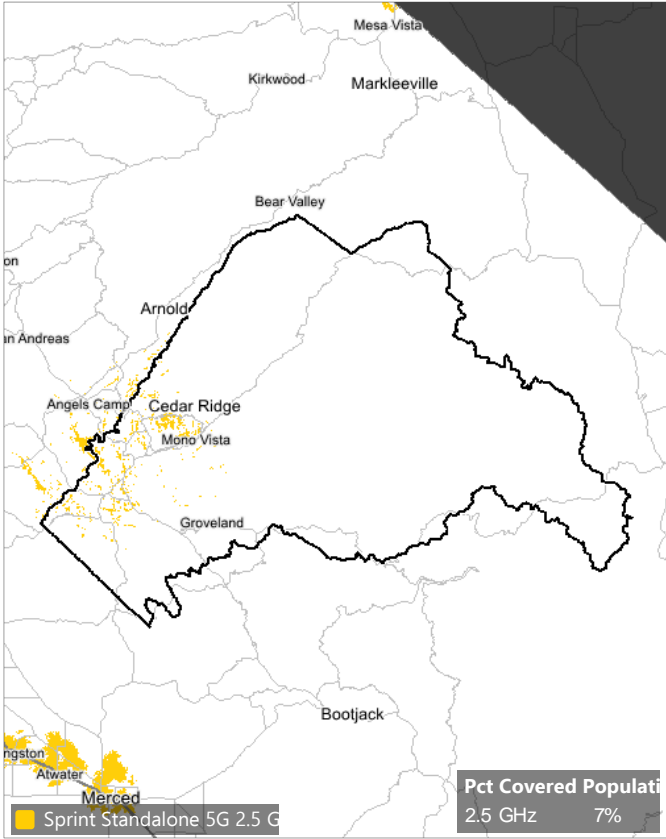


Projected 2021 5G Coverage: Tuolumne County (06109)

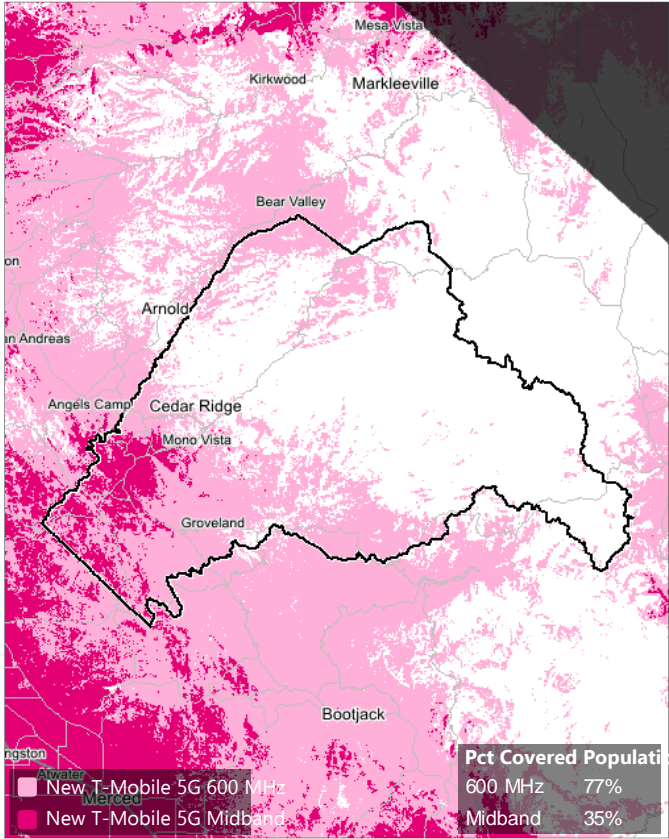
T-Mobile Standalone



Sprint Standalone

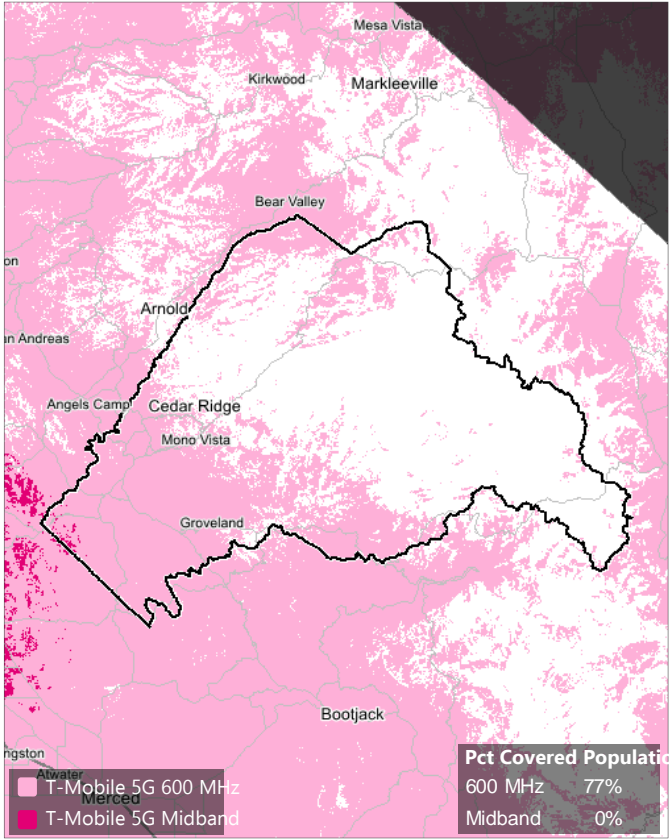


New T-Mobile

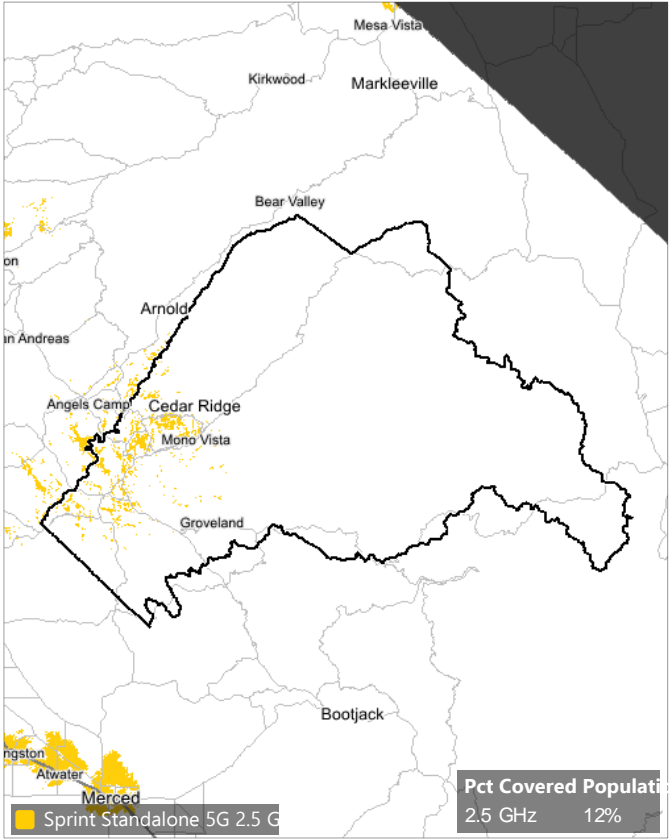


Projected 2024 5G Coverage: Tuolumne County (06109)

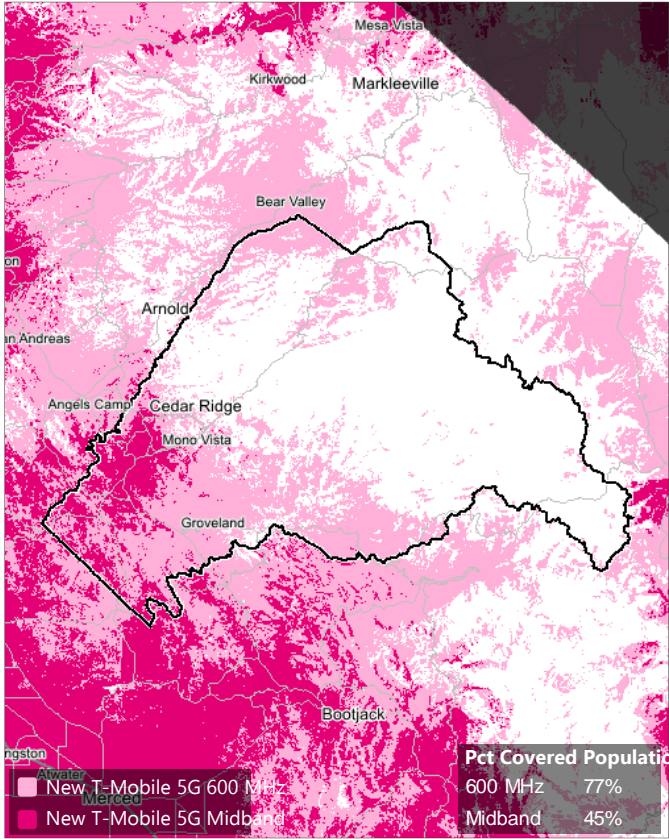
T-Mobile Standalone



Sprint Standalone

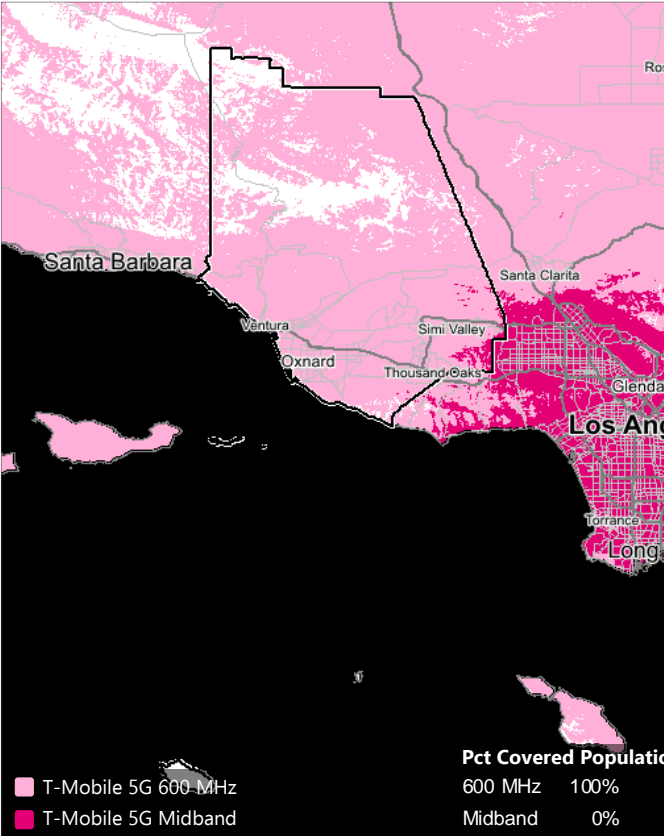


New T-Mobile

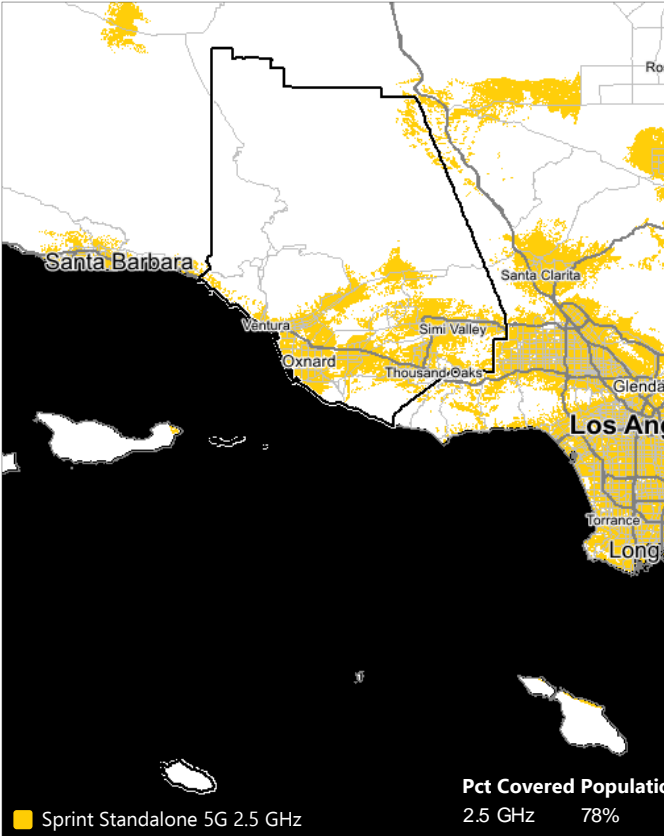


Projected 2021 5G Coverage: Ventura County (06111)

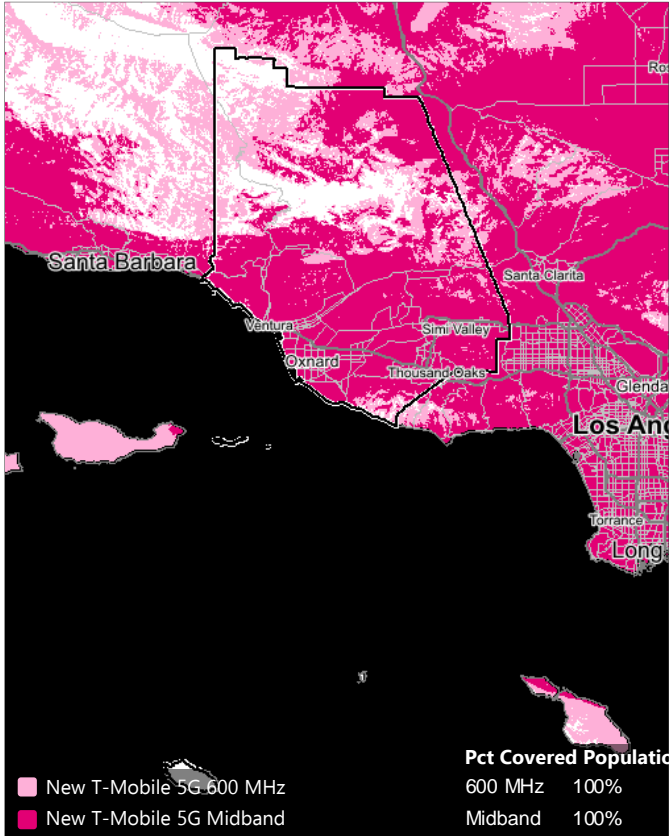
T-Mobile Standalone



Sprint Standalone

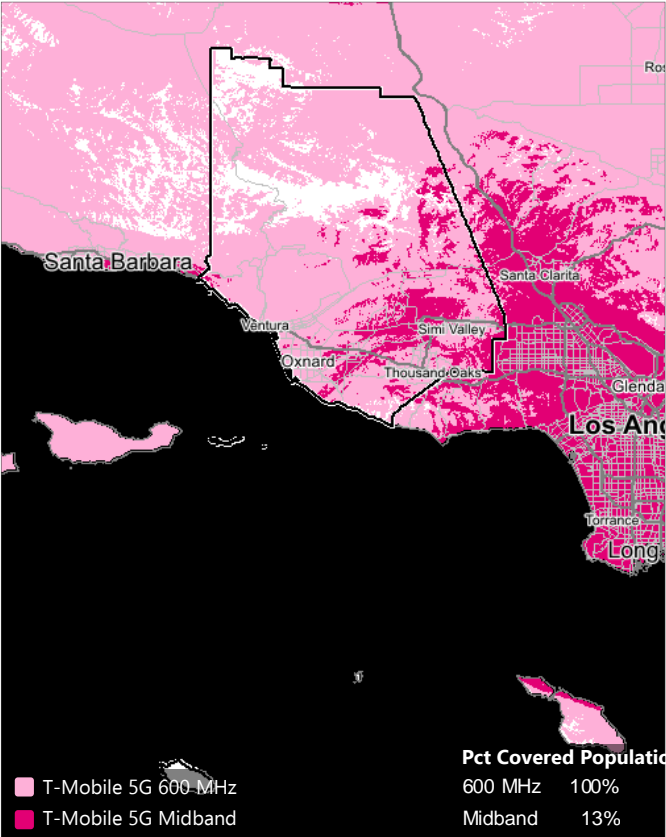


New T-Mobile

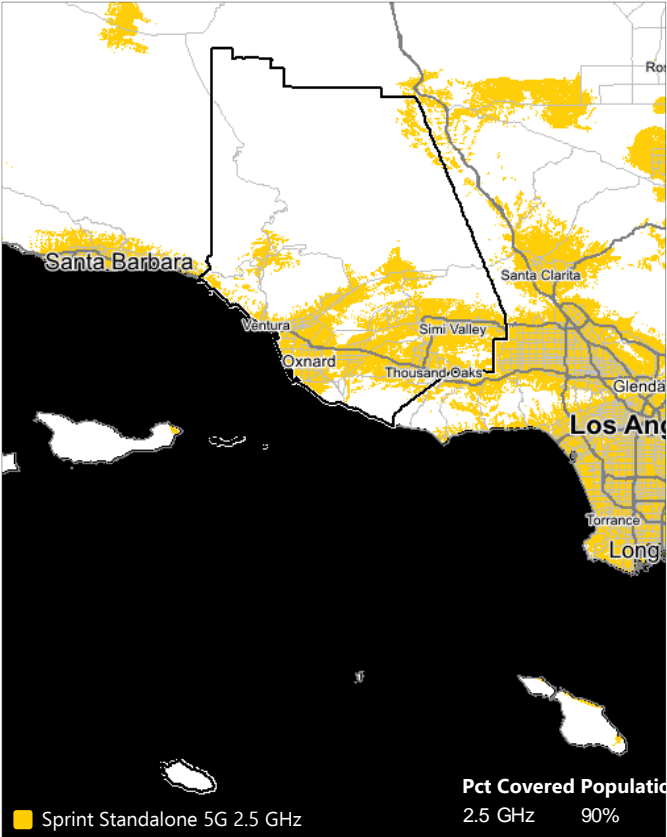


Projected 2024 5G Coverage: Ventura County (06111)

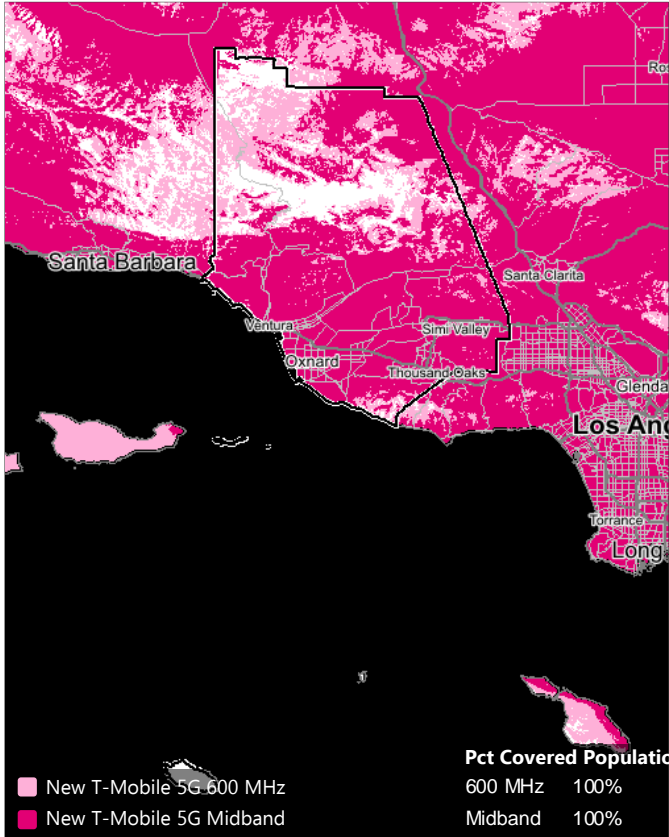
T-Mobile Standalone



Sprint Standalone

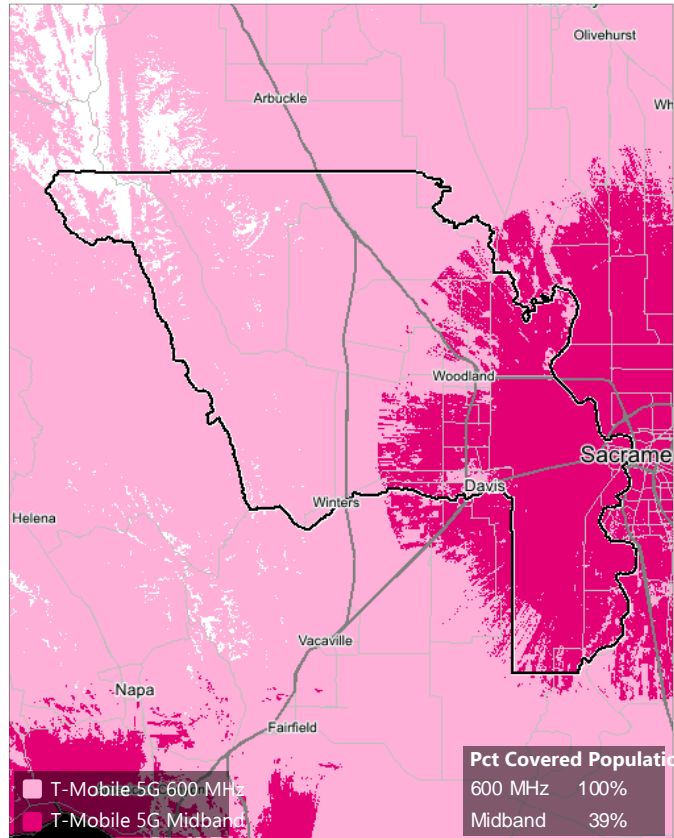


New T-Mobile

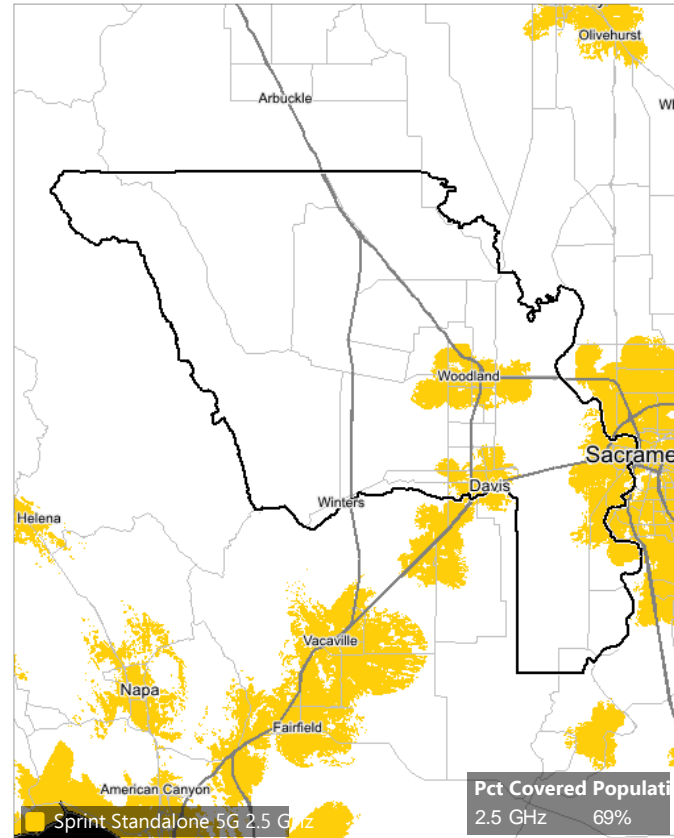


Projected 2021 5G Coverage: Yolo County (06113)

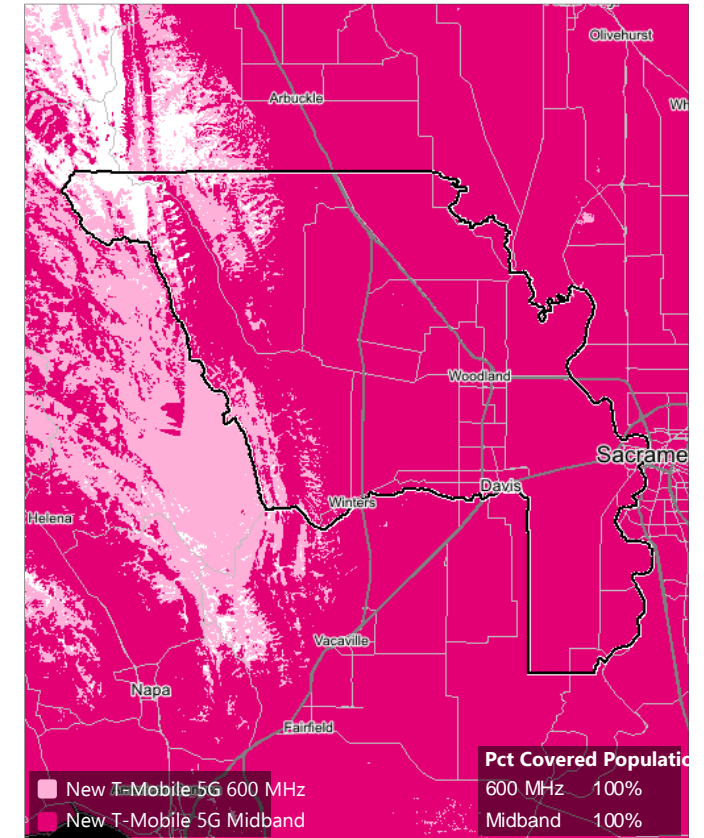
T-Mobile Standalone



Sprint Standalone

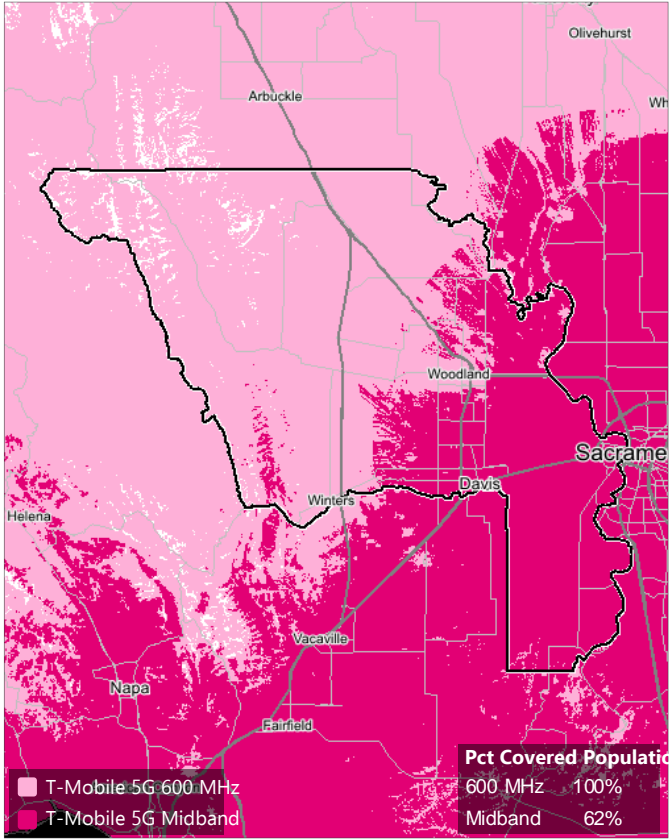


New T-Mobile

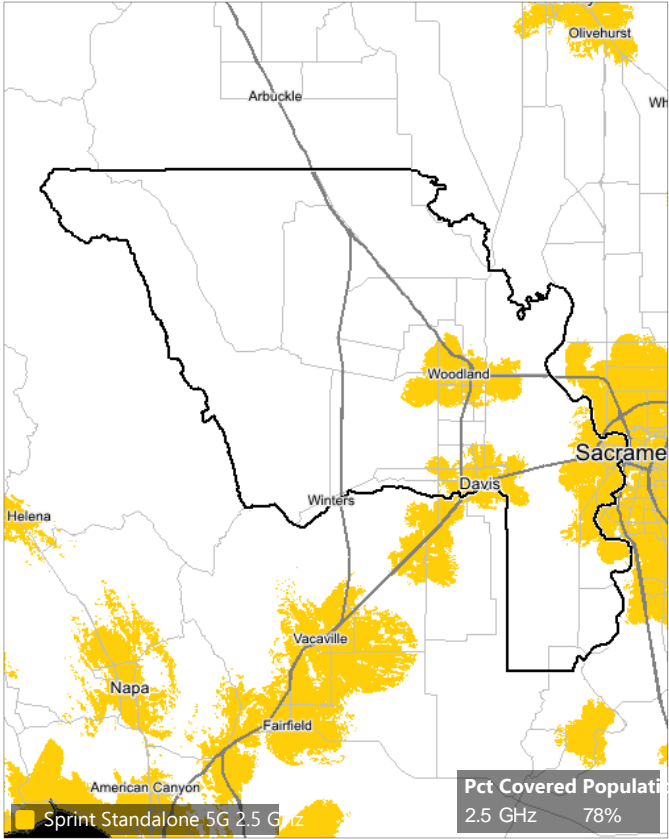


Projected 2024 5G Coverage: Yolo County (06113)

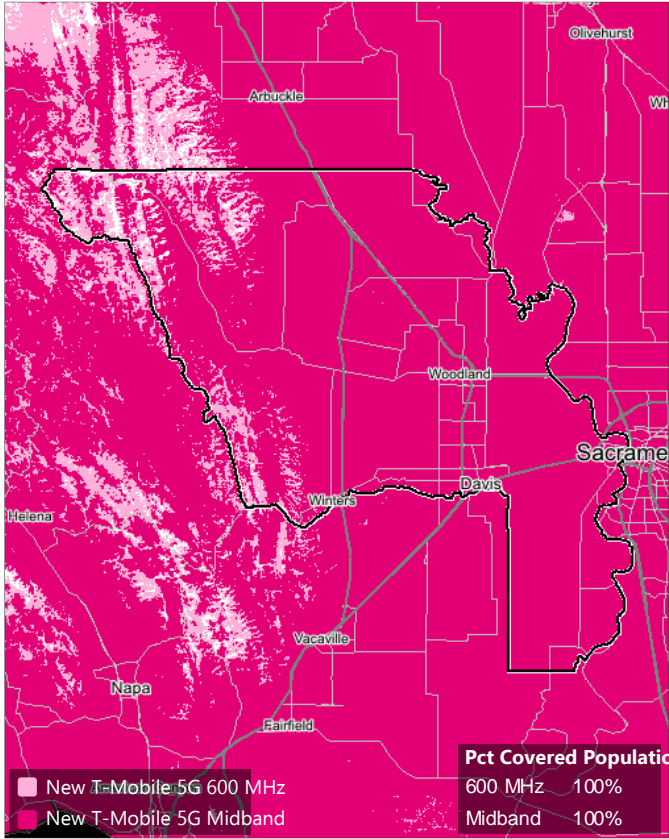
T-Mobile Standalone



Sprint Standalone

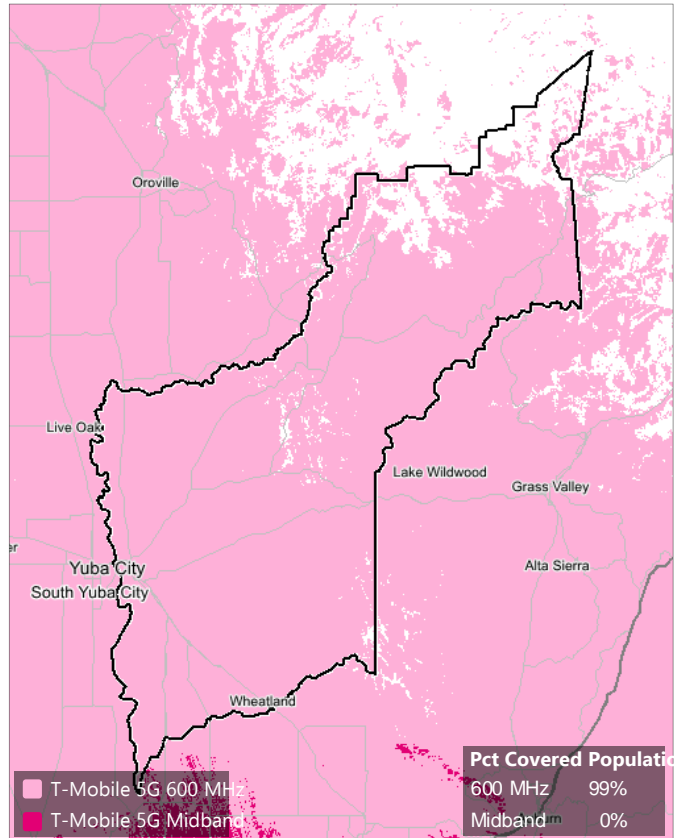


New T-Mobile

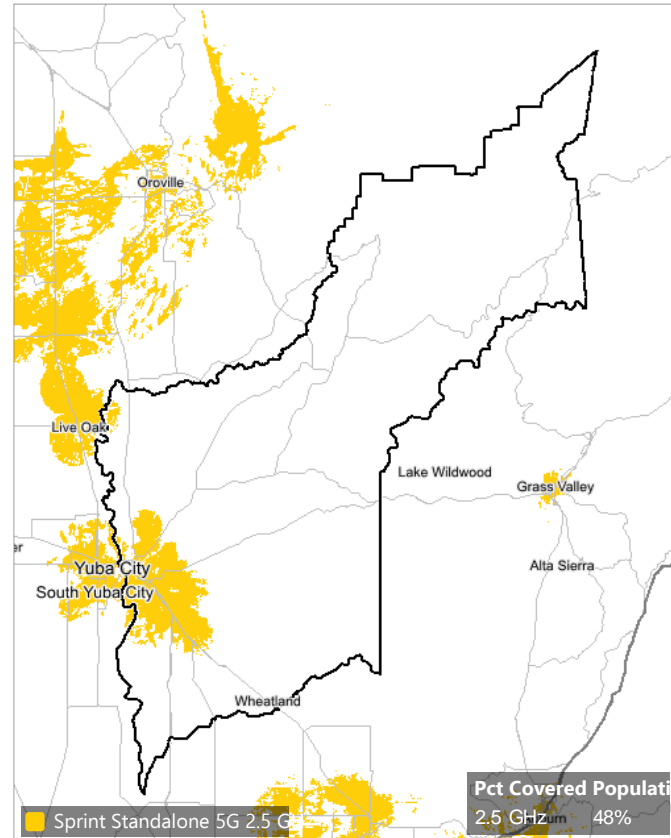


Projected 2021 5G Coverage: Yuba County (06115)

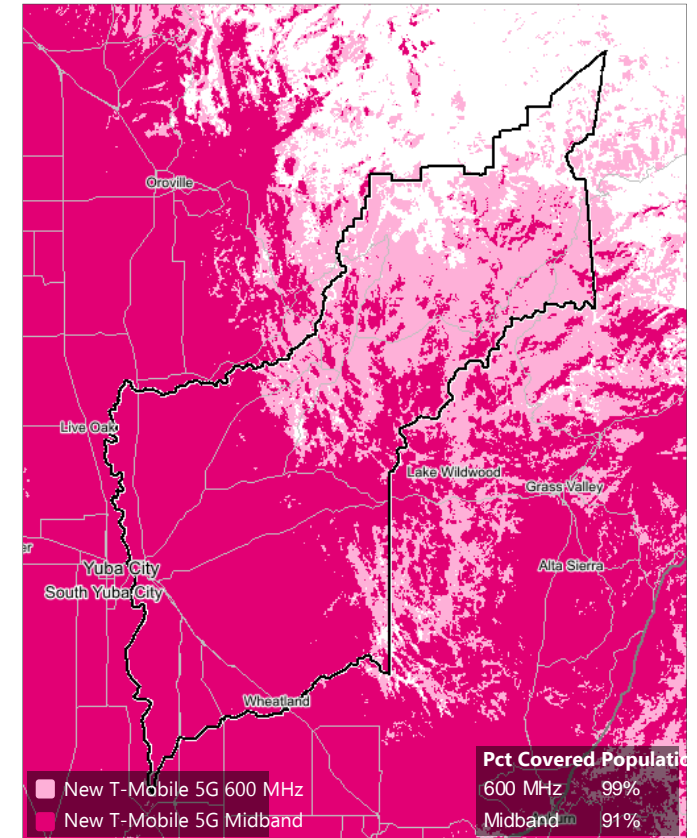
T-Mobile Standalone



Sprint Standalone

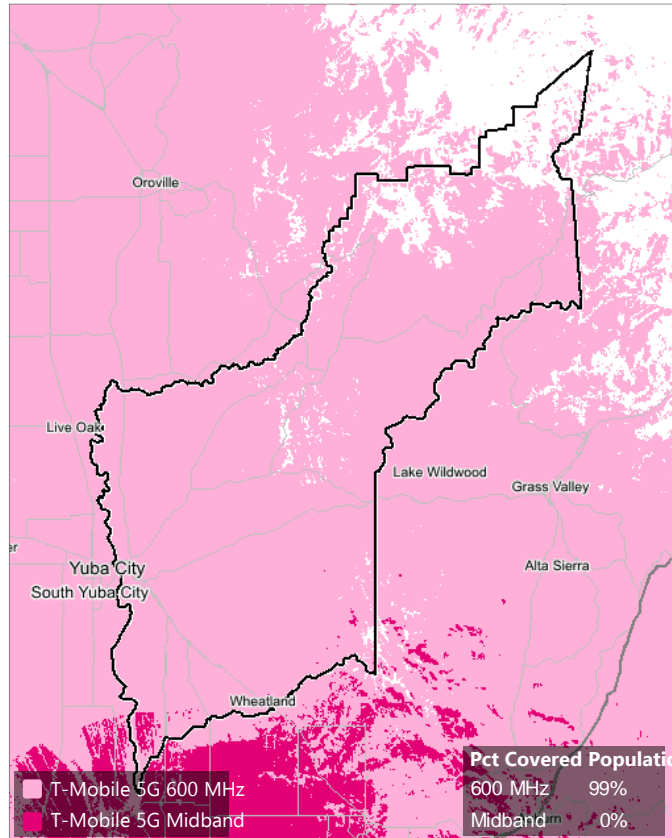


New T-Mobile

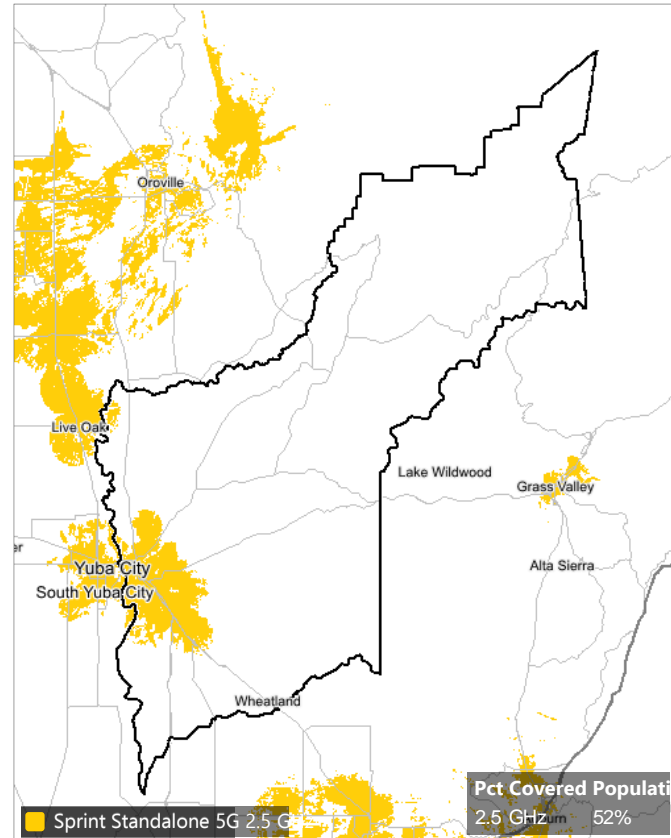


Projected 2024 5G Coverage: Yuba County (06115)

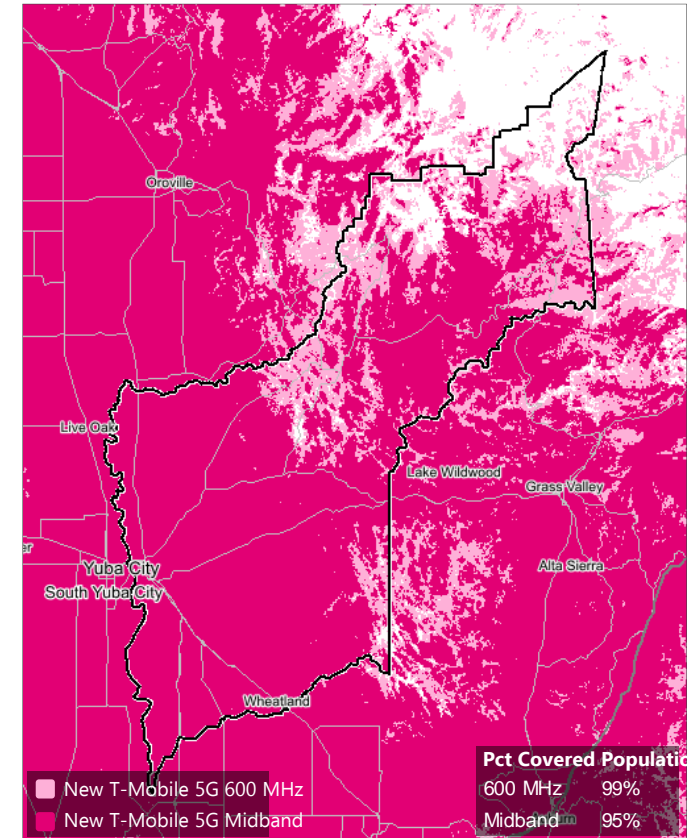
T-Mobile Standalone



Sprint Standalone



New T-Mobile



ATTACHMENT E

—PUBLIC VERSION—
(ENTIRE ATTACHMENT SUBMITTED UNDER SEAL)