ATTACHMENT 6

REGIONAL NETWORK ENGINEERING & OPERATIONS

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COVERAGE OBJECTIVE & ENGINEERING JUSTIFICATION

Ragle Ranch & BA90016

February 28, 2024
Prepared by: Chris Cubanske

COVERAGE JUSTIFICATION

OVERVIEW

Vertical Bridge is proposing to build a new structure for the future collocation of multiple carriers at 9300 Mill Station Rd., Sebastopol, CA 95472 in Sonoma County. T-Mobile is proposing to collocate its equipment at a minimum 65' tip height elevation on the new 70' stealth faux-tree structure (Note: the top 5' of the typical stealth tower is unusable due to the stealth design). T-Mobile understands that the Sonoma County is currently considering several different stealth design options for Vertical Bridge's proposed tower. Please note that the maps provided herein demonstrate that a minimum of 65' antenna tip height is required to meet T-Mobile's engineering objectives, but the height of the overall structure may fluctuate based on the stealth design options Vertical Bridge has presented to the County for approval.

This proposed antenna tip height at 65' meets T-Mobile's coverage objectives providing in-building 4G and 5G wireless coverage within a rural area northwest of Sebastopol, in the vicinity of Mill Station Road & Ferguson Road, and surrounding residential areas presently not adequately served by T-Mobile's network. This includes an area north of (and including) Occidental Road and areas outside the reach of adjacent T-Mobile facilities. This coverage objective was determined through a combined analysis of sales requests based on customer feedback that the rural areas surrounding Sebastopol are inadequately covered, and radio frequency engineering design. This facility will allow T-Mobile to provide more reliable wireless service with fewer dropped calls, improved call quality, and improved access to additional wireless services that the public now demands. This includes emergency 911 calls throughout the area.

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COVERAGE JUSTIFICATION (CONT.)

FEDERAL LAW

- The Telecommunications Act of 1996 prohibits a local jurisdiction from taking any action on a wireless siting permit that "prohibit[s] or [has] the effect of prohibiting the provision of personal wireless services." 47 U.S.C. § 332(c)(7)(B)(i)(II).
- According to the Federal Communications Commission ("FCC") Order adopted in September 2018, a local jurisdiction's action has the effect of prohibiting the provision of wireless services when it "materially limits or inhibits the ability of any competitor or potential competitor to compete in a fair and balanced legal and regulatory environment." Under the FCC Order, an applicant need not prove it has a significant gap in coverage; it may demonstrate the need for a new wireless facility in terms of adding capacity, updating new technologies, and/or maintaining high quality service.
    - *Accelerating Wireless and Wireline Broadband Deployment by Removing Barriers to Infrastructure Investment*, Declaratory Ruling and Third Report and Order, WT Docket No. 17-79, WC Docket No. 17-84, FCC 18-133 (rel. Sept. 27, 2018); 83 Fed. Reg. 51867 (Oct. 15, 2018), *affirmed in part and vacated in part*, *City of Portland v. United States*, 969 F.3d 1020 (9th Cir. 2020), *cert. denied*, 594 U.S. ___, 141 S.Ct. 2855 (June 28, 2021)(No. 20-1354) ("FCC Order").
- A local government's denial of an application to install a personal wireless service facility has the effect of prohibiting the provision of personal wireless service if materially inhibits or limits T-Mobile's ability to deploy the facilities, technologies, or services that conform to T-Mobile's network standards and objectives.

COVERAGE JUSTIFICATION (CONT.)

FEDERAL LAW (CONT.)

- While T-Mobile is no longer required to show a significant gap in service coverage, in the Ninth Circuit, a local jurisdiction clearly violates section 332(c)(7)(B)(i)(II) when it prevents a wireless carrier from using the least intrusive means to fill a significant gap in service coverage. *T-Mobile U.S.A., Inc. v. City of Anacortes*, 572 F.3d 987, 988 (9th Cir. 2009).
  - **Significant Gap**. Reliable in-building coverage is now a necessity and every community's expectation. Consistent with the abandonment of land line telephones and reliance on only wireless communications, federal courts now recognize that a "significant gap" can exist based on inadequate in-building coverage. See, e.g., *T-Mobile Central, LLC v. Unified Gavernment of Wyandatte County/Kansas City,* 528 F. Supp. 2d 1128, 1168-69 (D.Kan. 2007*), affirmed in part,* 546 F.3d 1299 (10th Cir. 2008); *MetraPCS, Inc. v. City and County of San Francisco,* 2006 WL 1699580, *10-11 (N.D. Cal. 2006).
  - **Least Intrusive Means.** The least intrusive means standard "requires that the provider 'show that the manner in which it proposes to fill the significant gap in service is the least intrusive on the values that the denial sought to serve.'" 572 F.3d at 995, *quoting MetroPCS, Inc. v. City of San Francisco*, 400 F.3d 715, 734 (9th Cir. 2005). These values are reflected by the local code's preferences and siting requirements.

COVERAGE JUSTIFICATION (CONT.)

COVERAGE OBJECTIVE

- **Figure A —Existing T-Mobile Coverage** shows existing T-Mobile wireless services in the general area of the proposed new site, which demonstrates the current deficiency in coverage in the targeted service area. The Blue Dot indicates the location of the proposed new WCF. The Magenta Dot indicates the location of existing T-Mobile WCF sites; coverage from T-Mobile existing WCF sites is shaded in green. As can be seen, there is a coverage deficiency in all areas not shaded in green. Currently, the target coverage area has minimal to no 4G in-building voice service and does not have adequate 4G service.
- **Figure B—Projected New T-Mobile Coverage** identifies the projected coverage from the proposed new WCF with an overall stealth structure height of 70' (antenna tip height of 65').
  - Vertical Bridge originally requested an overall stealth structure height of 80' (antenna tip height of 75') to meet the service requirements for the proposed facility.
  - Subsequent to the initial application, Sonoma County requested that Vertical Bridge lower the height of the overall stealth structure height to 70' (antenna tip height of 65'). This is the minimum height where a T-Mobile wireless device can be reliably used to make and receive telephone calls and use data service in the presence of varying signals within the intended service area.
  - **The new facility will provide 2.14 Square Miles of reliable, in-building service, to a population of 994 residents, and significant coverage improvements to nearby roadways.**

COVERAGE JUSTIFICATION (CONT.)

COVERAGE OBJECTIVE

- **Figure C — Coverage Comparison between 70' and 50':** Sonoma County requested that T-Mobile provide coverage scenario for 50' overall stealth structure height, which would reduce the tip height of the antennas to 45'. This adjustment in height would result in a **27% reduction** in square miles receiving reliable coverage, and **43% reduction** in the population receiving new, in-building coverage (994 residents @ 70' vs. 566 residents @ 50').
- **Figure D — Coverage Comparison between 70' and 40':** This adjustment in height would result in a **39% reduction** in square miles receiving reliable coverage, and **56% reduction** in the population receiving new, in-building coverage (994 residents @ 70' vs. 437 residents @ 40').

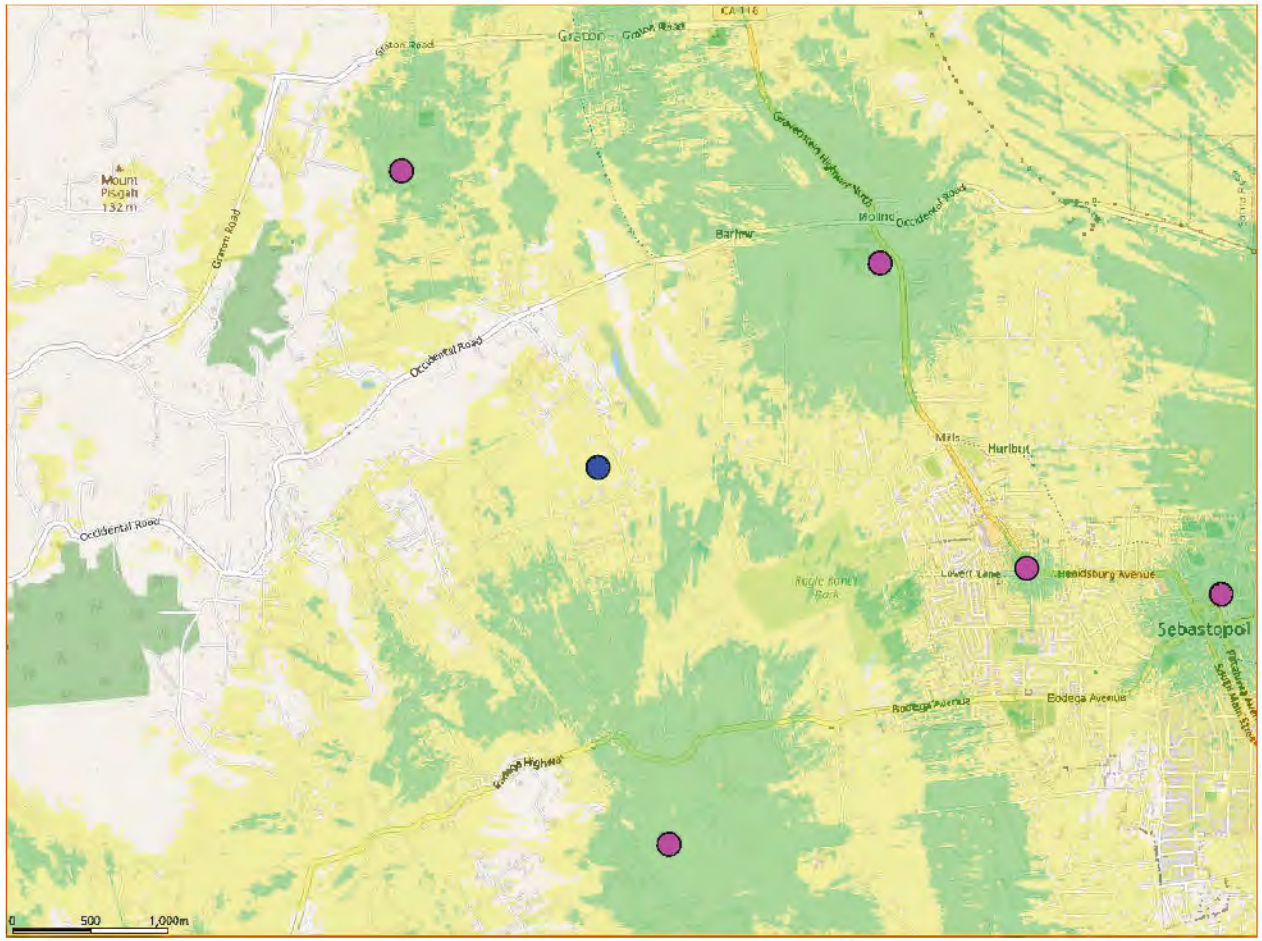
CONCLUSION

- T-Mobile has determined that a 70' stealth structure that accommodates a 65' antenna height is the minimum height necessary at this location for the effective operation of its wireless network and to meet its service objectives. Any height lower than 70' (65' antenna tip height), such as the 50' (45' antenna tip) and 41' (35' antenna tip) scenarios requested by the County would fail to meet T-Mobile's service objectives and would materially inhibit T-Mobile's ability to serve this portion of Sonoma County.

FIGURE A – EXISTING SERVICE WITHOUT PROPOSED SITE

MID BAND (AWS-2100 MHZ) LTE SERVICE MAP (RSRP)

Legend	Reliable Coverage
Existing Sites w/o New Tower	2,896 Residents



	Reliable Coverage: -100dBm < RSRP
	Marginal Coverage : -115dBm < RSRP < -100dBm
	Existing T-Mobile Facilities
	Proposed Facility

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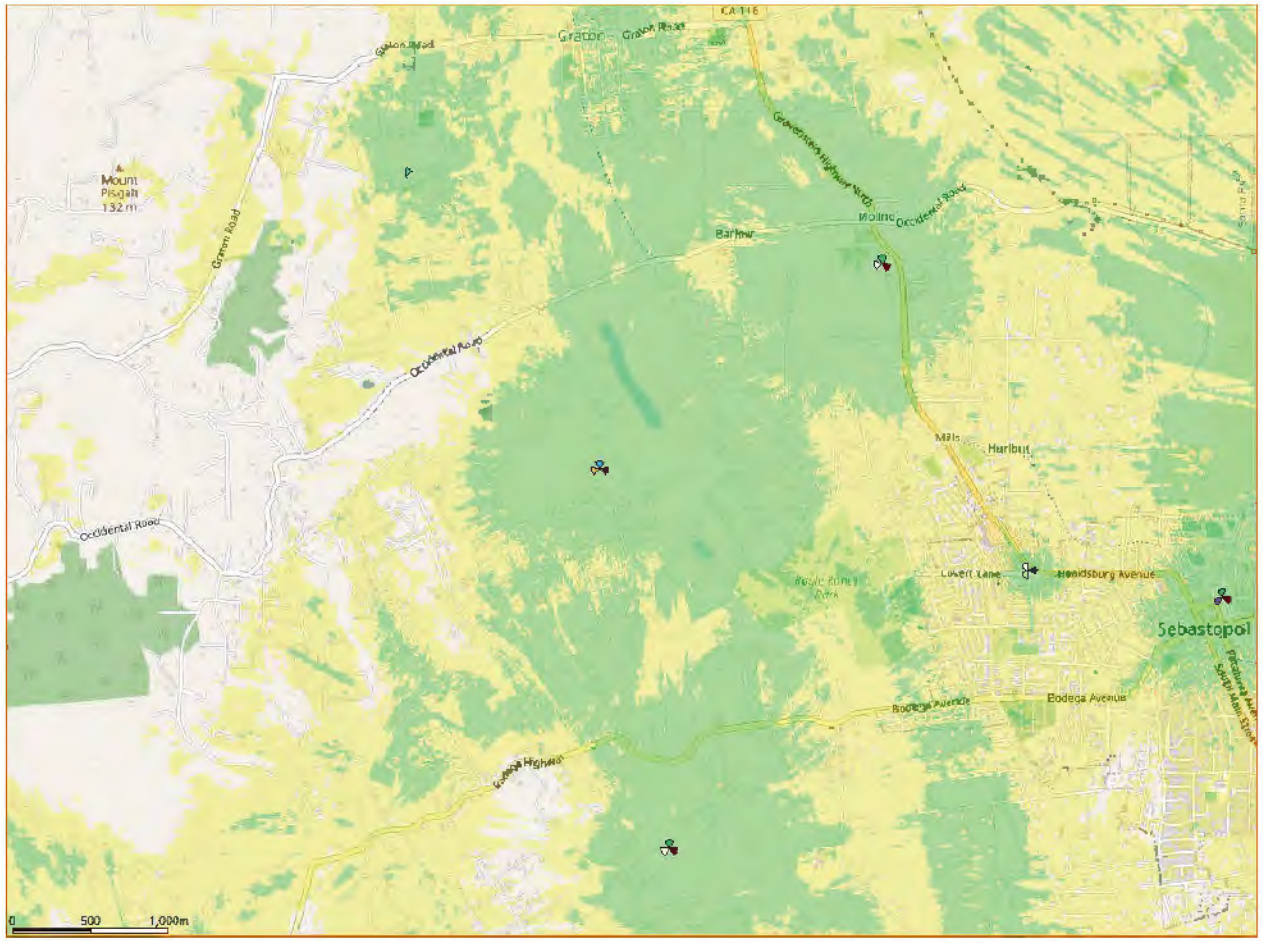
FIGURE B – EXISTING SERVICE WITH THE PROPOSED SITE ON 70' STEALTH TOWER

MID BAND (AWS-2100 MHZ) LTE SERVICE MAP (RSRP)

Legend	Population - Reliable Coverage
Existing Sites w/o New Tower	2,896 Residents
Existing Sites + New 70' Tower	3,890 Residents
Net Increase	+ 994 Residents

- New **70' Stealth Tower** with 65' Antenna Tip Height

Tower Height	Square Miles - Reliable Coverage
70' Tower	2.14



	Reliable Coverage: -100dBm < RSRP
	Marginal Coverage : -115dBm < RSRP < -100dBm
	Existing T-Mobile Facilities
	Proposed Facility

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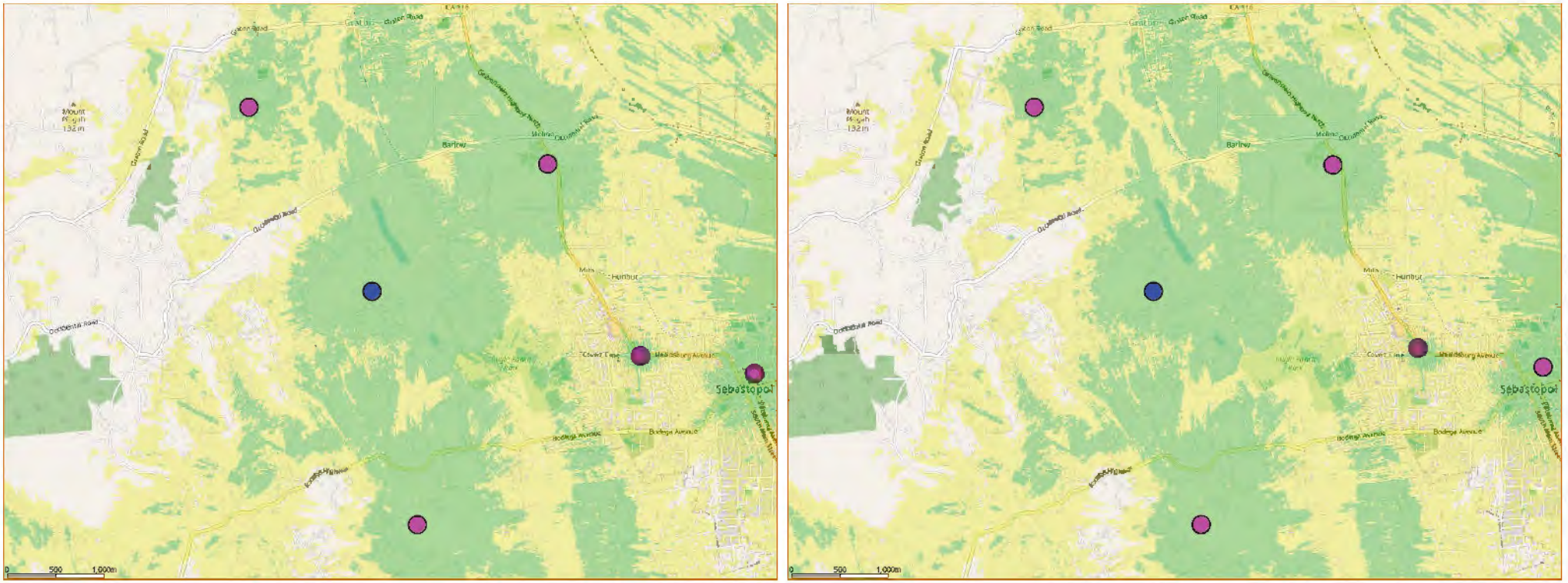
FIGURE C – COMPARISON OF COVERAGE FROM PROPOSED SITE – STEALTH TOWER HEIGHT 70’ VS 50’ AGL

70’ Tower (65’ Antenna Tip) **MID BAND (AWS-2100 MHZ) LTE SERVICE MAP (RSRP)** **50’ Tower** (45’ Antenna Tip)



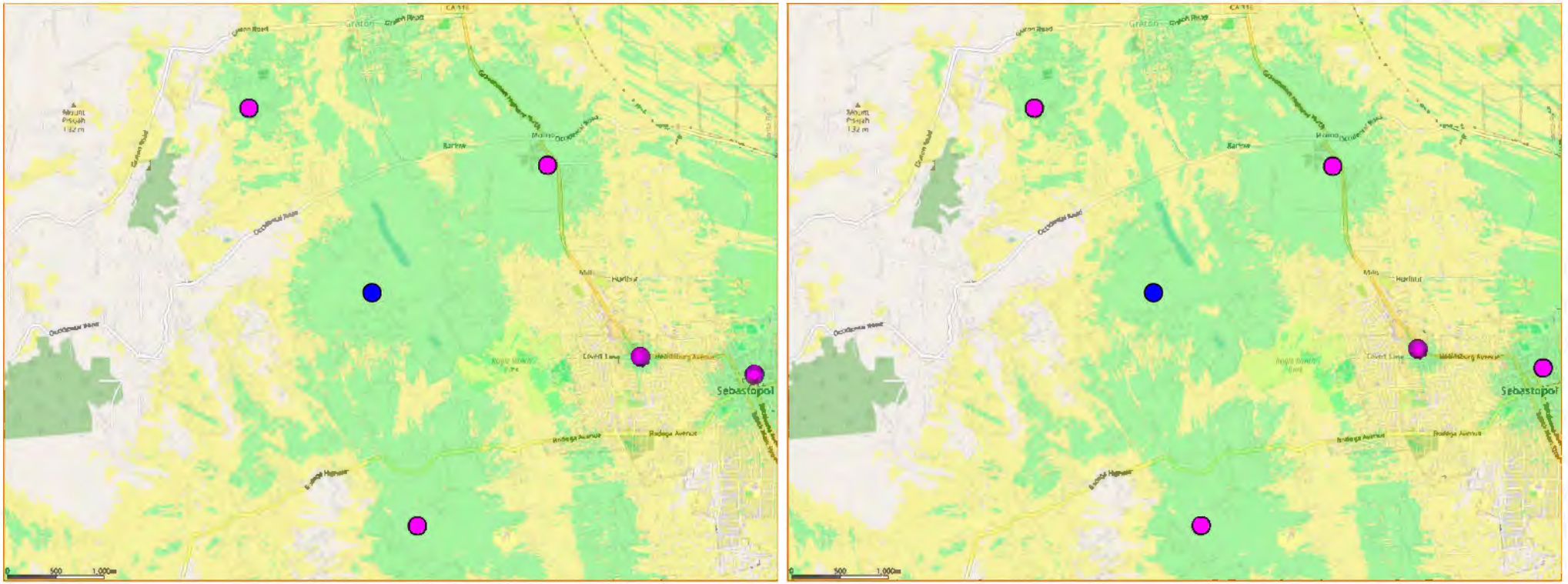
	Reliable Coverage: -100dBm < RSRP
	Marginal Coverage : -115dBm < RSRP < -100dBm
	Existing T-Mobile Facilities
	Proposed Facility

Legend	Pops - Reliable Coverage	Net Change
Existing Sites + New 70’ Tower	3,890 Residents	+ 994 Residents
Existing Sites + New 50’ Tower	3,462 Residents	+556 Residents
% Change		- 428 Residents (-43%)

Tower Height	Square Miles - Reliable Coverage
70’ Tower	2.14
50’ Tower	1.57
% Change	-27%

FIGURE D – COMPARISON OF COVERAGE FROM PROPOSED SITE – STEALTH TOWER HEIGHT 70' VS 40' AGL

70' Tower (65' Antenna Tip) **MID BAND (AWS-2100 MHZ) LTE SERVICE MAP (RSRP)** **40' Tower** (35' Antenna Tip)



	Reliable Coverage: -100dBm < RSRP
	Marginal Coverage : -115dBm < RSRP < -100dBm
	Existing T-Mobile Facilities
	Proposed Facility

Legend	Pops Reliable Coverage	Net Change
Existing Sites + New 70' Tower	3,890 Residents	+ 994 Residents
Existing Sites + New 40' Tower	3,333 Residents	+437 Residents
% Change		- 557 Residents (-56%)

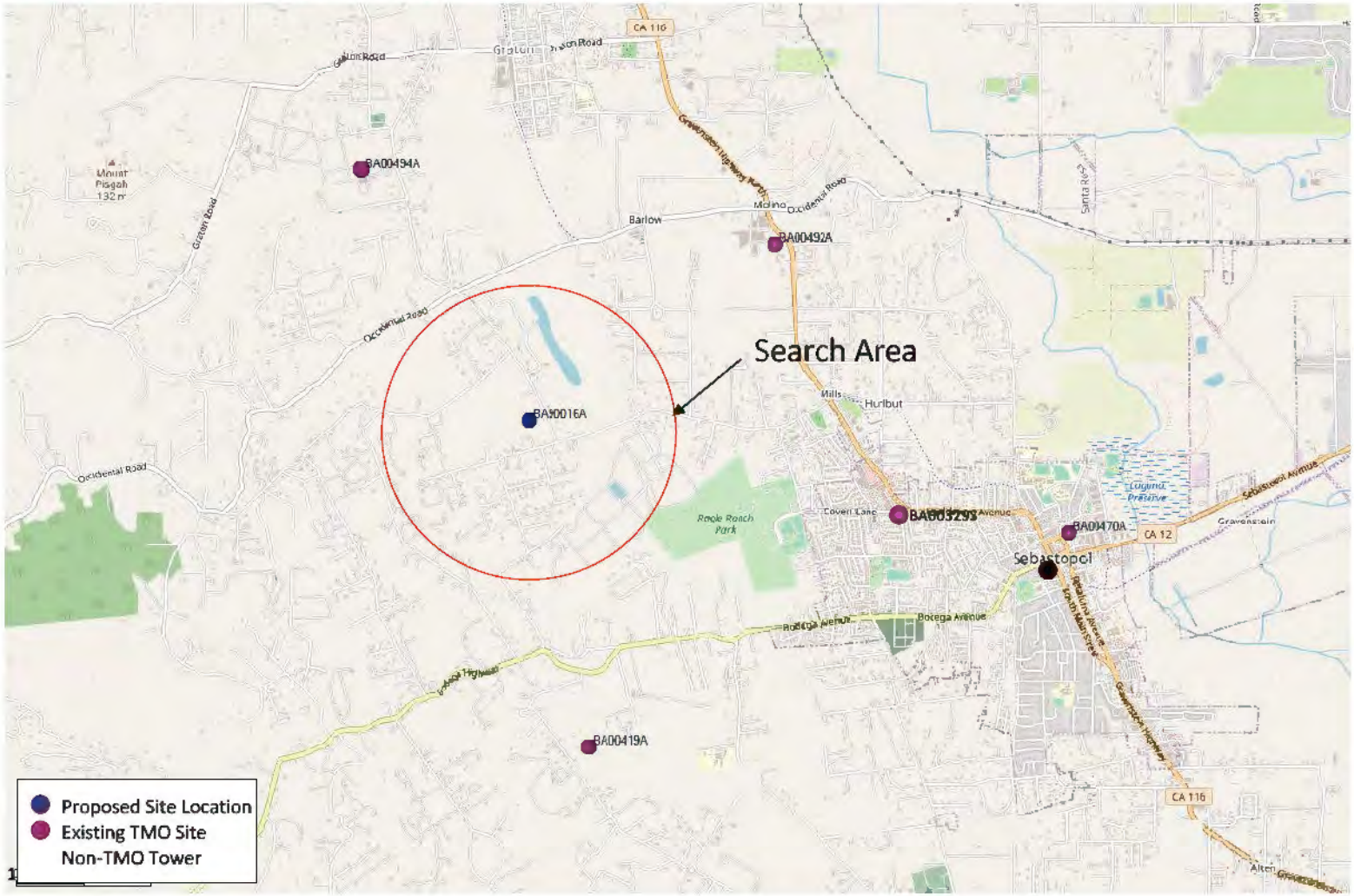
Tower Height	Square Miles - Reliable Coverage
70' Tower	2.14
50' Tower	1.30
% Change	-39%

ALTERNATIVE SITE ANALYSIS

SEARCH RING

- T-Mobile's radio frequency ("RF") engineers performed an RF engineering study, considering multiple objectives, to determine the approximate site location and antenna height required to fulfill the noted network objectives for the targeted service area. From this study, T-Mobile's RF engineers identified a "search ring" area where a WCF may be located to provide effective service in the target coverage area.
- **Figure E —Targeted Search Ring** indicates the search ring T-Mobile's RF engineers established for this proposed site. A discussion of the methodology T-Mobile's RF engineers used to identify the search ring is included at the end of this RF Justification document. There are no existing towers within the Search Radius. All existing towers outside of the search radius are at or near existing T-Mobile facilities and would not meet the service objectives of the proposed facility.

FIGURE E – TARGETED SEARCH RING



There are no existing towers within the Search Radius. All existing towers outside of the search radius are at or near existing T-Mobile facilities and would not meet the service objectives of the proposed facility.

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COVERAGE METHODOLOGY

T-Mobile's RF engineers use the following signal strength standards to demonstrate the quality of coverage depicted on the maps herein.

- **Reliable Coverage.** Green represents minimum signal strength of -100dBm, T-Mobile's design criteria for reliable in-building residential voice coverage at 2100 MHz. This signal strength is required for customers to take advantage of T-Mobile's Home Internet services.
- **Marginal Coverage.** Yellow represents minimum signal strength of -115dBm, but less than -100dBm, T-Mobile's design criteria for in-vehicle coverage at 2100 MHz. Yellow represents in-vehicle coverage where T-Mobile customers are unable to access high speed internet indoors. Customers are unable to access T-Mobile's Home Internet services with this signal strength.
- **No Coverage.** Signal strength less than -115dBm is not shown, as it does not meet T-Mobile's design standards for reliable in-building or in-vehicle coverage.
- **T-Mobile's 4G & 5G Online Coverage Map.** The online coverage map approximates anticipated **outdoor coverage** (including 600Mhz 4G LTE) based on a variety of factors, which may include limited or no coverage areas, and does not guarantee service availability; some data-intensive uses may have decreased functionality in low-bandwidth areas, especially indoors or on the exterior edges of the approximated coverage area. Within coverage areas, network changes, traffic volume, outages, technical limitations, signal strength, customer equipment, obstructions, weather and other conditions may interfere with service quality and availability. Some coverage (e.g., Narrowband IoT, millimeter wave 5G) not depicted.

SEARCH RING METHODOLOGY

T-Mobile's RF engineers used coverage propagation software systems to predict the coverage provided by the proposed new WCF. The software and T-Mobile's RF engineers considered the general factors outlined below, as well as more project-specific factors such as the type of antenna, antenna tilt, etc. Within coverage areas, network changes, traffic volume, outages, technical limitations, signal strength, customer equipment, obstructions, weather and other conditions may interfere with service quality and availability.

- **Coverage.** The antenna site must be located in an area where the radio frequency broadcasts will provide adequate coverage within the targeted service area. The RF engineer must take into consideration the coverage objectives for the site as well as the terrain in and around the area to be covered. Because radio frequency broadcasts travel in a straight line and diminish as they travel further away from the antennas, it is generally best to place an antenna site near the center of the desired coverage area. However, in certain cases, the search ring may be located away from the center of the desired coverage area due to the existing coverage, the surrounding terrain, or other features that might affect the radio frequency broadcasts, *e.g.*, buildings or sources of electrical interference.
- **Clutter.** T-Mobile's WCFs must "clear the clutter"—the WCF site must be installed above or close to RF obstructions (the "clutter") to enable the RF signals to extend beyond and clear the clutter. T-Mobile radio frequencies do not penetrate mountains, hills, rocks, or metal, and are diminished by trees, brick and wood walls, and other structures. Accordingly, T-Mobile's antennas must be installed above or close to the "clutter" to provide high quality communications services in the desired coverage areas. Additionally, if the local code requires us to accommodate additional carriers on the support structure, the structure must be even taller to also allow the other carriers' antennas to clear the clutter.
- **Call Handoff.** The WCF site must be in an area where the radio broadcasts from the site will allow seamless "call handoff" with adjacent WCF sites. Call handoff is a feature of a wireless communications system that allows an ongoing telephone conversation to continue uninterrupted as the user travels from the coverage area of one antenna site into the coverage area of an adjacent antenna site. This requires coverage overlap for a sufficient distance and/or period of time to support the mechanism of the call handoff.
- **Quality of Service.** Users of wireless communications services want to use their services where they live, work, commute and play, including when they are indoors. T-Mobile's coverage objectives include the ability to provide indoor coverage in areas where there are residences, businesses and indoor recreational facilities.

SEARCH RING METHODOLOGY (CONT.)

- **Radio Frequencies Used by System.** The designs of wireless communications systems vary greatly based upon the radio frequencies that are used by the carrier. If the carrier uses radio frequencies in the 600 MHz to 850 MHz range, the radio signals will travel farther and will penetrate buildings better than the radio frequencies in the 2100 MHz band. As a result, wireless communications systems that use lower radio frequencies will need fewer sites than wireless communications systems that use higher radio frequencies.
- **Land Use Classifications.** T-Mobile's ability to construct a WCF site on any particular property is affected by state and local regulations, including zoning and comprehensive plan classifications, goals, and policies. T-Mobile's search rings take these laws and regulations into consideration.

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Declaration

I, Chris Cubanske, state that I am a qualified and experienced Communications Engineer whose work is a matter of record in over 100 jurisdictions in the State of California.

I am a Network RF Engineer for T-Mobile and am responsible for the Northern California Market. My formal education includes Electrical Engineering (E.E.) I have over 25 years of experience in radio frequency analysis, engineering, RF exposure studies, interference mitigation, wireless communications radio frequency networks, and the design of new wireless communications sites for new networks as well as sites to fill in gaps in coverage and capacity for existing networks.

I prepared the attached "Coverage Objective & Engineering Justification" dated February 28, 2024 and have reviewed the attached project narrative detailing the technical requirements for the site and the alternatives analysis.

- Based on my background (detailed above) as a radio frequency engineer, and my comprehensive analysis of the data associated with this proposed site and the T-Mobile network, I hereby certify that my RF Justification and the project narrative are true and accurate, to the best of my knowledge, and form the basis of my analysis.

- Based on the information submitted to Sonoma County, I have concluded that T-Mobile's attachment of a wireless facility to the proposed Vertical Bridge tower with an antenna tip height of 65' is required to meet T-Mobile's needs for improved quality and service and will significantly improve service to the community.

Additional Considerations:

- The previous RF engineering maps that were submitted with the Vertical Bridge application were produced by an outside vendor for T-Mobile using an older version of RF modeling software, which is why some of the coverage predictions differ from the attached Justification.

- I completed new RF engineering maps using the latest version of modeling

software (Atoll v. Assett), incorporating updated geodata, clutter data (buildings, vegetation, etc.) specific to this location within Sonoma County, and incorporating technical parameters that are tuned specifically for T-Mobile's network frequencies and characteristics.

- The average tip height of T-Mobile's antennas located on other rural towers nearby the proposed facility is approximately 68', compared with 65' on the proposed tower.

- In order to meet T-Mobile's coverage objective the in-building signal levels (minimum of -100 dBm < RSRP), depicted in green on the attached coverage maps, are required to effectively provide high quality, reliable in building coverage as well as Home Internet Service, a broadband wireless service that serves residential and business customers.

DocuSigned by:
Chris Cubanske
B0AA3B2EE882434...

RF Engineering, T-Mobile

Dated: 3/21/2024

Vertical Bridge • Site No. US-CA-7225
T-Mobile West LLC • Proposed Base Station (Site No. BA90016)
9300 Mill Station Road • Sebastopol, California

Statement of Hammett & Edison, Inc., Consulting Engineers

The firm of Hammett & Edison, Inc., Consulting Engineers, has been retained by Vertical Bridge, a wireless telecommunications facilities provider, to evaluate the T-Mobile West LLC base station (Site No. BA90016) proposed to be located at 9300 Mill Station Road near Sebastopol, California, for compliance with appropriate guidelines limiting human exposure to radio frequency ("RF") electromagnetic fields.

Executive Summary

T-Mobile proposes to install directional panel antennas on a tall pole, configured to resemble a pine tree, to be sited in an undeveloped area east of the residence located at 9300 Mill Station Road in unincorporated Sonoma County near Sebastopol. The proposed operation will comply with the FCC guidelines limiting public exposure to RF energy.

Prevailing Exposure Standard

The U.S. Congress requires that the Federal Communications Commission ("FCC") evaluate its actions for possible significant impact on the environment. A summary of the FCC's exposure limits is shown in Figure 1. These limits apply for continuous exposures and are intended to provide a prudent margin of safety for all persons, regardless of age, gender, size, or health. The most restrictive limit for exposures of unlimited duration at several wireless service bands are as follows:

Wireless Service Band	Transmit Frequency	"Uncontrolled" Public Limit	Occupational Limit (5 times Public)
Microwave (point-to-point)	1–80 GHz	1.0 mW/cm^2	5.0 mW/cm^2
Millimeter-wave	24–47	1.0	5.0
Part 15 (WiFi & other unlicensed)	2–6	1.0	5.0
C-Band	3,700 MHz	1.0	5.0
BRS (Broadband Radio)	2,490	1.0	5.0
WCS (Wireless Communication)	2,305	1.0	5.0
AWS (Advanced Wireless)	2,110	1.0	5.0
PCS (Personal Communication)	1,930	1.0	5.0
Cellular	869	0.58	2.9
SMR (Specialized Mobile Radio)	854	0.57	2.85
700 MHz	716	0.48	2.4
600 MHz	617	0.41	2.05
[most restrictive frequency range]	30–300	0.20	1.0

ATTACHMENT 8

General Facility Requirements

Base stations typically consist of two distinct parts: the electronic transceivers (also called "radios") that are connected to the traditional wired telephone lines, and the antennas that send the wireless signals created by the radios out to be received by individual subscriber units. The transceivers are often located at ground level and are connected to the antennas by coaxial cables. Because of the short wavelength of the frequencies assigned by the FCC for wireless services, the antennas require line-of-sight paths for their signals to propagate well and so are installed at some height above ground. The antennas are designed to concentrate their energy toward the horizon, with very little energy wasted toward the sky or the ground. This means that it is generally not possible for exposure conditions to approach the maximum permissible exposure limits without being physically very near the antennas.

Computer Modeling Method

The FCC provides direction for determining compliance in its Office of Engineering and Technology Bulletin No. 65, "Evaluating Compliance with FCC-Specified Guidelines for Human Exposure to Radio Frequency Radiation," dated August 1997. Figure 2 describes the calculation methodologies, reflecting the facts that a directional antenna's radiation pattern is not fully formed at locations very close by (the "near-field" effect) and that at greater distances the power level from an energy source decreases with the square of the distance from it (the "inverse square law"). This methodology is an industry standard for evaluating RF exposure conditions and has been demonstrated through numerous field tests to be a conservative prediction of exposure levels.

Site and Facility Description

Based upon information provided by Vertical Bridge, including zoning drawings by Draftlink, dated June 16, 2023, T-Mobile proposes to install twelve directional panel antennas – three RFS Model APXVAALL24, three Ericsson Model AIR6419, and six inactive* spares – on a 65-foot steel pole, configured to resemble a pine tree,† to be sited in an undeveloped area about 670 feet east of the single-family residence located at 9300 Mill Station Road in unincorporated Sonoma County, about 1½ miles west of Sebastopol. The RFS and Ericsson antennas would employ 2° and up to 19° downtilt, respectively, would be mounted at an effective height of about 61 feet above ground, and would be oriented in identical groups of four toward 0°T, 110°T,‡ and 250°T.‡ The maximum effective radiated power in any direction would be 34,940 watts, representing simultaneous operation at 14,230 watts for

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* It is recommended that RF exposure conditions be re-evaluated for compliance with FCC limits at such time as these antennas are proposed to be put into service.

† Foliage atop the pole puts the overall height at about 70 feet.

‡ Based upon information received from Vertical Bridge subsequent to the date of the drawings.

BRS,[§] 6,960 watts for AWS, 9,570 watts for PCS, 880 watts for 700 MHz, and 3,300 watts for 600 MHz service. Also proposed to be mounted on the pole at an effective height of about 56 feet above ground is a 2-foot microwave "dish" antenna, for interconnection of this site with others in the T-Mobile network. There are reported no other wireless telecommunications base stations at the site or nearby.

Study Results

For a person anywhere at ground, the maximum RF exposure level due to the proposed T-Mobile operation, including the contribution of the microwave dish, is calculated to be 0.061 mW/cm^2, which is 6.2% of the applicable public exposure limit. The maximum calculated level at any nearby building[**] is 2.5% of the public exposure limit. It should be noted that these results include several "worst-case" assumptions and therefore are expected to overstate actual power density levels from the proposed operation.

No Recommended Mitigation Measures

Due to their mounting height, the antennas would not be accessible to unauthorized persons, and so no measures are necessary to comply with the FCC public exposure guidelines. It is presumed that T-Mobile will, as an FCC licensee, take adequate steps to ensure that its employees or contractors receive appropriate training and comply with FCC occupational exposure guidelines whenever work is required near the antennas themselves.

Conclusion

Based on the information and analysis above, it is the undersigned's professional opinion that operation of the base station proposed by T-Mobile West LLC at 9300 Mill Station Road near Sebastopol, California, will comply with the prevailing standards for limiting public exposure to radio frequency energy and, therefore, will not for this reason cause a significant impact on the environment. The highest calculated level in publicly accessible areas is much less than the prevailing standards allow for exposures of unlimited duration. This finding is consistent with measurements of actual exposure conditions taken at other operating base stations.

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§ T-Mobile reports maximum effective radiated power in this band of 59,310 watts, to which a duty cycle of 75% is applied; a statistical factor of 32% is also included, to account for spatial distribution of served users, based on the United Nations International Telecommunication Union ITU-T Series K, Supplement 16, dated May 20, 2019.

** Including the residences located at least 480 feet away, based on photographs from Google Maps.

Authorship

The undersigned author of this statement is a qualified Professional Engineer, holding California Registration Nos. E-13026 and M-20676, which expire on June 30, 2025. This work has been carried out under his direction, and all statements are true and correct of his own knowledge except, where noted, when data has been supplied by others, which data he believes to be correct.

William F. Hammett, P.E.
707/996-5200

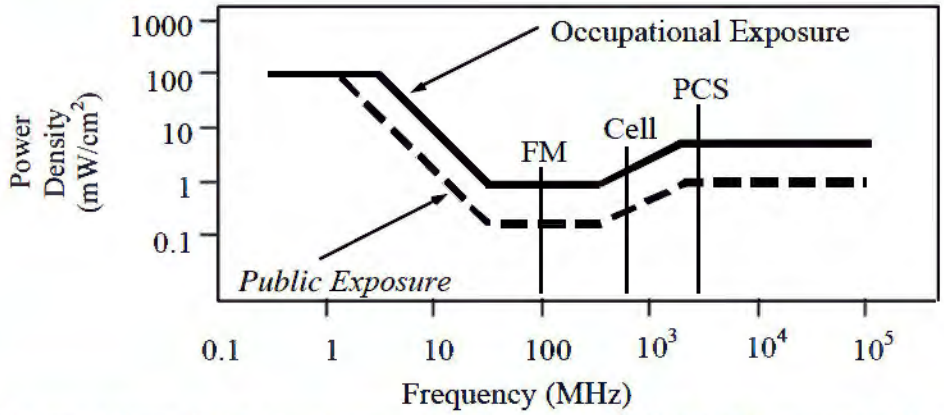
March 20, 2024

FCC Radio Frequency Protection Guide

The U.S. Congress required (1996 Telecom Act) the Federal Communications Commission ("FCC") to adopt a nationwide human exposure standard to ensure that its licensees do not, cumulatively, have a significant impact on the environment. The FCC adopted the limits from Report No. 86, "Biological Effects and Exposure Criteria for Radiofrequency Electromagnetic Fields," published in 1986 by the Congressionally chartered National Council on Radiation Protection and Measurements ("NCRP"). Separate limits apply for occupational and public exposure conditions, with the latter limits generally five times more restrictive. The more recent standard, developed by the Institute of Electrical and Electronics Engineers IEEE C95.1-2019, "Safety Levels with Respect to Human Exposure to Electric, Magnetic, and Electromagnetic Fields, 0 Hz to 300 GHz," includes similar limits. These limits apply for continuous exposures from all sources and are intended to provide a prudent margin of safety for all persons, regardless of age, gender, size, or health.

As shown in the table and chart below, separate limits apply for occupational and public exposure conditions, with the latter limits (in *italics* and/or dashed) up to five times more restrictive:

Frequency	Electromagnetic Fields (f is frequency of emission in MHz)					
Applicable Range (MHz)	Electric Field Strength (V/m)		Magnetic Field Strength (A/m)		Equivalent Far-Field Power Density (mW/cm^2)	
0.3 – 1.34	614	*614*	1.63	*1.63*	100	*100*
1.34 – 3.0	614	*823.8/f*	1.63	*2.19/f*	100	*180/f^2*
3.0 – 30	1842/ f	*823.8/f*	4.89/ f	*2.19/f*	900/ f^2	*180/f^2*
30 – 300	61.4	*27.5*	0.163	*0.0729*	1.0	*0.2*
300 – 1,500	$3.54\sqrt{f}$	*$1.59\sqrt{f}$*	$\sqrt{f}/106$	*$\sqrt{f}/238$*	f/300	*f/1500*
1,500 – 100,000	137	*61.4*	0.364	*0.163*	5.0	*1.0*



Higher levels are allowed for short periods of time, such that total exposure levels averaged over six or thirty minutes, for occupational or public settings, respectively, do not exceed the limits, and higher levels also are allowed for exposures to small areas, such that the spatially averaged levels do not exceed the limits. Hammett & Edison has incorporated conservative calculation formulas in the FCC Office of Engineering and Technology Bulletin No. 65 (August 1997) for projecting field levels in a computer program capable of calculating, at thousands of locations on an arbitrary grid, the total expected power density from any number of individual radio frequency sources. The program allows for the inclusion of uneven terrain in the vicinity, as well as any number of nearby buildings of varying heights, to obtain more accurate projections.

RFE.CALC™ Calculation Methodology

Assessment by Calculation of Compliance with FCC Exposure Guidelines

Hammett & Edison has incorporated the FCC Office of Engineering and Technology Bulletin No. 65 ("OET-65") formulas (see Figure 1) in a computer program that calculates, at millions of locations on a grid, the total expected power density from any number of individual radio frequency sources. The program uses the specific antenna patterns from the manufacturers and allows for the inclusion of uneven terrain in the vicinity, as well as any number of nearby buildings of varying heights, to obtain accurate projections of RF exposure levels. The program can account for spatial-averaging when antenna patterns are sufficiently narrow, and time-averaging is typically considered when operation is in single-frequency bands, which require time-sharing between the base station and the subscriber devices.

OET-65 provides this formula for calculating power density in the far-field from an individual RF source:

$$\text{power density} \quad S = \frac{2.56 \times 1.64 \times 100 \times RFF^2 \times ERP}{4 \times \pi \times D^2} \quad \text{in } mW/cm^2$$

where ERP = total Effective Radiated Power (all polarizations), in kilowatts,
RFF = three-dimensional relative field factor toward point of calculation, and
D = distance from antenna effective height to point of calculation, in meters.

The factor of 2.56 accounts for the increase in power density due to reflections, assuming a reflection coefficient of 1.6 (1.6 x 1.6 = 2.56). This factor is typically used for all sources unless specific information from FCC filings by the manufacturer indicate that a different reflection coefficient would apply. The factor of 1.64 is the gain of a half-wave dipole relative to an isotropic radiator. The factor of 100 in the numerator converts to the desired units of power density.

Because antennas are not true "point sources," their signal patterns may not be fully formed at close distances and so exposure levels may be lower than otherwise calculated by the formula above. OET-65 recommends the cylindrical model formula below to account for this "near-field effect":

$$\text{power density} \quad S = \frac{180}{\theta_{BW}} \times \frac{0.1 \times P_{net}}{\pi \times D \times h} \quad \text{in } mW/cm^2$$

where P_{net} = net power input to antenna, in watts,
θ_{BW} = half-power beamwidth of antenna, in degrees,
D = distance from antenna effective height to point of calculation, in meters, and
h = aperture height of antenna, in meters.

The factor of 0.1 in the numerator converts to the desired units of power density.

OET-65 confirms that the "crossover" point between the near- and far-field regions is best determined by finding where the calculations coincide from the two different formulas, and the program uses both formulas to calculate power density.