Attachment B

UMFUS Compatibility Showing

This attachment demonstrates compatibility of the proposed gateway earth stations with terrestrial Upper Microwave Flexible Use Service ("UMFUS") operations in the 27.5-28.35 GHz ("28 GHz") and 47.2-48.2 GHz ("47 GHz") bands, consistent with Subsections 25.136(a)(4) and (d)(4) of the FCC's rules,[1] except to the extent a limited waiver is requested below to permit any *de minimis* nonconformance with respect to four proposed gateways.

For each proposed gateway, Hughes assessed compliance with Subsections 25.136(a)(4) and (d)(4),[2] and determined the geographic contours set forth below, based upon the following assumptions:

1) Hughes utilized a simulated antenna radiation mask provided by the manufacturer, which is more stringent than the spectrum mask defined in Section 25.209. Hughes calculated the antena elevation and azimuth, as well as the off-axis angle and attenuation at each azimuth from 0 to 360 degrees.

2) For each azimuth, Hughes calculated a distance from the gateway for which the power flux density ("PFD") at 10 meters above ground level is at a threshold minimum of -77.6 dBm/m^2/MHz). The equivalent isotropically radiated power ("EIRP") is assumed to be a clear-sky EIRP minus the on-axis antenna directivity (*i.e.*, 8.5 dBm/MHz), and the spreading loss is the normal 20log(d) + 11 dB. Hughes further accounted for clutter attenuation as quantified by ITU-R Recommendation P.2108-0.

3) Hughes plotted the distances for each azimuth into a .kml file for representation of the contours in Google Earth. Hughes calculated the 2010 Census population of each census

[1] *See* 47 C.F.R. § 25.136(a)(4), (d)(4).

[2] Hughes' amendment ("Amendment") to its twenty gateway applications ("Applications") seeks merely minor changes affecting its 47 GHz gateway operations, as initially proposed. These minor changes — consisting of antenna site changes, an increase in EIRP and EIRP density, and an increase in antenna size (for 10 gateways) — do not constitute a "major amendment" under Section 25.116(b), at least with respect to the proposed 47 GHz gateway operations. *See* 47 C.F.R. § 25.116(b). Notably, the Amendment does not seek any changes to the proposed orbital location or operating frequencies in the 47 GHz band (or the larger Q/V-band). *See* 47 C.F.R. § 25.116(b)(1). Moreover, the proposed changes will not affect compliance with all applicable antenna performance masks and off-axis EIRP density limits, and thus will not increase the potential for harmful interference to other authorized services. *See id.* Indeed, based upon a search of the Commission's Universal Licensing System database, there are no terrestrial 47 GHz licensees that could receive any interference from Hughes' proposed 47 GHz gateway operations. Accordingly, the proposed 47 GHz gateway operations should be grandfathered under Subsection 25.136(d)(3) because the Applications for such operations were filed prior to February 1, 2018 (*i.e.*, on August 3, 2017), and not subject to Subsection 25.136(d)(4)'s requirements. *See* 47 C.F.R. § 25.136(d)(3)-(4). Nonetheless, in an abundance of caution, Hughes is submitting an assessment of compliance with Subsection 25.136(d)(4) to demonstrate compatibility of its proposed gateways with UMFUS operations in the 47 GHz band.

tract contained within the contour, using the actual area method, when necessary, to estimate populations of census tracts partially covered.

4) Hughes also used Google Earth and GIS mapping software tools for visual inspection of whether the contour areas contain any of the following ("Major Venues and Roads"): major event venues, urban mass transit routes, passenger railroads, cruise ship ports, and roads identified as Interstate, Other Freeway and Expressway, or Other Principal Arterial in the Federal Highway Administration Office of Planning, Environment, and Realty Executive Geographic Information System map.

As demonstrated in the attached Comsearch report (Attachment A), Hughes has completed all required frequency coordination for the 28 GHz band with terrestrial licensees for all twenty proposed gateways, consistent with UMFUS coordination requirements under Subsection 25.136(a)(4)(iv).[3] Frequency coordination for the 47 GHz band, however, is not required because there are no terrestrial UMFUS licensees in the band.[4] Comsearch also has advised Hughes that no frequency coordination database for the 47 GHz band is available for use in any event.

As shown in the individual site analyses below, the remaining requirements under Subsections 25.136(a)(4)(i)-(iii) and (d)(4)(i)-(iii) (*i.e.*, maximum number of earth stations within a county, population limits, and Major Venues and Roads restrictions)[5] are met for all proposed gateways, except four (in Bismarck, ND, Santa Clara, CA, Rifle, CO, and Missoula, MT).

For those four proposed gateways, all UMFUS compatibility requirements for the 28 GHz band under Subsection 25.136(a)(4) are met, except that the contour areas overlap 72 to 320 meters of a Major Road. Three of these gateways (in Missoula, Bismarck, and Santa Clara), however, are collocated with operational fixed-satellite service ("FSS") earth stations in the 28 GHz band, and the contour area for the fourth gateway (in Rifle) overlaps merely 72 meters of a Major Road, with vacant lots abutting that stretch of the road.

Furthermore, for the four proposed gateways, all UMFUS compatibility requirements for the 47 GHz band under Subsection 25.136(d)(4) are met, except that the contour areas for three of those gateways (in Bismarck, Santa Clara, and Rifle) overlap 53 to 205 meters of a Major Road. The overlaps in Bismarck and Rifle encompass portions of roadway that are both substantially shorter than a standard city block and abutted by vacant lots or unpopulated areas. Moreover, the overlap in Santa Clara encompasses such a short segment of a Caltrain commuter rail line that passenger trains, moving at a speed of 127 km/hr or higher, can pass through in less than 6 seconds.

Accordingly, in view of such *de minimis* overlap and potential impact on UMFUS operations in the 28 GHz and 47 GHz bands, Hughes requests a limited waiver of Subsections 25.136(a)(4)(iii)

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[3] *See* 47 C.F.R. § 25.136(a)(4)(iv), (d)(4)(iv).

[4] *See* 47 C.F.R. § 25.136(d)(4)(iv) (requiring coordination of 47 GHz operations with terrestrial UMFUS licensees).

[5] *See* 47 C.F.R. § 25.136(a)(4)(i)-(iii), (d)(4)(i)-(iii).

and (d)(4)(iii) for the four proposed gateways.[6] Grant of the requested waiver will serve the public interest by allowing deployment of gateways required to support the provision of an innovative, advanced broadband delivery system that has the potential to reach millions of underserved consumers across the United States, providing high-capacity broadband services at estimated download speeds of 100 Mbps or more. Grant of the requested waiver is also consistent with the Commission's policy objective to ensure compatibility with UMFUS operations. Here, any potential impact on UMFUS operations is *de minimis*, given that the contour areas are very lightly populated (*i.e.*, 0 to approximately 129 people) and overlap only 53 to 320 meters of a Major Road.

The special circumstances warranting a waiver for the four gateways are further discussed in detail in the individual site analyses set forth below. Notably, three of these proposed gateways (*i.e.*, in Missoula, Bismarck, and Santa Clara) are collocated with an existing grandfathered 28 GHz earth station,[7] and thus any potentially affected Major Roads are already impacted by ongoing 28 GHz operations. These three gateway sites were chosen specifically to reduce potential interference that otherwise would result from selecting an alternative site that is permitted under Section 25.136(a)(4), but not collocated with an existing grandfathered 28 GHz earth station in the area. Indeed, the Commission has encouraged collocation as a best practice for selecting sites for earth stations operating in the 28 GHz band.[8] This best practice creates a significant incentive for FSS operators to collocate their 28 GHz earth stations, thus benefitting UMFUS operators by concentrating FSS operations into a single portion of an UMFUS county and leaving the remainder of the county undisturbed.[9]

Furthermore, the fourth gateway site (in Rifle) was chosen due to the availability of necessary facilities (*e.g.*, sufficient power, accessibility, land, and fiber) required for gateway operations in an area where construction of the earth station is feasible. All such suitable locations in Rifle are near a main thoroughfare, such as Government Road, thus rendering an overlap with such roads

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[6] The Commission may waive its rules for "good cause" if: (1) special circumstances warrant a deviation from the general rule; and (2) such deviation will not undermine the policy objective of the rule and will otherwise serve the public interest. *See* 47 C.F.R. § 1.3; *Northeast Cellular Tel. Co. v. FCC*, 897 F.2d 1164 (D.C. Cir. 1990); *WAIT Radio v. FCC*, 418 F.2d 1153 (D.C. Cir. 1969).

[7] Because these three proposed gateways are collocated with a grandfathered 28 GHz earth station authorized prior to July 14, 2016, such collocated gateways also should be grandfathered under Subsection 25.136(a)(2), thus avoiding any need for waiver of Subsection 25.136(a)(4). In an abundance of caution and to secure grandfathered status for the three proposed gateways, Hughes intends to file modification applications to add the collocated gateway antennas to the existing grandfathered 28 GHz earth station licenses. Grant of such license modifications will provide additional or alternative Commission authorizations to operate the three collocated gateways under grandfathered licenses, and does not preclude any grant of the amended Applications for new licenses.

[8] *See Public Notice*, "International Bureau Seeks Comment on Implementing Earth Station Siting Methodologies," DA 17-606 (June 21, 2017) ("Public Notice"); *see also Use of Spectrum Bands Above 24 GHz for Mobile Radio Servs.*, Report and Order and Further Notice of Proposed Rulemaking, 31 FCC Rcd 8014 (2016) ("*Spectrum Frontiers Order*").

[9] *See* Comments of EchoStar Satellite Operating Corp. and Hughes, GN Docket No. 14-177, IB Docket No. 17-172 (filed July 21, 2017).

unavoidable. Consequently, a waiver is warranted because the overlapped portion of Government Road is of a sufficiently short length, bounded on both sides by vacant lots, such that any potential impact on UMFUS operations (in the 28 GHz or 47 GHz band) is *de minimis*.

Similarly, any potential impact of the proposed 47 GHz gateway operations in Bismarck and Santa Clara is *de minimis* because the contour areas are virtually unpopulated and overlap insubstantial portions of roadway or railway.

1. Flagstaff, AZ—28 GHz

    a. No other authorized 28 GHz earth station in Coconino County.

    b. Population within contour: 0.

    c. No Major Venues or Roads within contour.

2. Boise, ID—28 GHz

    a. Two other authorized 28 GHz earth stations (Call Signs E150090 and E110044), one of which is collocated with proposed gateway, in Ada County.

    b. Population within contour: 0.

    c. No Major Venues or Roads within contour.

3. Bend, OR—28 GHz

    a. No other authorized 28 GHz earth station in Deschutes County.

    b. Population within contour: 0.

    c. No Major Venues or Roads within contour.

4. North Las Vegas, NV—28 GHz

    a. Two other authorized 28 GHz earth stations (Call Signs E150089 and E160110), one of which is collocated with proposed gateway, in Clark County.

    b. Population within contour: 0.

    c. No Major Venues or Roads within contour.

5. Rapid City, SD—28 GHz

    a. One other authorized 28 GHz earth station (Call Sign E160111) in Pennington County.

    b. Population within contour: 0.

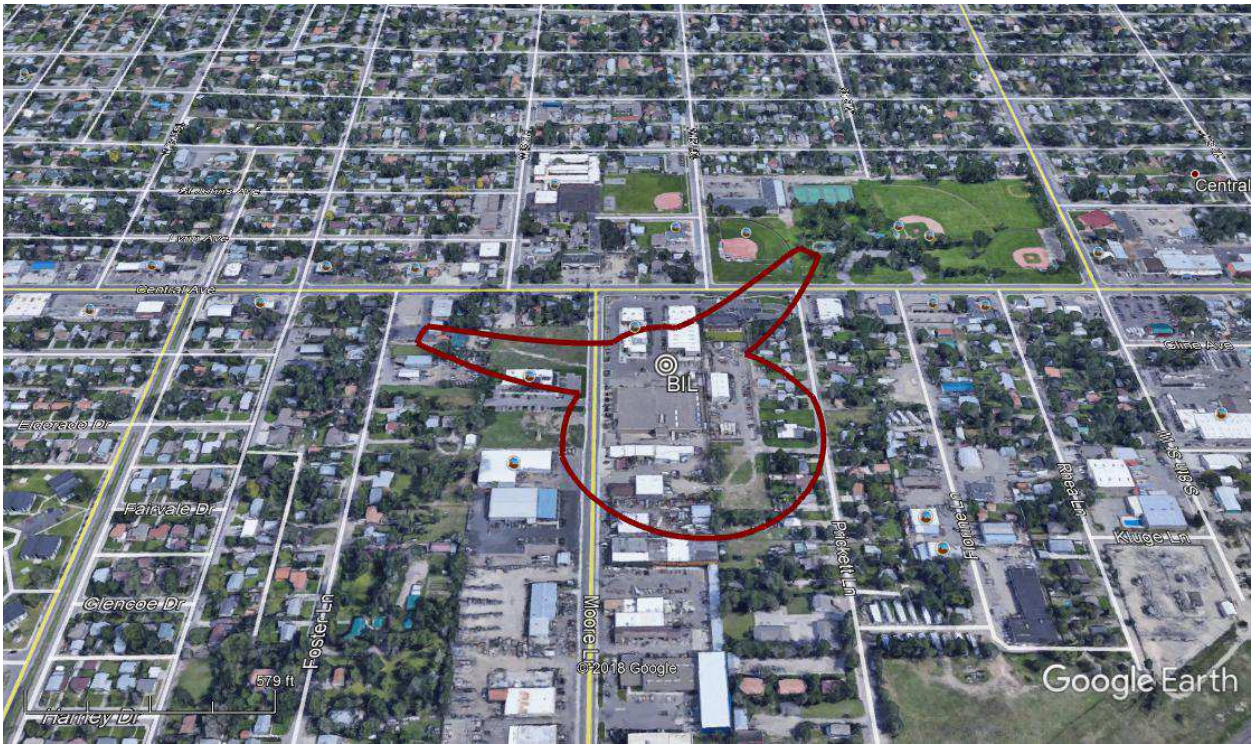
    c. No Major Venues or Roads within the contour. Although the contour for Rapid City, South Dakota, appears to overlap U.S. Highway 16, the proposed earth station site is elevated at least 107 feet above, and the antenna will be pointed away from, the highway. The actual PFD 10 meters above the highway will be less than -77.6 dBm/m2/MHz.

6. Billings, MT—28 GHz

   a. Collocated with one other authorized 28 GHz earth station (Call Sign E150092) in Yellowstone County.

   b. Population within contour: No more than 251, which is the total population of the census blocks partially overlapped by the contour. The actual population within the contour will be be less than 251 and less than maximum permitted population of 450 for Yellowstone County (population = 151,965).

   c. No Major Venues or Roads within contour.



7. North Platte, NE—28 GHz

    a. Collocated with two other authorized 28 GHz earth stations (Call Signs E150080 and E160069) in Lincoln County.

    b. Population within contour: 0.

    c. No Major Venues or Roads within contour.

8. Tucson, AZ—28 GHz

   a. Two other authorized 28 GHz earth stations in Pima County, both of which (Call signs E110052 and E160117) are colocated at another site.

   b. Population within contour: 0.

   c. No Major Venues or Roads within contour.

9. Cheyenne, WY—28 GHz

    a. Collocated with one other authorized 28 GHz earth station (Call Sign E150077) in Laramie County.

    b. Population within contour: 0.

    c. No Major Venues or Roads within contour.

10. Simi Valley, CA—28 GHz

    a. One other authorized 28 GHz earth station (Call Sign E160022) in Ventura County.

    b. Population within contour: 0.

    c. No Major Venues or Roads within contour.

11. Quincy, WA—28 GHz

    a. No other authorized 28 GHz earth station in Grant County.

    b. Population within contour: 0.

    c. No Major Venues or Roads within contour.

12. Lindon, UT—28 GHz

a. Collocated with one other authorized 28 GHz earth station (Call Sign E150086) in Utah County.

b. Population within contour: approximately 20, or less than maximum permitted population (*i.e.*, 0.1 percent, or 516) for Utah County (population =516,564).

c. No Major Venues or Roads within contour.

13. Yuma, AZ—28 GHz

a. No other authorized 28 GHz earth station in Yuma County.

b. Population within contour: approximately 54, or less than maximum permitted population of 450 for Yuma County (population = 201,453).

c. No Major Venues or Roads within contour.

14. Reno, NV—28 GHz

    a. No other authorized 28 GHz earth station in Storey County.

    b. Population within contour: 0.

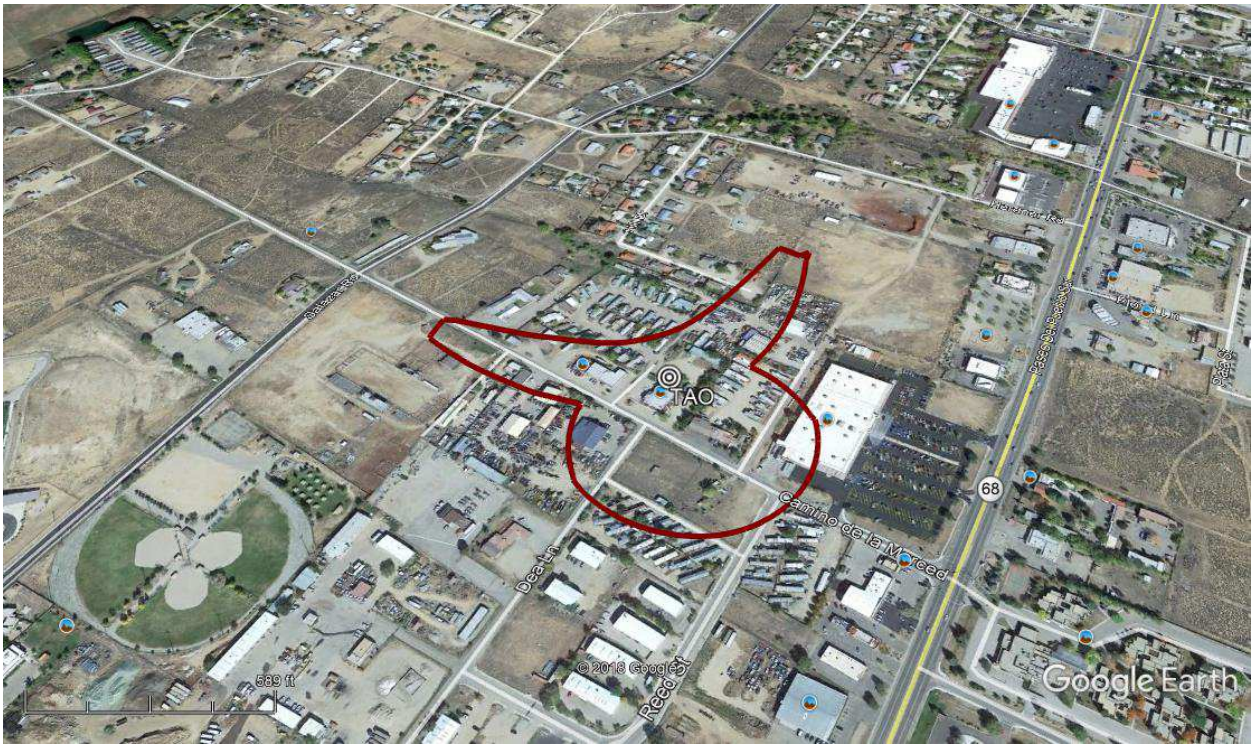
    c. No Major Venues or Roads within contour.

15. Taos, NM—28 GHz

a. No other authorized 28 GHz earth station in Taos County.

b. Population within contour: approximately 32 (*i.e.*, less than maximum permitted aggregate population of 450 for Taos County (population = 32,956).

c. No Major Venues or Roads within contour.



16. Driggs, ID—28 GHz

    a. No other authorized 28 GHz earth station in Teton County.

    b. Population within contour: 0.

    c. No Major Venues or Roads within contour.

17. Missoula, MT—28 GHz

    a. Collocated with one other authorized 28 GHz earth station (Call Sign E150091) in Missoula County.

    b. Population within contour: 0.

    c. No Major Venues or Roads within contour, except for 155 meters along Business I-90 (an arterial road), for which a limited waiver is requested above.

The contour overlaps Business I-90 for approximately 155 meters adjacent to the site.A waiver is warranted for several reasons:

1) The population within the contour is zero.
2) The overlapped portion of Business I-90 (a Principal Arterial) is already impacted by Hughes's collocated and operational 28 GHz earth station (Call Sign E150091).
3) The site was specifically chosen to *minimize* impact on UMFUS operation in Missoula County by limiting impact to the area already affected by the existing 28 GHz earth station at the same site.

18. Bismarck, ND—28 GHz

a. Collocated with one other authorized 28 GHz earth station (Call Sign E150082) in Burleigh County.

b. Population within contour: No more than 127, which is the total population of the census blocks partially overlapped by the contour. The actual population within the contour will be be less than 127 and less than maximum permitted population of 450 for Burleigh County (population = 86,111).

c. No Major Venues or Roads within contour, except for 320 meters along 43rd Ave NE (an arterial road), for which a limited waiver is requested above.

The contour overlaps East 43rd Avenue by approximately 320 meters adjacent to the site. A waiver is warranted for several reasons:

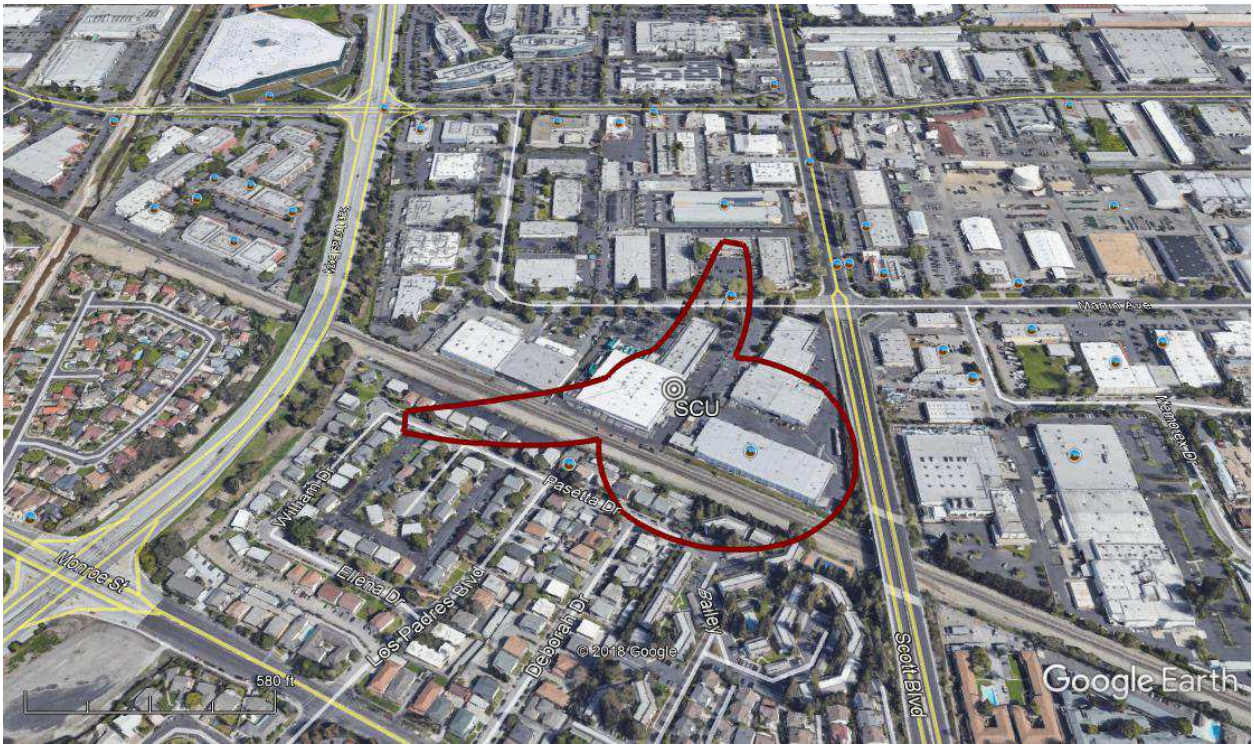
1) There does not appear to be any inhabited facility within the contour along East 43rd Avenue.
2) The overlapped portion of East 43rd Avenue (a Principal Arterial) is already impacted by Hughes's collocated and operational 28 GHz earth station (Call Sign E150082).
3) The site was specifically chosen to *minimize* impact on UMFUS operation in Burleigh County by limiting impact to the area already affected by the existing 28 GHz earth station at the same site.

19. Santa Clara, CA—28 GHz

    a. Collocated with one other authorized 28 GHz earth station (Call Sign E150087) in Santa Clara County.

    b. Population within contour: approximately 129, or less than maximum permitted population (*i.e.*, 0.1 percent, or 1,781) for Santa Clara County (population = 1,781,642).

    c. No Major Venues or Roads within contour, except for 295 meters along the Caltrain ralroad, for which a limited waiver is requested above.



The contour overlaps the Caltrain railroad by approximately 295 meters adjacent to the site. A waiver is warranted for several reasons:

1) The population within the contour (approximated by the actual area method applied to the census block to the southwest of the railroad) is well under the population permitted to fall within cumulative UMFUS contours in Santa Clara County.
2) The overlapped portion of the railroad is already impacted by Hughes's collocated and operational 28 GHz earth station (Call Sign E150087).
3) The site was specifically chosen to *minimize* impact on UMFUS operation in Santa Clara county by limiting impact to the area already affected by the existing 28 GHz earth station at the same site.

20. Rifle, CO—28 GHz

a. No other authorized 28 GHz earth station in Garfield County.

b. Population within contour: no more than 95, which is the total population of the census blocks partially overlapped by the contour. The actual population within the contour will be be less than 95 and less than maximum permitted population of 450 for Garfield County population = 56, 684).

c. No Major Venues or Roads within contour, except for 72 meters along Government Road, for which a limited waiver is requested above.

The contour overlaps the Government Road by approximately 72 meters adjacent to the site. A waiver is warranted for several reasons:

1) The portion of Government Road that is overlapped is straddled by vacant lots on either side, with no apparent facility affected. Because the overlap is of a sufficiently short length, bounded on both sides by vacant lots, the impact of the waiver is de minimis.
2) This site was chosen due to the availability of necessary facilities for the operation of the earth station (adequate power, accessibility, land, and fiber) in an area in which construction of the earth station is feasible. All such suitable locations in Rifle are near a main thoroughfare, such as Government Road.

21. Flagstaff, AZ—47.2 GHz

a. No other authorized 47.2 GHz earth station in Coconino County or Flagstaff, Arizona, Partial Economic Area 180.

b. Population within contour: 0.

c. No Major Venues or Roads within contour.

22. Boise, ID—47.2GHz

a. No other authorized 47.2 GHz earth station in Coconino County or in Boise City, Idaho, Partial Economic Area 150.

b. Population within contour: 0.

c. No Major Venues or Roads within contour.

23. Bend, OR—47.2 GHz

a. No other authorized 47.2 GHz earth station in Deschutes County or Bend, Oregon, PEA 213.

b. Population within contour: 0.

c. No Major Venues or Roads within contour.

24. North Las Vegas, NV—47.2GHz

a. No other authorized 47.2 GHz earth station in in Clark County or Las Vegas, Nevada, PEA 26.

b. Population within contour: 0.

c. No Major Venues or Roads within contour.

25. Rapid City, SD—47.2 GHz

a. No other authorized 47.2 GHz earth station in Pennington County or Rapid City, South Dakota, PEA 276..

b. Population within contour: 0.

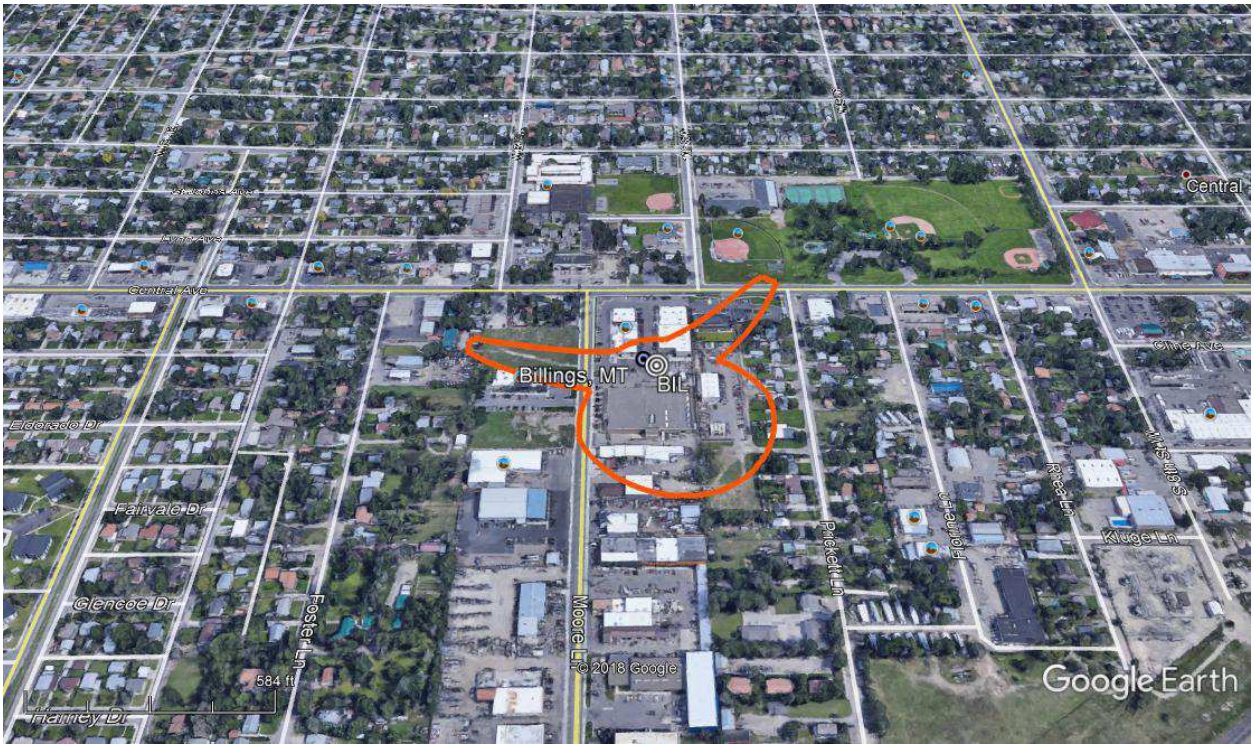
c. No Major Venues or Roads within the contour. Although the contour for Rapid City, South Dakota, appears to overlap U.S. Highway 16, the proposed earth station site is elevated at least 107 feet above, and the antenna will be pointed away from, the highway. The actual PFD 10 meters above the highway will be less than -77.6 dBm/m2/MHz.

26. Billings, MT—47.2 GHz

a. No other authorized 47.2 GHz earth station in Yellowstone County or Bozeman, Montana, PEA 190.

b. Population within contour: No more than 251, which is the total population of the census blocks partially overlapped by the contour. The actual population within the contour will be be less than 251 and less than maximum permitted population of 2,250 for the Bozeman, Montana, PEA (population = 324,077).

c. No Major Venues or Roads within contour.



27. North Platte, NE—47.2 GHz

a. No other 47.2 GHz earth station in Lincoln County or North Platte, Nebraska, PEA 374.

b. Population within contour: 0.

c. No Major Venues or Roads within contour.

28. Tucson, AZ—47.2 GHz

a. No other authorized 47.2 GHz earth stations in Pima County or Tucson, Arizona PEA 53.

b. Population within contour: 0.

c. No Major Venues or Roads within contour.

29. Cheyenne, WY—47.2 GHz

a. No other authorized 47.2 GHz earth station in Laramie County or Cheyenne, Wyoming, PEA 257.

b. Population within contour: 0.

c. No Major Venues or Roads within contour.

30. Simi Valley, CA—47.2 GHz

a. No other authorized 47.2 GHz earth station in in Ventura County or Los Angeles, California, PEA 2.

b. Population within contour: 0.

c. No Major Venues or Roads within contour.

31. Quincy, WA—47.2 GHz

a. No other authorized 47.2 GHz earth station in Grant County or Wenatchee, Washington, PEA 206.

b. Population within contour: 0.

c. No Major Venues or Roads within contour.

32. Lindon, UT—47.2 GHz

a. No other authorized 47.2 GHz earth station in Utah County or Salt Lake City, Utah, PEA 27.

b. Population within contour: approximately 20, or less than maximum permitted population (2,250 people) for the Salt Lake City, Utah, PEA (population = 2,142,152).

c. No Major Venues or Roads within contour.

33. Yuma, AZ—47.2 GHz

a. No other authorized 47.2 GHz earth station in Yuma County or Yuma, Arizona, PEA 157.

b. Population within contour: approximately 54, or less than maximum permitted population of 2,250 for the Yuma, Arizona, PEA (population = 390,768).

c. No Major Venues or Roads within contour.

34. Reno, NV—47.2 GHz

a. No other authorized 47.2 GHz earth station in Storey County or Reno, Nevada, PEA 76.

b. Population within contour: 0.

c. No Major Venues or Roads within contour.

35. Taos, NM—47.2 GHz

a. No other authorized 47.2 GHz earth station in Taos County or Espanola, New Mexico, PEA 357.

b. Population within contour: approximately 32 (*i.e.*, less than maximum permitted aggregate population of 2,250 for the Espanola, New Mexico, PEA (population = 73,813).

c. No Major Venues or Roads within contour.

36. Driggs, ID—47.2 GHz

    a. No other authorized 47.2 GHz earth station in Teton County or Pocatello, Idaho, PEA 187.

    b. Population within contour: 0.

    c. No Major Venues or Roads within contour.

37. Missoula, MT—47.2 GHz

a. No other authorized 47.2 GHz earth station in Missoula County or Helena, Montana, PEA 158.

b. Population within contour: 0.

c. No Major Venues or Roads within contour.

38. Bismarck, ND—47.2 GHz

a. No other authorized 47.2 GHz earth station in Burleigh County or Bismarck, North Dakota, PEA 325.

b. Population within contour: No more than 127, which is the total population of the census blocks partially overlapped by the contour. The actual population within the contour will be be less than 127 and less than maximum permitted population of 2,250 for the Bismarck, North Dakota, PEA (population = 108,779).

c. No Major Venues or Roads within contour, except for 125 meters along 43rd Ave NE (an arterial road), for which a limited waiver is requested above.

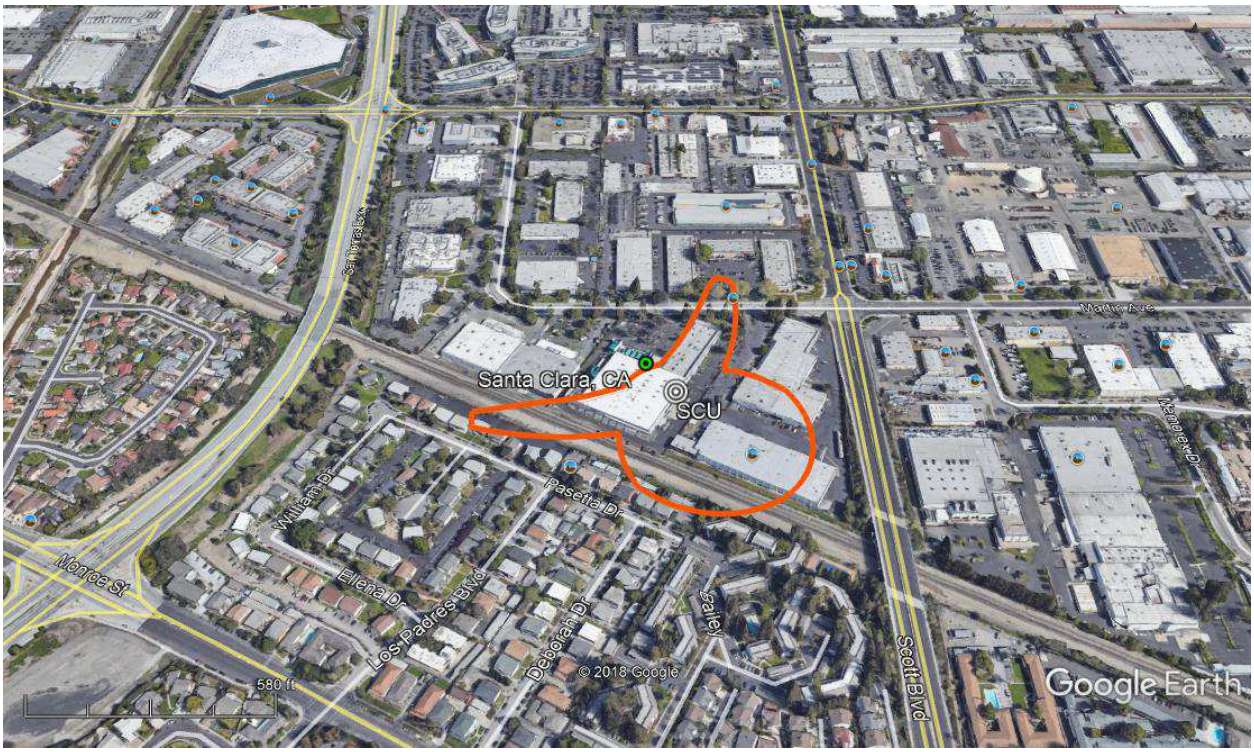
The contour overlaps East 43rd Avenue by approximately 125 meters in two stretches adjacent to the site. This application was filed before February 1, 2018, and this earth station should be authorized on this basis; however, in the alternative, a waiver of 47 C.F.R. § 25.136(d)(4)(iii) is warranted because there is not any inhabited facility within the contour along East 43rd Avenue.

39. Santa Clara, CA—47.2 GHz

a. No other 47.2 GHz earth station in Santa Clara County or San Francisco, CA, PEA 4.

b. Population within contour: approximately 30, or less than maximum permitted population (*i.e.*, 0.1 percent, or 9,027) for the San Francisco, California, PEA (population = 9,027,937).

c. No Major Venues or Roads within contour, except for 205 meters along the Caltrain ralroad, for which a limited waiver is requested above.



The contour overlaps the Caltrain railroad by approximately 205 meters in two stretches adjacent to the site. This application was filed before February 1, 2018, and this earth station should be authorized on this basis; however, in the alternative, a waiver of 47 C.F.R. § 25.136(d)(4)(iii) is warranted because of the de minimis amount of time a passenger train travelling along the impacted segment at Caltrain's standard speed of 127 km/hr will be within the contour for 5.81 seconds out of the 57 minute trip from San Francisco to San Jose.

40. Rifle, CO—47.2GHz

a. No other authorized 47.2 GHz earth station in Garfield County or the Grand Junction, Colorado, PEA 102.

b. Population within contour: 0 (while the contour partially overlaps census with a combined population of 95, there are no dwellings apparent within the contour).

c. No Major Venues or Roads within contour, except for 53 meters along Government Road, for which a limited waiver is requested above.

The contour overlaps the Government Road by approximately 53 meters adjacent to the site. This application was filed before February 1, 2018, and this earth station should be authorized on this basis; however, in the alternative, a waiver of 47 C.F.R. § 25.136(d)(4)(iii) is warranted because of the contour overlaps at a portion of Government Road that is straddled by vacant lots on either side, with no apparent facility affected. Because the overlap is of a sufficiently short length, bounded on both sides by vacant lots, the impact of the waiver is de minimis.