

**ATTACHMENT B**

**UMFUS Compatibility Showing  
(Bismarck, ND; Call Sign E170169)**

**1. Section 25.136(a)(4) assessment – 27.5-28.35 GHz**

**1.1. Section 25.136(a)(4)(i) – Number of earth stations**

As of November 2020, the only other earth station licensed or proposed in the 27.5-28.35 GHz band in the relevant license area is a collocated earth station licensed to Hughes (call sign E150082) that is grandfathered in 27.85-28.35 GHz.

**1.2. Section 25.136(a)(4)(ii) and (iii) – Power Flux Density (“PFD”) contour population and highway/event/railway/port coverage**

**1.2.1. Assumptions**

The Section 25.136 PFD was determined using the publicly available software program Visualyse and based upon the Table 1 technical parameters for the Jupiter 3 earth station.

<b>Parameter</b>	<b>Value</b>
Latitude/longitude	46° 51' 6.0"N/ 100° 46' 58.5"W
Frequency (GHz)	28
Channel bandwidth (MHz)	470
Transmit power (dBW)	5.09
Antenna midline height above ground (m)	7
Antenna size (m)	10
On-axis antenna Gain (dBi)	67.91
Clear sky EIRP (dBW)	73
Antenna radiation pattern	Manufacturer calculated off-axis gain pattern (see Figure 1)
Clutter	Recommendation ITU-R P.452-16, Suburban
Terrain	NASA SRTM data 30 m resolution <sup>1</sup>

*Table 1. Jupiter 3 gateway earth station technical parameters at 28 GHz*

Figure 1 shows the sum of the manufacturer’s calculated co-polarized and cross-polarized off-axis gain patterns. Measured antenna patterns are not available for the off-axis angles of importance because of the size of the antenna<sup>2</sup>; hence, calculated antenna patterns provided by the manufacturer are used.

<sup>1</sup> <http://dwtkns.com/srtm30m/>

<sup>2</sup> See 47 C.F.R. § 25.132(d)

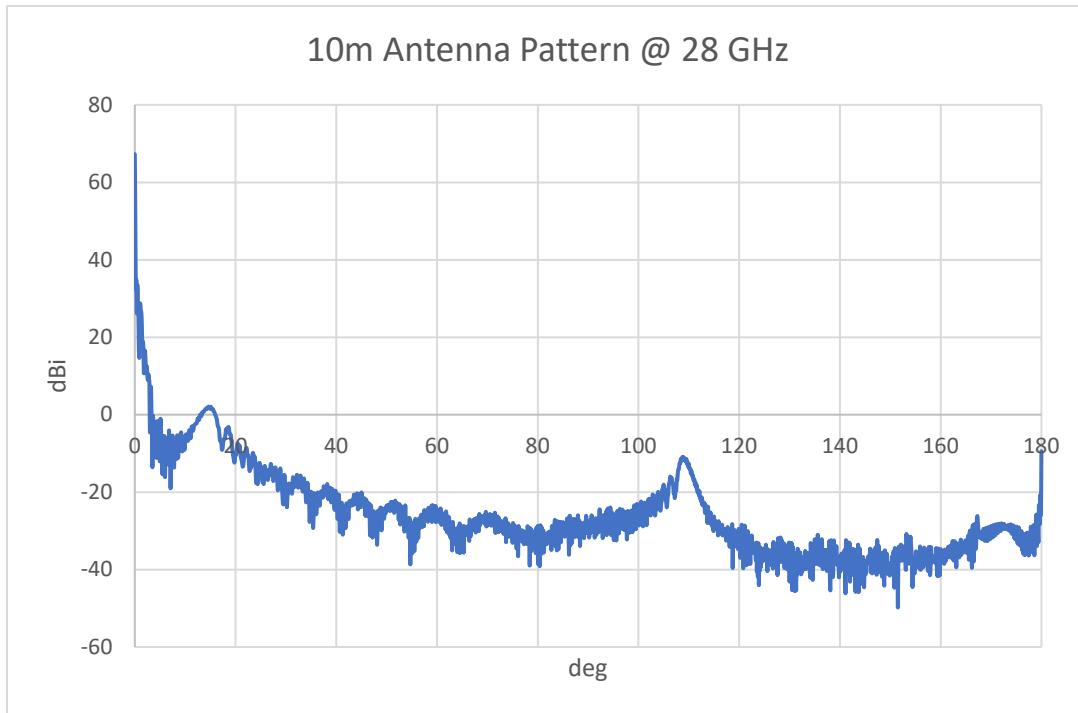


Figure 1. SED calculated off-axis gain pattern at 28 GHz

The earth station uses adaptive modulation and coding as well as uplink power control to maintain the desired availability. The percentage of time that the earth station will exceed the clear sky levels is small. Using Recommendation ITU-R P.618, Hughes has determined that the power levels are within 1 dB of the clear sky input power for 96.42% of the time and within 2 dB of the clear sky input power for 98.65% of the time.

Further, the earth station is licensed for clear sky EIRP levels pursuant to Section 25.204(e) of the Commission's rules.

The earth station is collocated with a grandfathered earth station (call sign E150082) operating in 27.85-28.35 GHz. Results are provided in Section 2.2.2 for the 27.5-27.85 GHz band, where the Jupiter 3 single entry PFD is assessed, and in Section 2.2.3 for the 27.85-28.35 GHz band, where the aggregate PFD contour for the grandfathered earth station and Jupiter 3 operating together is compared to the grandfathered PFD contour.

### 1.2.2. Results for 27.5-27.85 GHz

Visualyse Version 7 software was run using the Recommendation ITU-R P.452-16 propagation model option to generate the Section 25.136 contour for the 28 GHz band where the earth station generates a PFD, at 10 meters above ground level, of greater than or equal to  $-77.6 \text{ dBm/m}^2/\text{MHz}$ . The resulting PFD contour is shown in Figure 2 (and further specified in a KMZ file submitted with this application).

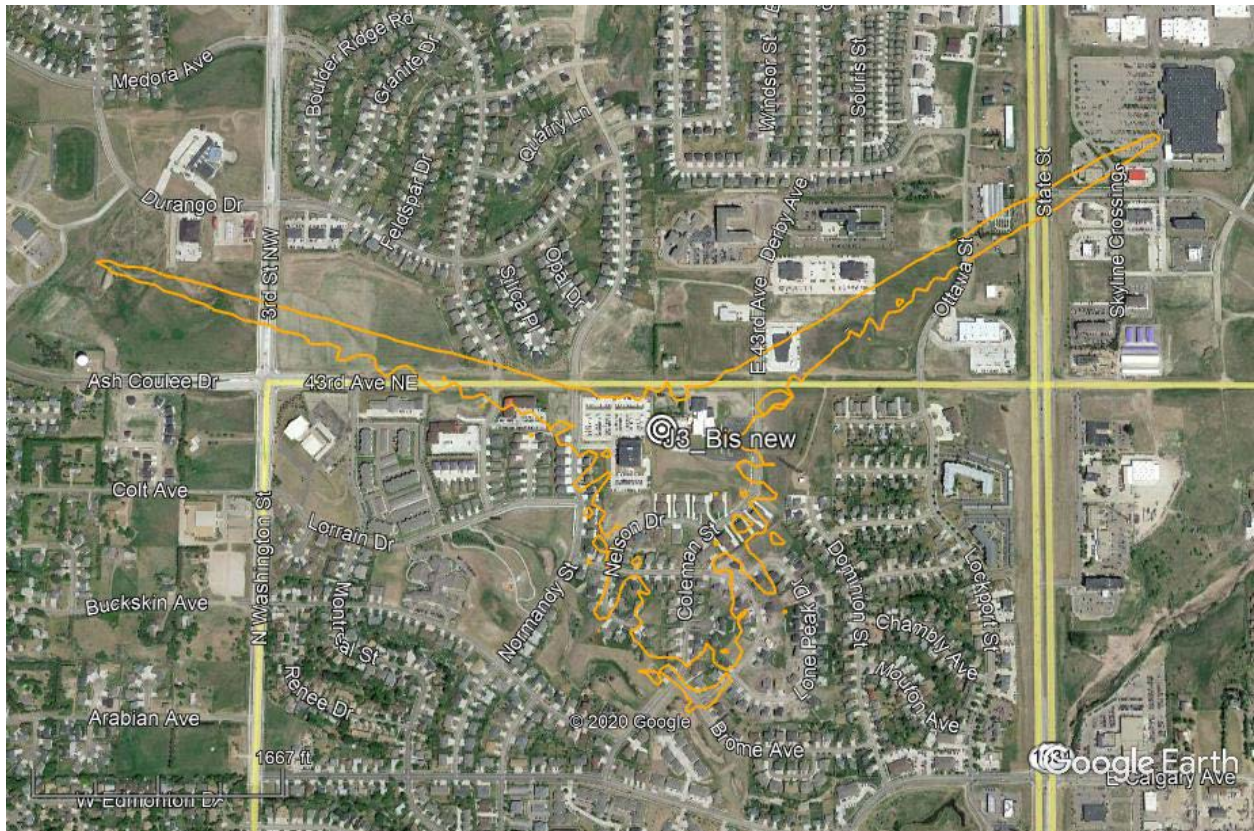


Figure 2. Section 25.136 pfd contour around the Bismarck earth station in the 27.5-27.85 GHz band

With respect to coverage of major roads (*i.e.*, Interstate, Other Freeways and Expressways, or Other Principal Arterial, according to the Federal Highway Administration HEPGIS map or Other Freeways and Expressways, or Other Principal Arterials identified by the North Dakota State Department of Transportation), the 27.5-27.85 GHz PFD contour covers approximately 452 meters of 43<sup>rd</sup> Avenue. The PFD contour also does not contain any major event venue, urban mass transit route, passenger railroad, or cruise ship port according to a visual inspection in Google Earth.

The population covered by the 27.5-27.85 GHz PFD contour was determined using the actual area method, where the population within the contour was calculated based on the proportion of the census geographic area covered by the PFD contour. Figure 3 shows the PFD contour overlaid on a census block map of the service area, with census block ID numbers depicted.

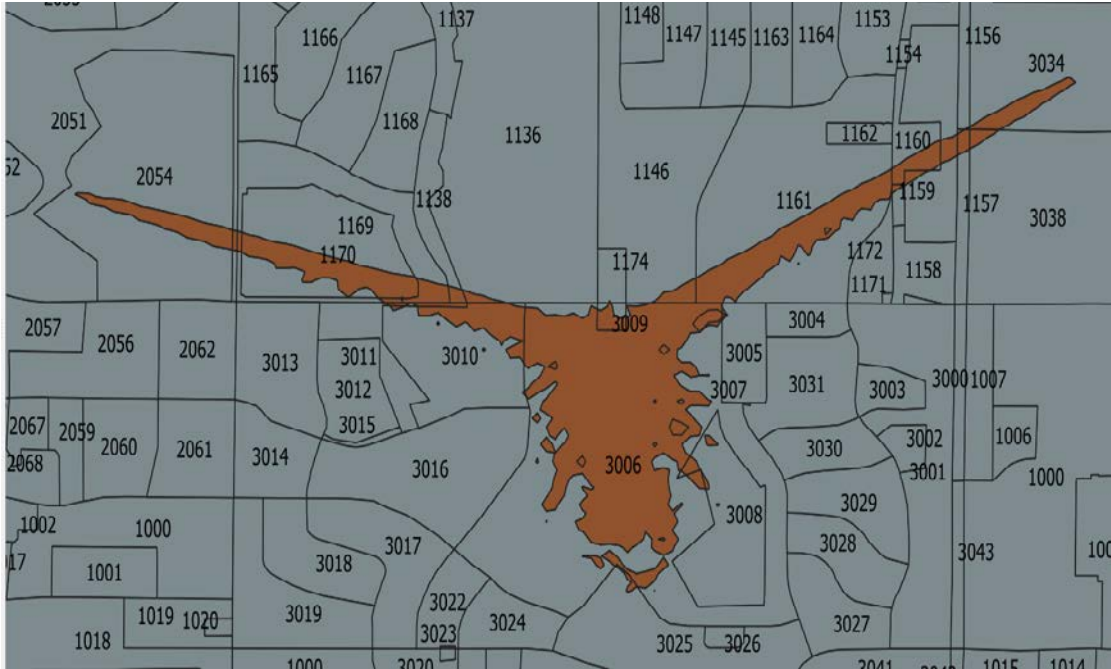


Figure 3. 27.5-27.85 GHz pfd contour overlaid on labeled census blocks

Table 2 provides the percentage of area of each census block covered by the contour, the associated population covered, and sums the population covered. The population covered is 79, thus the population coverage limit of 450 persons is met.

Census Tract	Census Block	Block Population	Total Block Area	Area Covered	Weighted Population
11101	3005	0	22941	224	0.00
11105	1155	2	50316	2918	0.12
11001	3034	0	143524	7578	0.00
11101	3011	127	24450	1560	8.10
11105	1172	0	15644	32	0.00
11101	3006	127	338821	170894	64.06
11104	2051	73	283344	476	0.12
11105	1138	23	18792	1157	1.42
11101	3008	0	56377	1676	0.00
11105	1174	2	8018	12	0.00
11105	1159	0	2562	310	0.00
11104	2054	0	197811	12000	0.00
11105	1161	6	173262	32963	1.14
11101	3010	0	70090	13677	0.00
11001	3038	0	165932	1552	0.00
11105	1170	0	85259	22147	0.00
11105	1136	0	919140	1222	0.00
11105	1157	0	10998	1329	0.00
11105	1160	0	15066	4929	0.00
11105	1146	0	126184	3044	0.00

11105	1169	27	50055	4529	2.44
11105	1156	0	10137	30	0.00
11101	3025	77	84610	593	0.54
11101	3009	2	4013	2736	1.36
<b>Total</b>					<b>79</b>

Table 2. Population coverage of 27.5-27.85 GHz pfd contour

### 1.2.3. Results for 27.85-28.35 GHz

Visualyse Version 7 software was run using the Recommendation ITU-R P.452-16 propagation model option to generate the Section 25.136 PFD contours for the 27.85-28.35 GHz band where 1) the collocated grandfathered earth station generates a pfd, at 10 meters above ground level, of greater than or equal to  $-77.6$  dBm/m<sup>2</sup>/MHz (“the grandfathered PFD contour”) and 2) where the collocated grandfathered earth station operating simultaneously with the Jupiter 3 earth station generates the same PFD (“the aggregate PFD contour”).

The Table 3 technical parameters were used for the grandfathered earth station:

Parameter	Value
Latitude/longitude	46° 51' 6.7" N, 100° 46' 57.8" W
Frequency (GHz)	28
Channel bandwidth (MHz)	250
Transmit power (dBW)	3.7
Antenna midline height above ground (m)	4.25
Antenna size (m)	8.1
On-axis antenna Gain (dBi)	65.3
Clear sky EIRP (dBW)	69
Antenna radiation pattern	Section 25.209(a)(1)
Clutter	Recommendation ITU-R P.452-16, Suburban
Terrain	NASA SRTM data 30 m resolution <sup>3</sup>

Table 3. Grandfathered gateway earth station technical parameters at 28 GHz

The resulting PFD contours are shown in Figure 4 (and further specified in a KMZ file submitted with this application). The blue PFD contour is the grandfathered PFD contour, and the red PFD contour is the aggregate PFD contour.

<sup>3</sup> <http://dwtkns.com/srtm30m/>



Figure 4. Section 25.136 grandfathered and aggregate PFD contours around the Bismarck earth station in the 27.85-28.35 GHz band

With respect to coverage of any major roads (i.e., Interstate, Other Freeways and Expressways, or Other Principal Arterial, according to the Federal Highway Administration HEPGIS map or Other Freeways and Expressways, or Other Principal Arterials identified by the North Dakota Department of Transportation), the 27.85-28.35 GHz aggregate PFD contour covers substantially the same roadway areas covered by the grandfathered PFD contour – approximately 272 meters of 43<sup>rd</sup> Ave (in addition to approximately 428 meters covered by the grandfathered PFD contour) and 60 meters of US Route 83. The PFD contour does not contain any major event venue, urban mass transit route, passenger railroad, or cruise ship port according to a visual inspection in Google Earth.

The population covered by the 27.85-28.35 GHz aggregate PFD contour, but not within the grandfathered contour, was determined using the actual area method, where the population within the contour was calculated based on the proportion of the census geographic area covered by the PFD contour. Figure 5 shows the PFD contours overlaid on a census block map of the service area, with census block ID numbers depicted. The area colored blue – inside the aggregate PFD contour but outside the grandfathered PFD contour – was assessed against the population limits.

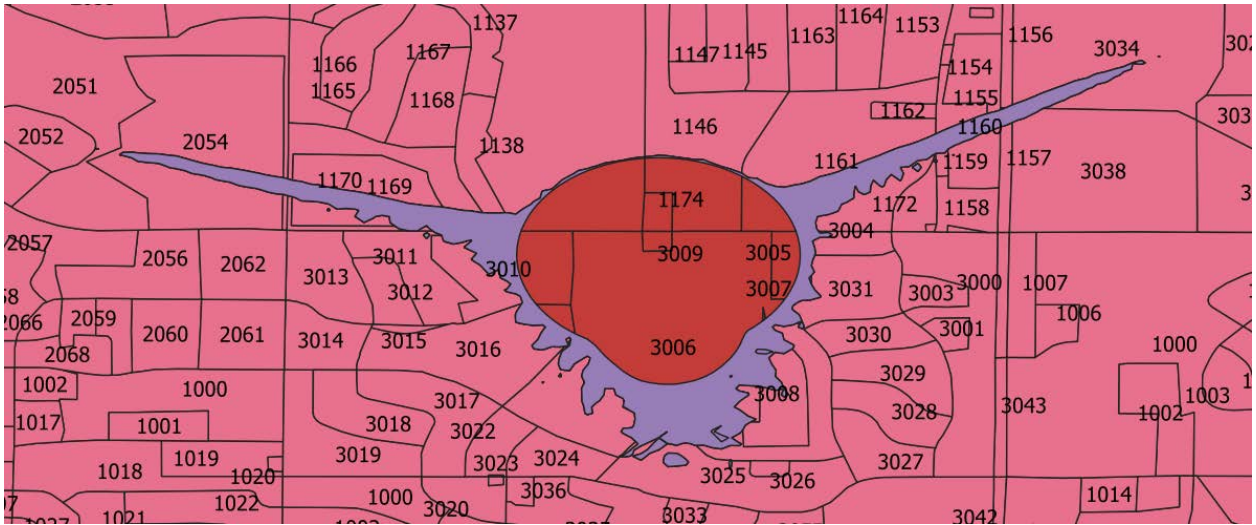


Figure 5. 27.85-28.35 GHz pfd contour overlaid on labeled census blocks

Table 4 provides the percentage of area of each census block covered by the pink area, the associated population covered, and sums the population covered. The population covered is 61, thus the population coverage limit of 450 persons is met.

Census Tract	Census Block	Block Population	Block Area	Block Area covered by Agg but not J2	Weighted Population
11001	3034	0	182823	9888	0.0
11001	3038	0	165984	1748	0.0
11101	3004	42	14178	1195	3.5
11101	3005	0	19861	7285	0.0
11101	3006	127	354506	77679	27.8
11101	3007	0	275	275	0.0
11101	3008	0	43715	13138	0.0
11101	3010	0	69204	16835	0.0
11101	3011	127	43885	2772	8.0
11101	3016	7	91115	9416	0.7
11101	3025	77	85850	9848	8.8
11101	3031	92	45970	1755	3.5
11101	3031	92	45970	119	0.2
11104	2051	73	283165	579	0.1
11104	2052	0	32659	0	0.0
11104	2054	0	196828	14825	0.0
11105	1136	0	914147	4658	0.0
11105	1138	23	28074	3287	2.7
11105	1146	0	129250	1321	0.0
11105	1155	2	51026	4213	0.2

11105	1156	0	10148	83	0.0
11105	1157	0	10998	1441	0.0
11105	1159	0	2562	498	0.0
11105	1160	0	14298	4481	0.0
11105	1161	6	168048	38741	1.4
11105	1169	27	50912	7281	3.9
11105	1170	0	72628	23583	0.0
11105	1172	0	15644	58	0.0
<b>Total</b>					<b>61</b>

Table 4. Population coverage of 27.85-28.35 GHz PFD contour (aggregate – grandfathered)

### 1.3. Section 25.136(a)(4)(iv) – Coordination

As demonstrated in the attached Coordination Report (Attachment A), coordination of the modified earth station operations was completed through Comsearch pursuant to Sections 25.136(a)(4)(iv) and 101.103(d) of the Commission’s rules.

## 2. Section 25.136(d)(4) assessment – 47.2-48.2 GHz

### 2.1. Section 25.136(d)(4)(i) – Number of earth stations

As of November 2020, there are no other earth stations licensed or proposed in the 47.2-48.2 GHz band in the relevant license area.

### 2.2. Section 25.136(d)(4)(ii) and (iii) – PFD contour population and highway/event/railway/port coverage

#### 2.2.1. Assumptions

The Section 25.136 PFD was determined using the publicly available software program Visualyse and based upon the Table 5 technical parameters for the Jupiter 3 earth station.

Parameter	Value
Latitude/longitude	46° 51' 6.0"N/ 100° 46' 58.5"W
Frequency (GHz)	47
Channel bandwidth (MHz)	470
Transmit power (dBW)	0.39
Antenna midline height above ground (m)	7
On-axis antenna Gain (dBi)	71.61
Clear sky EIRP (dBW)	72



Antenna radiation pattern	Manufacturer calculated off-axis gain pattern
Clutter	Recommendation ITU-R P.452-16, Suburban
Terrain	NASA SRTM data 30 m resolution <sup>4</sup>

Table 5. Jupiter 3 gateway earth station technical parameters at 47 GHz

Figure 6 provides a plot of the manufacturer’s calculated combined co-polarized and cross-polarized off-axis gain patterns. Measured antenna patterns are not available for the off-axis angles of importance because of the size of the antenna; hence, calculated antenna patterns provided by the manufacturer are used.

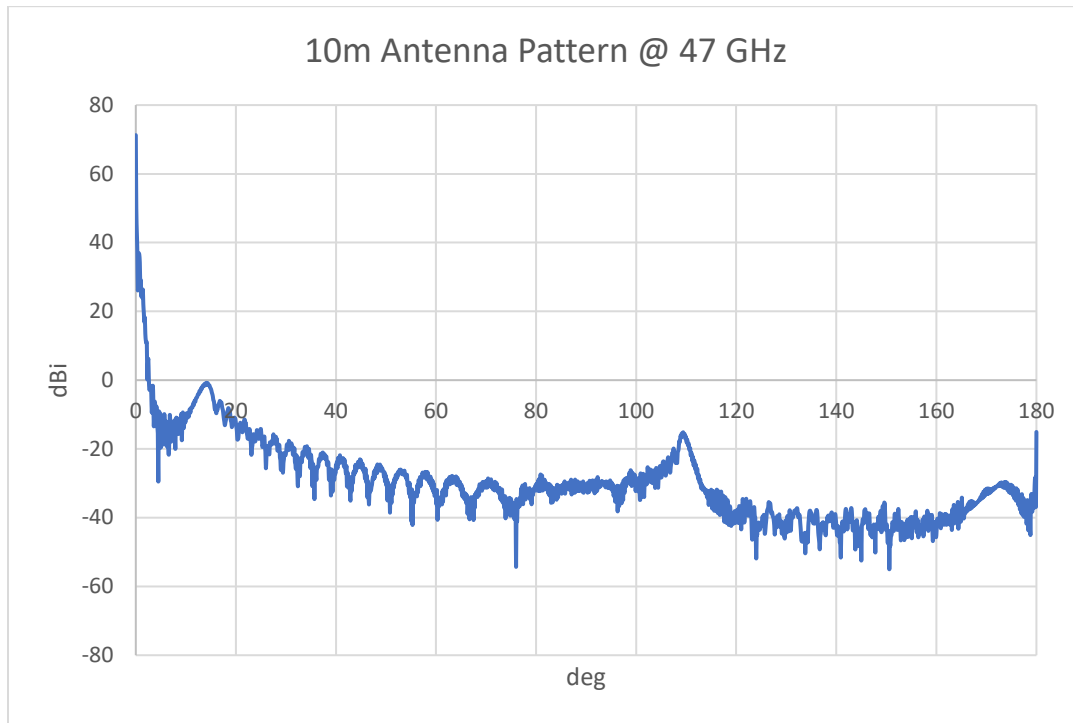


Figure 6. SED calculated off-axis gain pattern at 47 GHz

The earth station uses adaptive modulation and coding as well as uplink power control to maintain the desired availability. The percentage of time that the earth station will exceed the clear sky levels is small. Using Recommendation ITU-R P.618, Hughes has determined that the power levels are within 1 dB of the clear sky input power for 88.54% of the time and within 2 dB of the clear sky input power for 95.39% of the time.

Further, the earth station is licensed for clear sky EIRP levels pursuant to Section 25.204(e) of the Commission’s rules.

<sup>4</sup> <http://dwtkns.com/srtm30m/>

## 2.2.2. Results

Visualyse Version 7 software was run using the Recommendation ITU-R P.452-16 propagation model option to generate the Section 25.136 contour for the 47 GHz band where the earth station generates a pfd, at 10 meters above ground level, of greater than or equal to  $-77.6 \text{ dBm/m}^2/\text{MHz}$ . The resulting PFD contour is shown in Figure 7 (and further specified in a KMZ file submitted with this application).

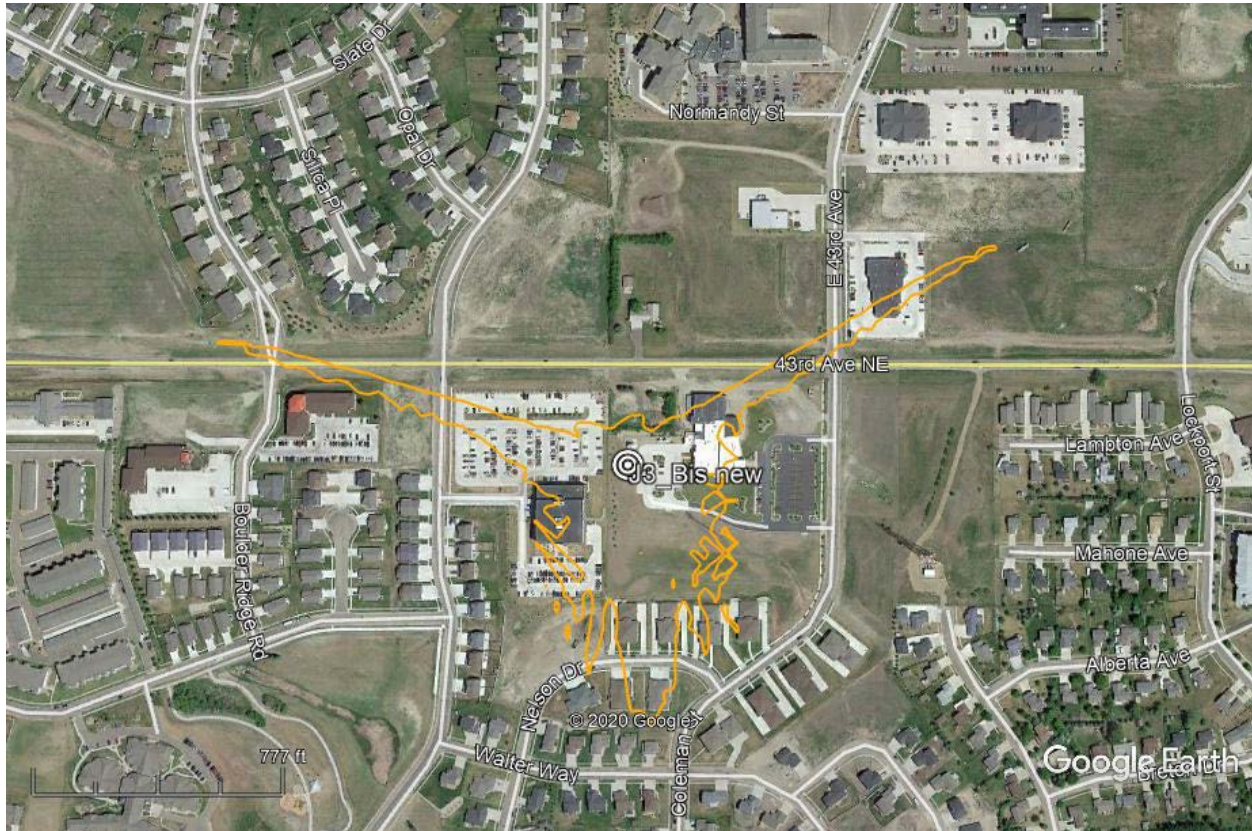


Figure 7. Section 25.136 pfd contour around the Bismarck earth station in the 47 GHz band

With respect to any major roads (*i.e.*, Interstate, Other Freeways and Expressways, or Other Principal Arterial according to the Federal Highway Administration HEPGIS map, or highways designated as Other Freeways and Expressways, or Other Principal Arterials by the North Dakota Department of Transportation), the 47 GHz PFD contour covers approximately 80 meters of 43<sup>rd</sup> Avenue. The PFD contour also does not contain any major event venue, urban mass transit route, passenger railroad, or cruise ship port according to a visual inspection in Google Earth.

The population covered by the 47 GHz PFD contour was determined using the actual area method, where the population within the contour was calculated based on the proportion of the census geographic area covered by the PFD contour. Figure 8 shows the 47 GHz PFD contour overlaid on a census block map of the service area, with census block ID numbers depicted.

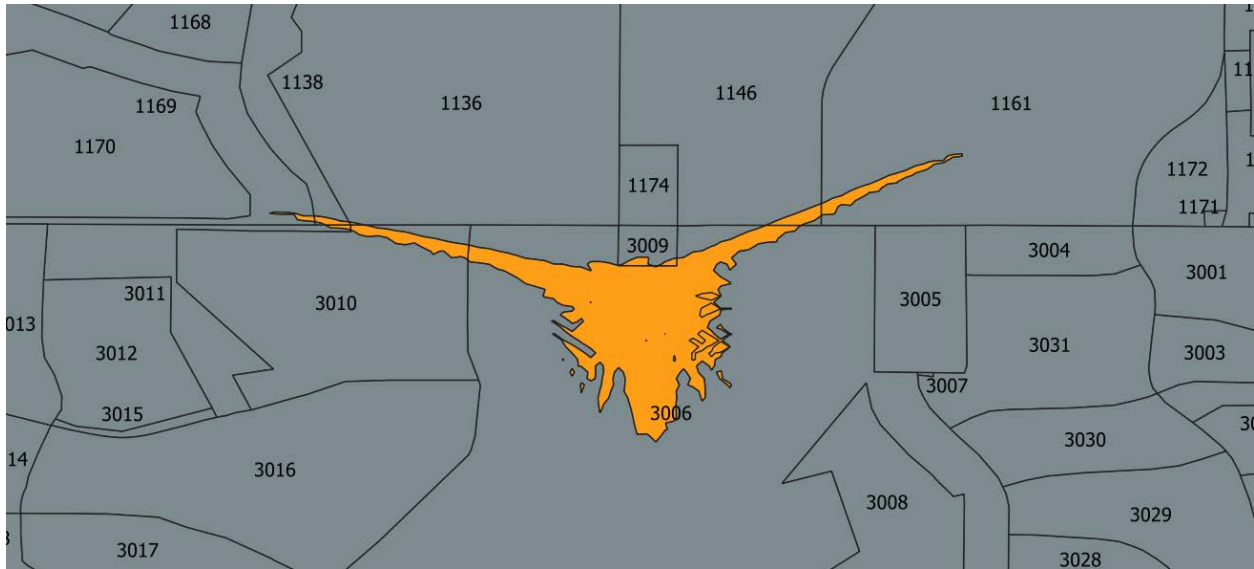


Figure 8. 47 GHz pfd contour overlaid on labeled census blocks

Table 6 provides the percentage of area of each census block covered by the contour, the associated population covered, and sums the population covered. The population coverage limit of 19410 persons is met.

Census Tract	Census Block	Block Population	Total Block Area	Area Covered	Weighted Population
11101	3011	127	24450	135	0.701227
11101	3006	127	338821	40884	15.324516
11105	1138	23	18792	320	0.391656
11105	1161	6	173262	1984	0.0687052
11101	3010	0	70090	2227	0
11105	1136	0	919140	34	0
11105	1146	0	126184	890	0
11105	1169	27	50055	227	0.1224453
11101	3009	2	4013	437	0.2177922
				Total	17

Table 6. Population coverage of 47 GHz pfd contour

### 2.3. Section 25.136(d)(4)(iv) – Coordination

As demonstrated in the attached Coordination Report (Attachment B), coordination of the modified parameters for the earth station was completed through Comsearch pursuant to Sections 25.136(d)(4)(iv) and 101.103(d) of the Commission’s rules.

### 3. Section 25.136(e)(3) assessment – 50.4-51.4 GHz

Operations in the 50.4-51.4 GHz band are grandfathered pursuant to 47 C.F.R. § 25.136(e)(3). The proposed modifications create no significant increase in interference risk to terrestrial operations with respect to PFD contour coverage of populations and major roads and venues, as shown below.

### 3.1. PFD contour population and highway/event/railway/port coverage

#### 3.1.1. Assumptions

The Section 25.136 PFD was determined using the publicly available software program Visualyse and based upon the 7 technical parameters for the Jupiter 3 earth station.

Parameter	Old site	New site
Latitude/longitude	46°51'7.20"N / 100°46'56.70"W	46° 51' 6.0"N/ 100° 46' 58.5"W
Frequency (GHz)	50.9	50.9
Channel bandwidth (MHz)	470	470
Transmit power (dBW)	0	0
Antenna midline height above ground (m)	7	7
On-axis antenna Gain (dBi)	72	72
Clear sky EIRP (dBW)	72	72
Antenna radiation pattern	Manufacturer calculated off-axis gain pattern	Manufacturer calculated off- axis gain pattern
Clutter	Recommendation ITU- R P.452-16, Suburban	Recommendation ITU-R P.452- 16, Suburban
Terrain	NASA SRTM data 30 m resolution <sup>5</sup>	NASA SRTM data 30 m resolution <sup>6</sup>

Table 7. Jupiter 3 gateway earth station technical parameters at 50.9 GHz

Figure 9 provides a plot of the manufacturer’s calculated combined co-polarized and cross-polarized off-axis gain patterns. Measured antenna patterns are not available for the off-axis angles of importance because of the size of the antenna; hence, calculated antenna patterns provided by the manufacturer are used.

<sup>5</sup> <http://dwtkns.com/srtm30m/>

<sup>6</sup> <http://dwtkns.com/srtm30m/>

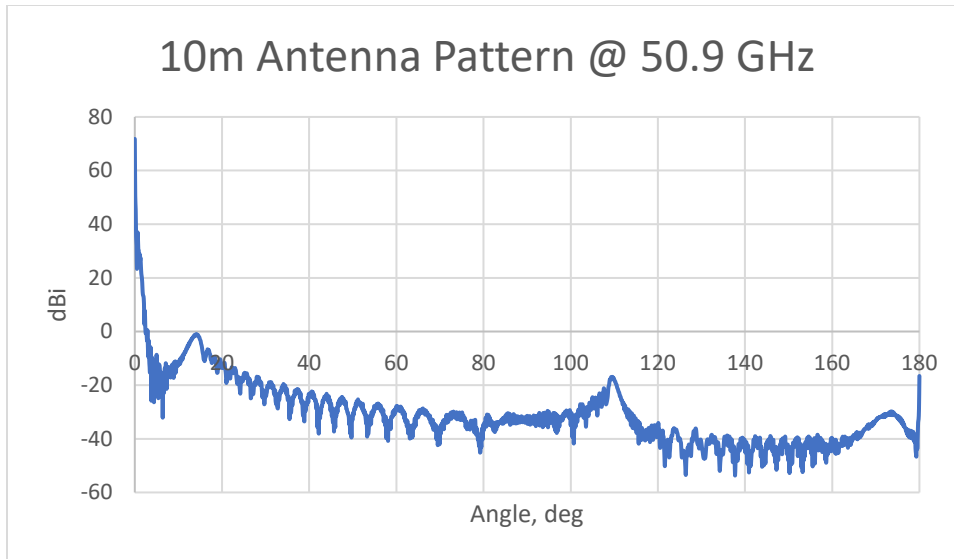


Figure 9. SED calculated off-axis gain pattern at 50.9 GHz

### 3.1.2. Results

Visualyse Version 7 software was run using the Recommendation ITU-R P.452-16 propagation model option to generate the Section 25.136 contour for the 51 GHz band where the earth station generates a pfd, at 10 meters above ground level, of greater than or equal to  $-77.6 \text{ dBm/m}^2/\text{MHz}$ . The resulting PFD contours for the old and new sites are shown in yellow and orange, respectively, in Figure 10.

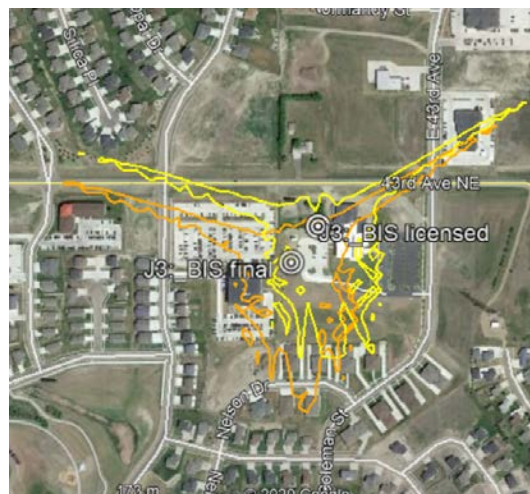


Figure 10. Section 25.136 pfd contours around the Bismarck earth station in the 50.9 GHz band at the old site location (yellow) and the new (orange)

With respect to any major roads (*i.e.*, Interstate, Other Freeways and Expressways, or Other Principal Arterial according to the Federal Highway Administration HEPGIS map, or highways designated as Other Freeways and Expressways, or Other Principal Arterials by the North Dakota Department of Transportation), the new PFD contour covers approximately 51 meters of 43<sup>rd</sup> Avenue, and the old PFD contour covers approximately 64 meters of 43<sup>rd</sup> Avenue. Neither PFD contour covers any major event

venue, urban mass transit route, passenger railroad, or cruise ship port according to a visual inspection in Google Earth.