

# Next Generation Very Large Array Memo #111

## First characterization of MID locations in Northern Mexico

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### Abstract

We present a first description of conditions for sites of the ngVLA MID-Array antenna configuration in Mexico. Three different aspects are discussed: terrain, infrastructure, and jurisdiction. In general terms, five of the sites are easily reachable, with only minor aspects to be considered. High voltage power and broadband internet access is a critical point, distance wise, for several of the locations. We outline the next steps to do for the MID-array antenna locations in Mexico.

## 1 Introduction

Depending on the final accepted configuration for the ngVLA MID-Array, a few antennas could be located in Mexican territory. A first basic characterization of the possible antenna sites is presented here, including:

1. Terrain, focusing on elevation, soil, vegetation
2. Infrastructure, such as nearby power lines, main and secondary roads, and internet access<sup>1</sup>
3. Jurisdiction, applying to lands part of Ejidos or Comunidades (both are socially owned) and National Parks.

Several sources have been used and all are in the public domain. The Instituto Nacional de Estadística y Geografía<sup>2</sup> (INEGI) stands out with its vast collection of digital maps [2] covering climate, topography, vegetation, communications, etc. Information for jurisdiction was obtained from Registro Agrario Nacional<sup>3</sup> (RAN) databases [4, 3] and from the Comisión Nacional de Áreas Naturales Protegidas<sup>4</sup> (CONANP) and Secretaría de Medio Ambiente y Recursos Naturales<sup>5</sup> (SEMARNAT) pages [1]. For each potential site, a focused study can be elaborated later, in particular for atmospheric conditions and further information on broadband internet.

### 1.1 Locations

Following configuration 28MOD (see details in memo#102, [5]), 7 antennas fall in Mexico, T27, T37, T38, T39, T48, T49, and T59 (see Fig. 1). T48 and T59 are in the state of Sonora, and the remaining ones in Chihuahua. In the following, we describe each of the locations, with emphasis on a neighborhood of 5 km in radius from the notional antenna positions. A change in the positions of this magnitude is considered small; typical baseline length between antennas in Mexico is in the order of hundreds of kilometers.

## 2 Terrain

Although the general conditions of the locations vary, most of them are in dry areas, relatively isolated, and with elevations between  $\sim 1000$  and  $2000$  m over the sea level, except for T59 at around 50 m, close to the coast.

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<sup>1</sup>ngVLA antennas will need broad-band internet access. Full information about availability is still being obtained, as it is in the private domain.

<sup>2</sup>or National Institute of Statistics and Geography

<sup>3</sup>or National Agrarian Registry

<sup>4</sup>or National Commission for Natural Protected Areas

<sup>5</sup>or Secretary of Environment and Natural Resources

Table 1 presents a general view of the topography for each of the antenna sites, including the state, elevation, temperature, and precipitation. Except where stated, all the information in our tables comes from INEGI, RAN, CONANP, and SEMARNAT. Figure 2 shows the surroundings for all the antenna locations, as seen from the Google Earth image service. T39, T48, and T49 fall around hills, especially the latter where there are larger differences in elevation. T27, T37, T38, and T59 fall in relatively flat areas, with only small to medium-sized bushes and trees. The location T27 falls in the middle of farming land, next to the border MEX-USA and the Bravo river. Both sides of the border have similar terrain. From the Google Earth images, T37, T38, T39, and T59 are uniform in vegetation with only small scattered bushes. The T48 image presents small to medium size bushes and trees; elevation changes are about 200 m among the few hills inside a 5 km radius. T49 is located in an area of dense vegetation with medium to large trees, and it is the least dry location. Elevation is uniform across hundreds of meters.

Figures 3 to 9 present map layers covering infrastructure- and terrain-related aspects for all antenna sites. All maps are on a scale of 1:100,000. Legend information is as follows:

- Large dotted circles have diameters of 5, 10, and 20 km centered at the antenna positions, which are marked by the 200m-sized black circle. There should not be obstacles similar to the height of an antenna within that footprint.
- Symbols
  - Orange circles with a centered black dot mark historic seismic activity
  - Pink triangles denote electrical substations
  - Black squares are small human settlements
  - Empty blue circles are water wells
- Specific icons are used for industrial buildings and mines (black color), and telecommunications infrastructure (blue), such as cellphone and radio towers
- Polygons
  - Rural and urban towns appear in dark and light pink, respectively, with their approximate population indicated
  - Water bodies are represented in blue
  - Areas prone to flooding are marked with blue stripes over white
  - Dark green is dense vegetation
  - Light brown with orange dots are sand regions
- Lines
  - Thick black for paved roads, black for dirt roads, and thin black for very narrow (typically one lane only) dirt roads
  - Dashed black are ducts for liquid transport, except water
  - Railway tracks are marked in black
  - Aerial (high voltage) power lines mounted on towers are marked in bright pink and green for one and two transmission lines, respectively
  - Thick dashed orange mark small aeroplane runways (no airport facilities)
  - Rivers are shown in thick blue, intermittent water streams (that depend on rain) are in dashed blue, and artificial water channels in light blue.
  - Elevation contour levels are shown in light orange with values in meters.
  - Faults and fractures are in thick brown



Elevation changes (and hills) in the vicinity of the antennas (within 20 km) can be more clearly seen in Figures 3 to 9, where elevation contours are included. There are water bodies in the vicinity of most of the locations but none closer than 2 km of the antenna positions. More commonly, water streams are located within a few hundred meters, although these (dashed blue lines) depend heavily on rain. It is therefore not expected to be a serious problem.

There are some scattered areas of seismic and volcanic activity near a couple of locations. While this can be common in Mexico, the closest areas of considerable activity are dozens to hundreds of kilometers away, and therefore not expected to be an issue.

### 3 Infrastructure

Table 2 gives a summary of distances to main infrastructure elements identified, including roads, powerlines, and human settlements. There are paved roads within a few hundreds of meters from most of the locations, which is critical for an adequate access. In the case of T49 and T59, there are dirt roads within the same distances. For these locations, the closest paved roads are more than 10 kilometers away. There are a few even narrower dirt roads (thin black lines) in most of the location neighborhoods, but these roads only connect small settlements and therefore are not very useful to the antenna sites themselves.

There are several very small towns nearby for all locations, with up to less than 3000 inhabitants. Medium-sized settlements are between 20 to 50 km away, and there are no big cities within 20 km. An exception is T37, for which the urban town of Ascención (~ 15000 inhabitants) is located 2 km away.

Aerial electricity lines (high voltage) are sparse in that region of the country, but a couple run very close (~ 1 km) to T27 and T39. For the other sites, the closest lines are between 30 to 80 kilometers away, except for the case of T59 at 13 kilometers. T39 is an atypical location, with a small settlement, railway tracks, an electric substation, and a mining area all within 3 km. This memo does not include low-voltage transmission lines (mounted on poles) connecting towns. Since this service is widely available for small towns, it is expected that the distance to low voltage power would be similar to the towns themselves (see Figures 3 to 9 and Table 2).

Telecommunications infrastructure is also sparse in the region. Closest antenna towers (e.g. cell-phone, radio) are at distances of 10–60 km. Information for internet fiber cabling is yet to be fully obtained, but it is not expected to be closer than a few dozens of kilometers for most of the locations due to their isolation (except for cases as T37, near medium size towns).

### 4 Jurisdiction

Table 3 lists whether the jurisdiction for the antenna locations is that of the Ejidos or Comunidades agrarian system. Lands in this system are socially owned and need different legal and social paths to be accessed, compared to those in the private or government sectors. In addition, a general type of vegetation and climate are given.

For a geographic representation, we reuse some of the layers (e.g. rivers and paved roads) from Figures 3 to 9 (see Section 2). In Fig. 10 we add:

- Polygons for Ejidos colored in yellow
- Farming plots marked by green stripes
- Natural protected areas shown in blue-grey

T27, T37, T48, and T59 fall into Ejidos. Indicated farming lands all fall within the respective Ejido or Comunidad, although as can be seen from the figures, not all the land inside these jurisdictions is for farming. T27 and T37 fall in farming areas, while for the others there are farming plots a few kilometers away.

Several projects in Mexico, e.g. LMT/GTM, are located inside National Parks, while others are in Ejidos (e.g. MEXART). Jurisdiction for a few of the antenna locations could change at a latter stage, if a more suitable area is found. This could include a National Park for example.

Legal aspects at the local and national level depend on the type of jurisdiction. In-detail documents with all relevant information are out of the scope of the present memo. But in general, if it is

Table 1: General geographic characteristics for antenna locations

Station	State	Elevation (m)	Temperature <sup>a</sup>		Precipitation <sup>b</sup> (mm)	Topography <sup>c</sup>
			Low	High		
T27	Chihuahua	1070	6	28	230	Flat area
T37	Chihuahua	1300	7	26	270	Flat area
T38	Chihuahua	1490	8	24	300	Flat area
T39	Chihuahua	1590	8	25	380	Hills
T48	Sonora	840	11	27	510	Mountainous
T49	Chihuahua	2150	8	19	960	Mountainous
T59	Sonora	50	14	30	120	Flat slope

<sup>a</sup>Values in Celsius (C). <sup>b</sup>Annual values. <sup>c</sup>As seen from google Earth images.

Table 2: Distances (in kilometers) to main infrastructure elements

Station	Roads <sup>a</sup> (type)	Aerial powerline	Telecommunication	Community	Other (type)
			antennas	(population)	
T27	0.4 (asphalt)	0.7	30	0.3 (100)	
T37	0.2 (asphalt)	50	20	2.5 (15000)	
T38	0.5 (asphalt)	30	35	10 (2700)	
T39	0.4 (asphalt)	1	35	2.5 (900)	2.5 (railway)
T48	0.5 (asphalt)	40	12	20 (1000)	
T49	0.1/15 (dirt/asphalt)	80	30	15 (1000)	15 (railway)
T59	0.5/12 (dirt/asphalt)	13	60	11 (350)	

All values for distances and population are approximate. <sup>a</sup>Specifying the closest dirt road only when there is no paved road within 1 km. As seen from Figures 3 to 9, dirt roads are common in the vicinity of most antenna locations.

possible based on scientific and infrastructure considerations, the project could aim to avoid Ejidos or Comunidades lands, in order to minimize the legal aspects to consider.

## 5 Conclusions

All the sites in Northern Mexico are relatively isolated, with no big cities within 20 km. There are a few mid-size towns within that radius, however. While this is desirable to some extent, it also implies that access to high voltage electricity and optical fiber lines will need to be built, for distances of up to a few dozens of kilometers in some cases. Paved roads are available within a few kilometers for all the locations, with many dirt roads in the vicinity providing mobility support to some degree.

Available digital map layers are adequate for a first characterization of antenna locations. Many of these maps are very recent (e.g. road network, 2021). It is straightforward to obtain new figures/information for any change in antenna positions. Finding alternative sites for very isolated places will be the subject of a forthcoming document.

## References

- [1] CONANP, digital maps, [http://sig.conanp.gob.mx/website/pagsig/info\\_shape.htm](http://sig.conanp.gob.mx/website/pagsig/info_shape.htm)
- [2] INEGI, digital maps library, <https://www.inegi.org.mx/app/mapas/>
- [3] PHINA, digital maps, <https://phina.ran.gob.mx/index.php>
- [4] RAN, digital maps, <https://datos.gob.mx/busca/organization/ran>
- [5] Walker. R. C. 2022, ngVLA memo #102

Table 3: Jurisdiction and land characteristics

Station	Ejido / Comunidad	Farming plot	Vegetation	Climate unit
T27	Ejido	Yes	irrigation agriculture	tempered very dry
T37	Ejido	Yes	induced pasture	tempered very dry
T38	No	No	natural pasture	tempered dry
T39	No	No	desert scrub, pasture	tempered dry
T48	No	No	subtropical scrub	semi-dry semi-warm
T49	Ejido	No	pine and holm oak forest	tempered sub-humid
T59	Ejido	No	desert scrub	very dry semi-warm

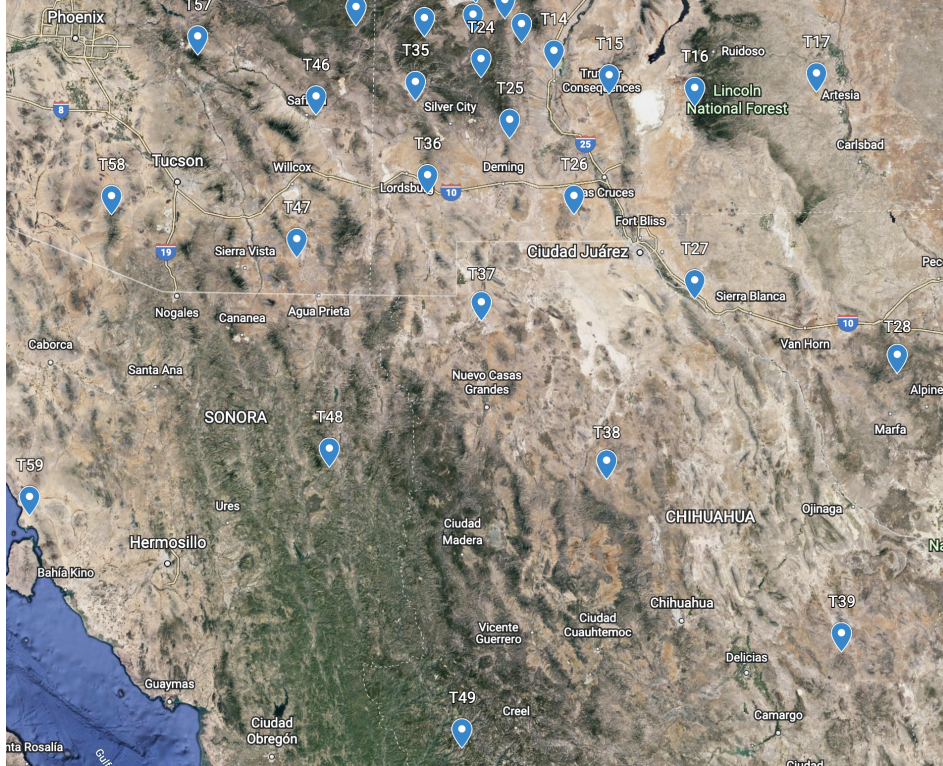


Figure 1: Distribution of MID (28MOD) antenna locations in Northern Mexico, together with some of the stations in the USA. Satellite image taken from the Google Earth service.





Figure 2: Panels displaying Google Earth images for T27, T37, T38, and T39 antenna locations, as indicated by the blue markings. Size of the image varies slightly across panels. Scale bar is located in the bottom part. Elevation values in the lower right are approximate.



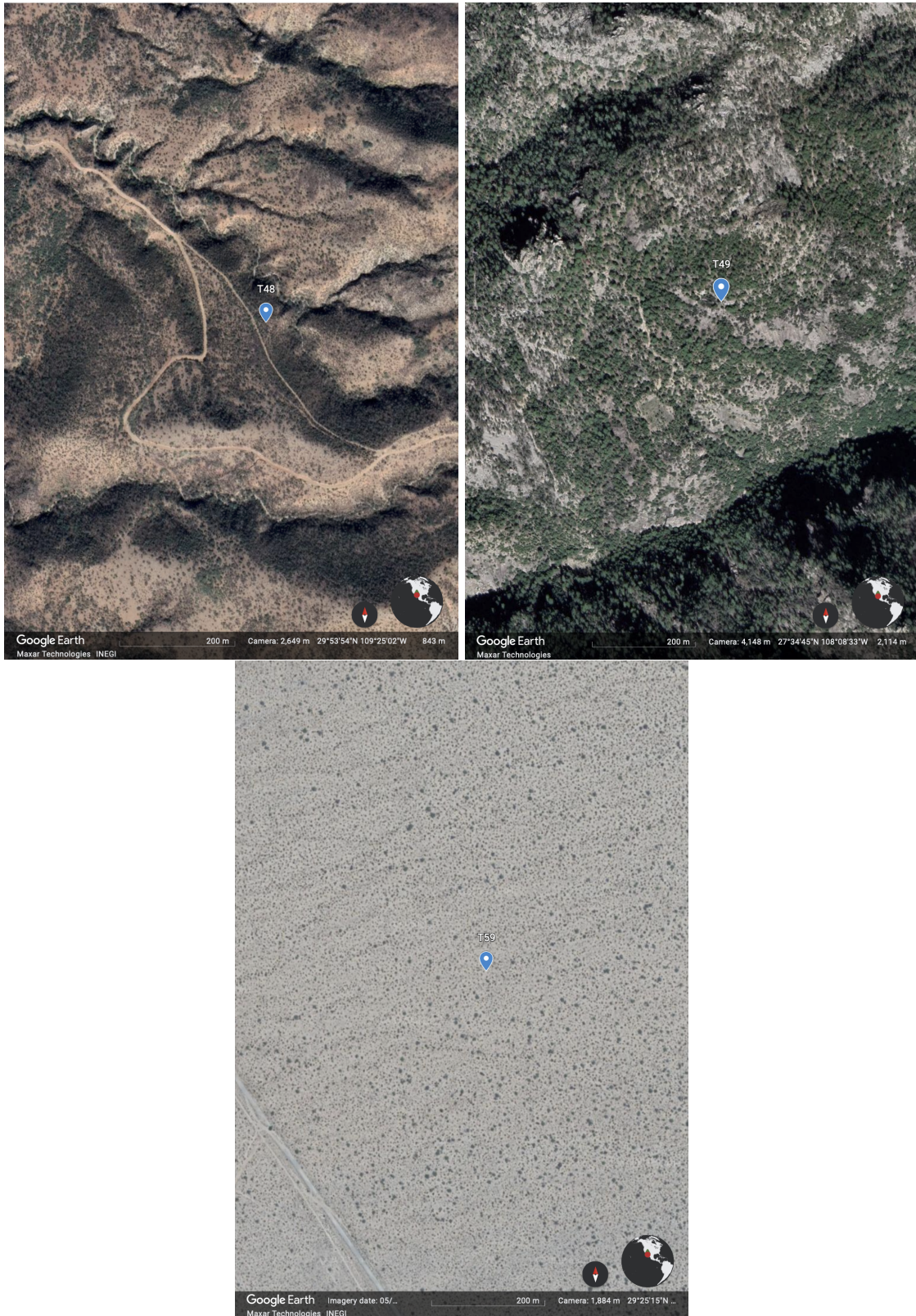


Figure 2 (Cont.): Panels displaying Google Earth images for T48, T49, and T59 antenna locations.

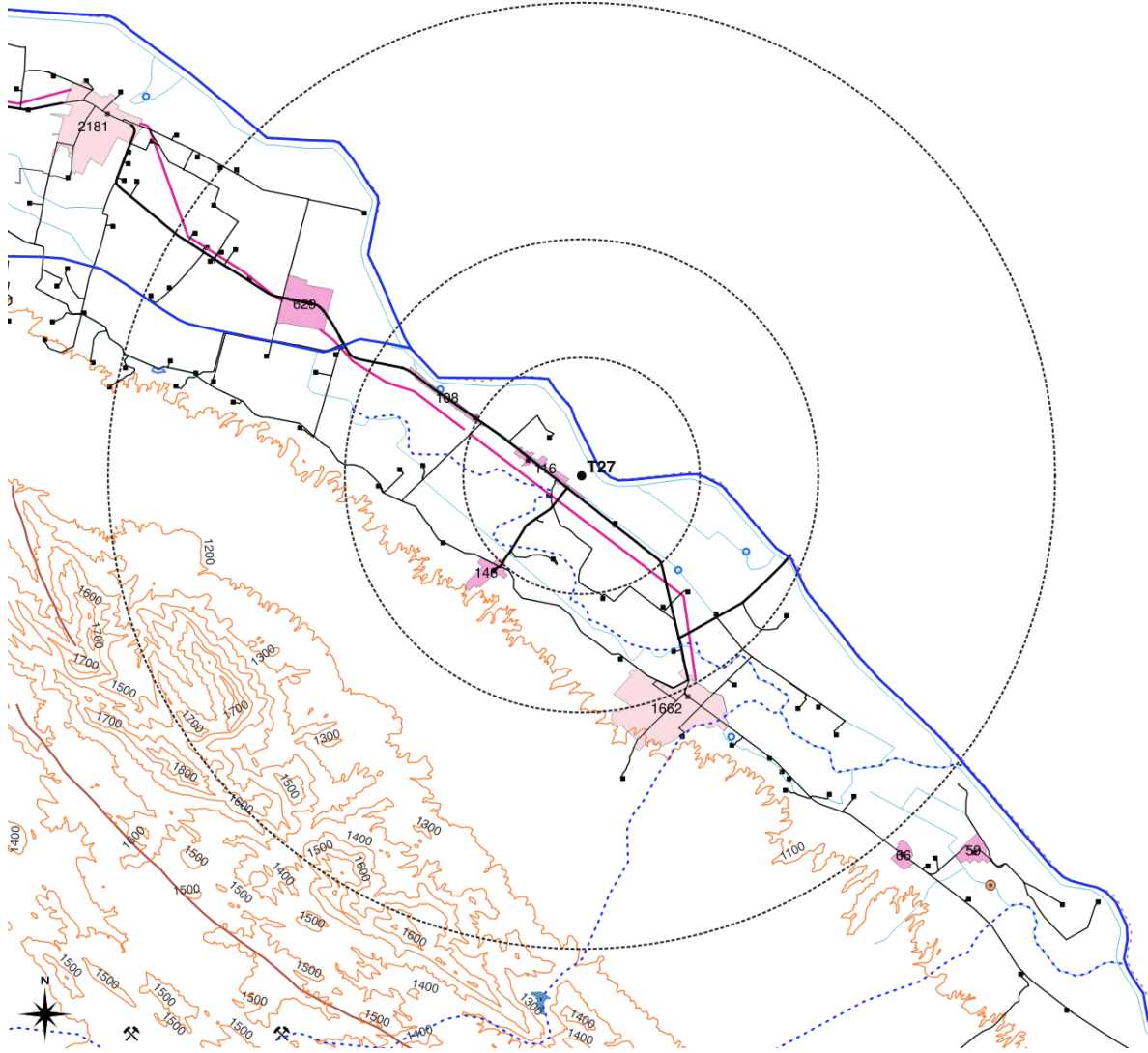


Figure 3: Neighbourhood of the T27 location, close to the border MEX-USA, falls in farm land next to the Bravo river.

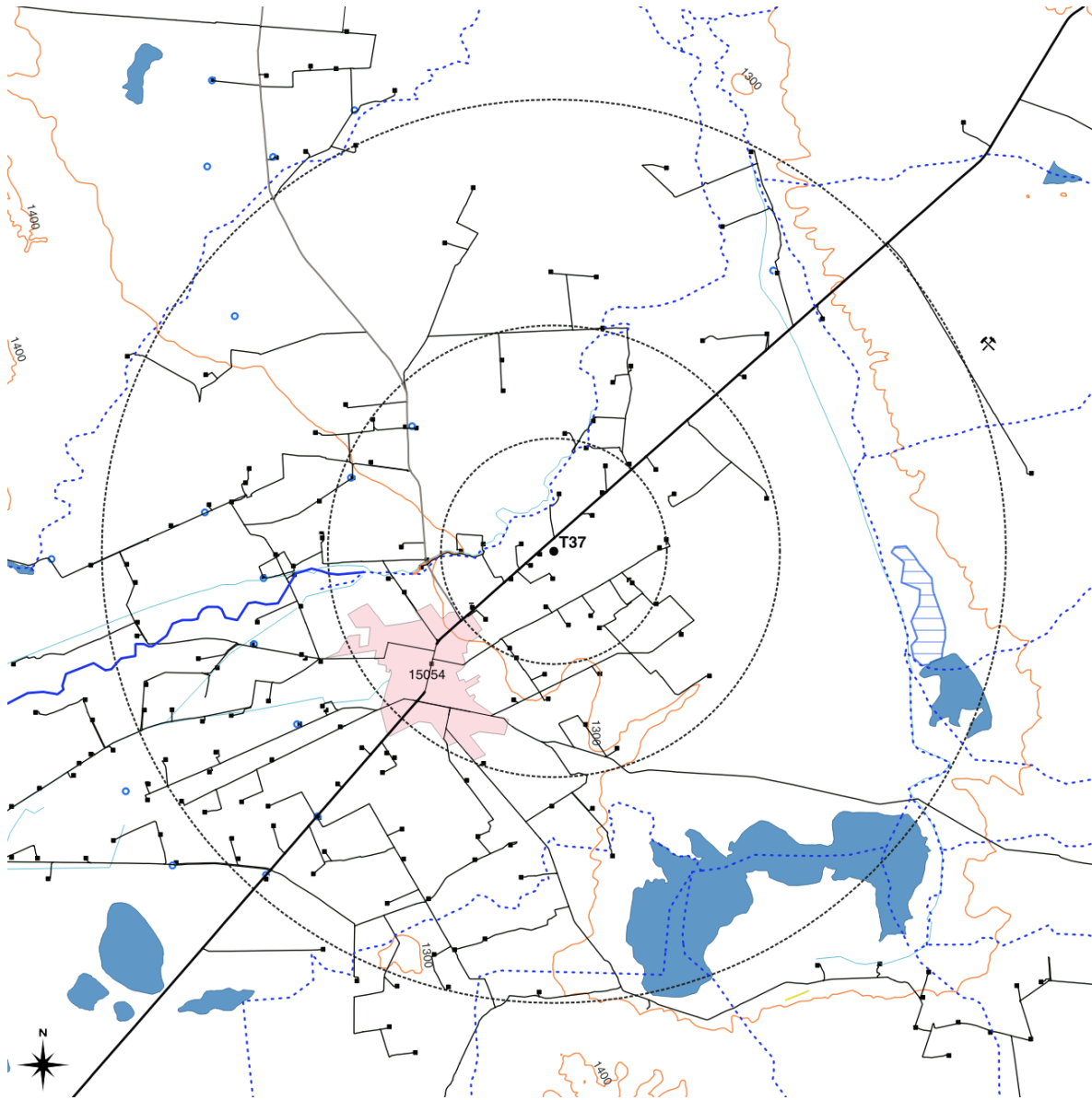


Figure 4: Neighbourhood of the T37 location. Flat area with roads and an urban settlement near to the antenna position.



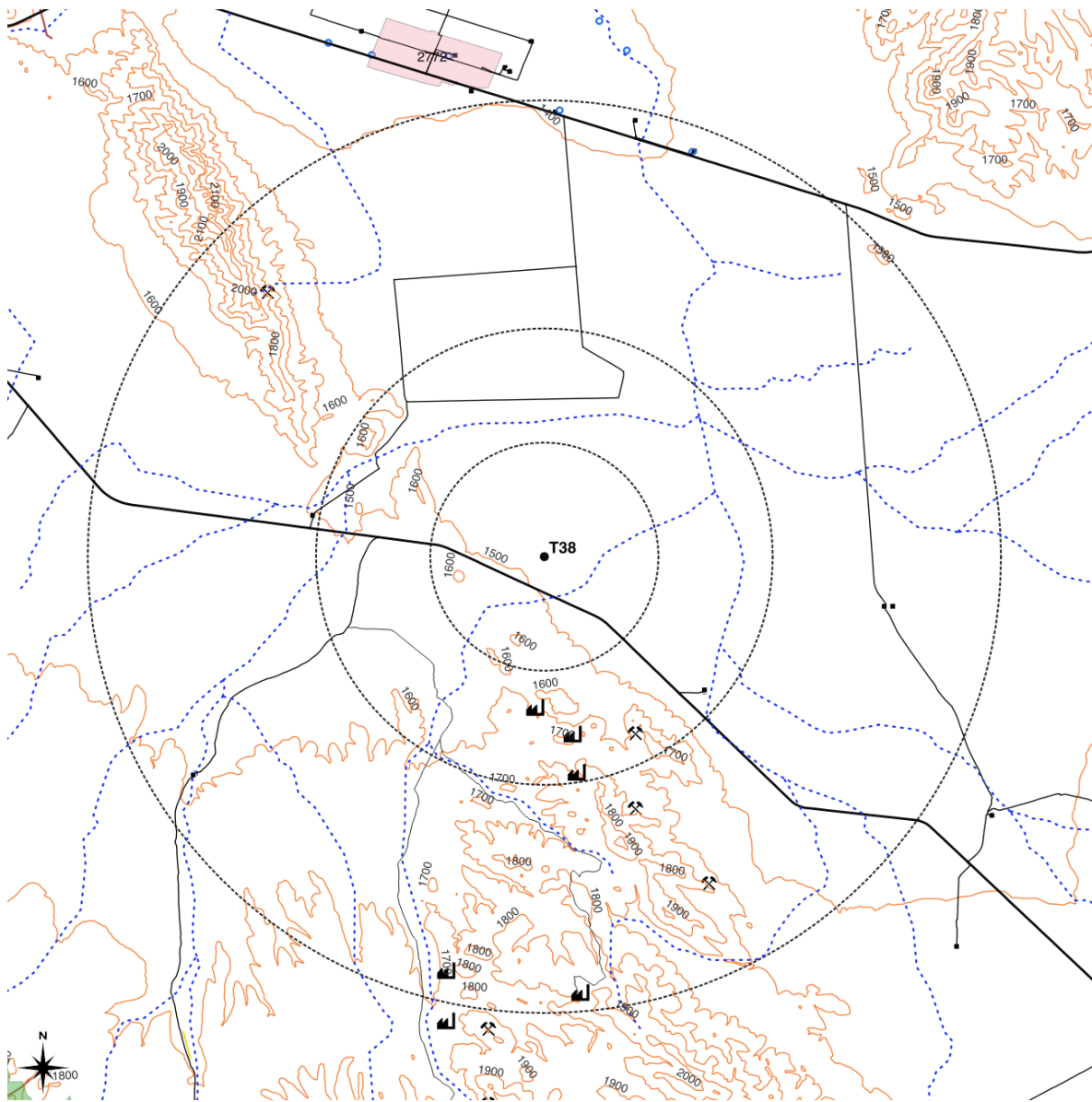


Figure 5: Neighbourhood of the T38 location. Flat area near paved and dirt roads.



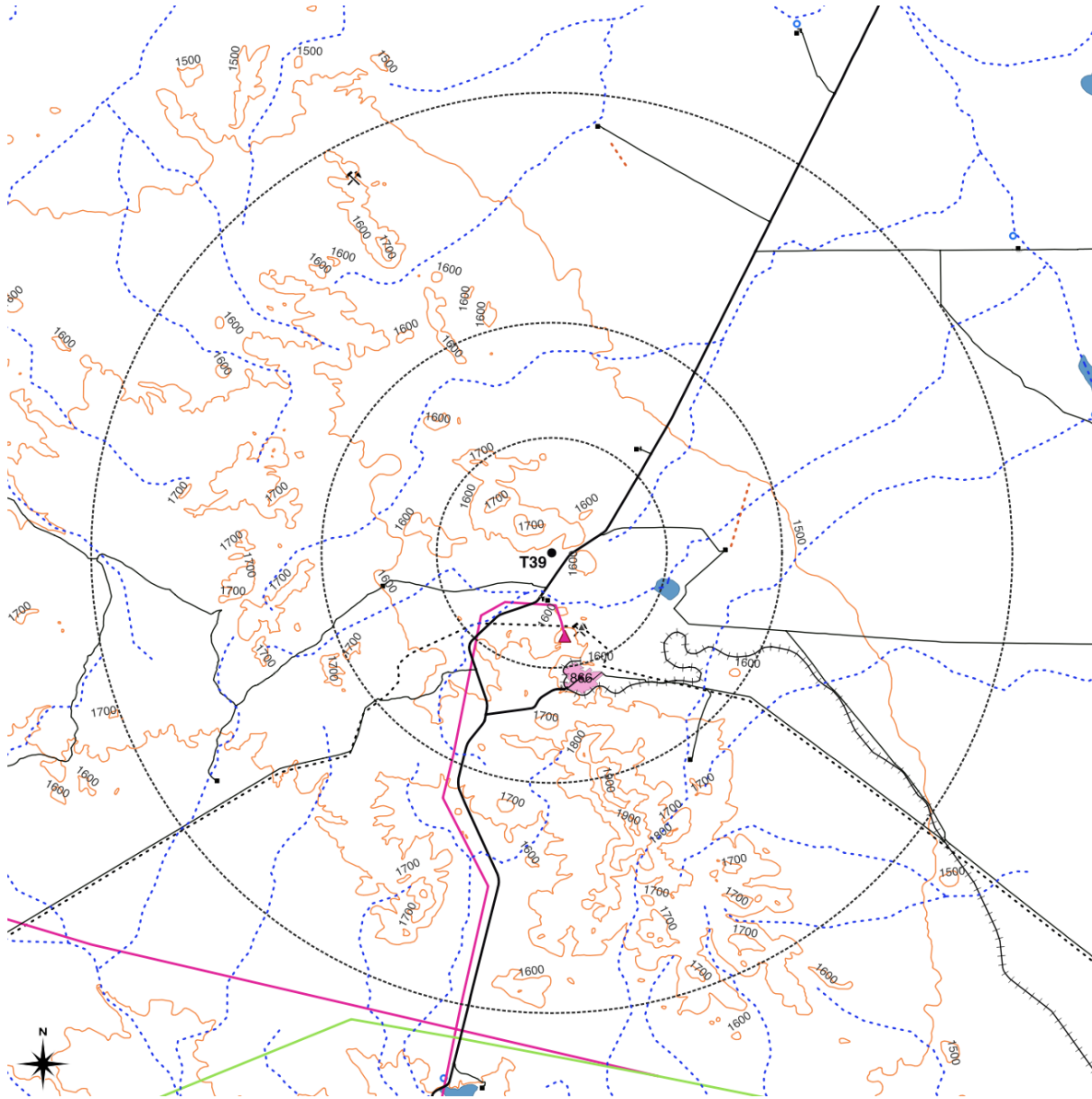


Figure 6: Neighbourhood of the T39 location. About 2 km South of the central position there is an electric substation and a mine (to the West of the town shown in light pink color), together with paved roads and railway tracks.

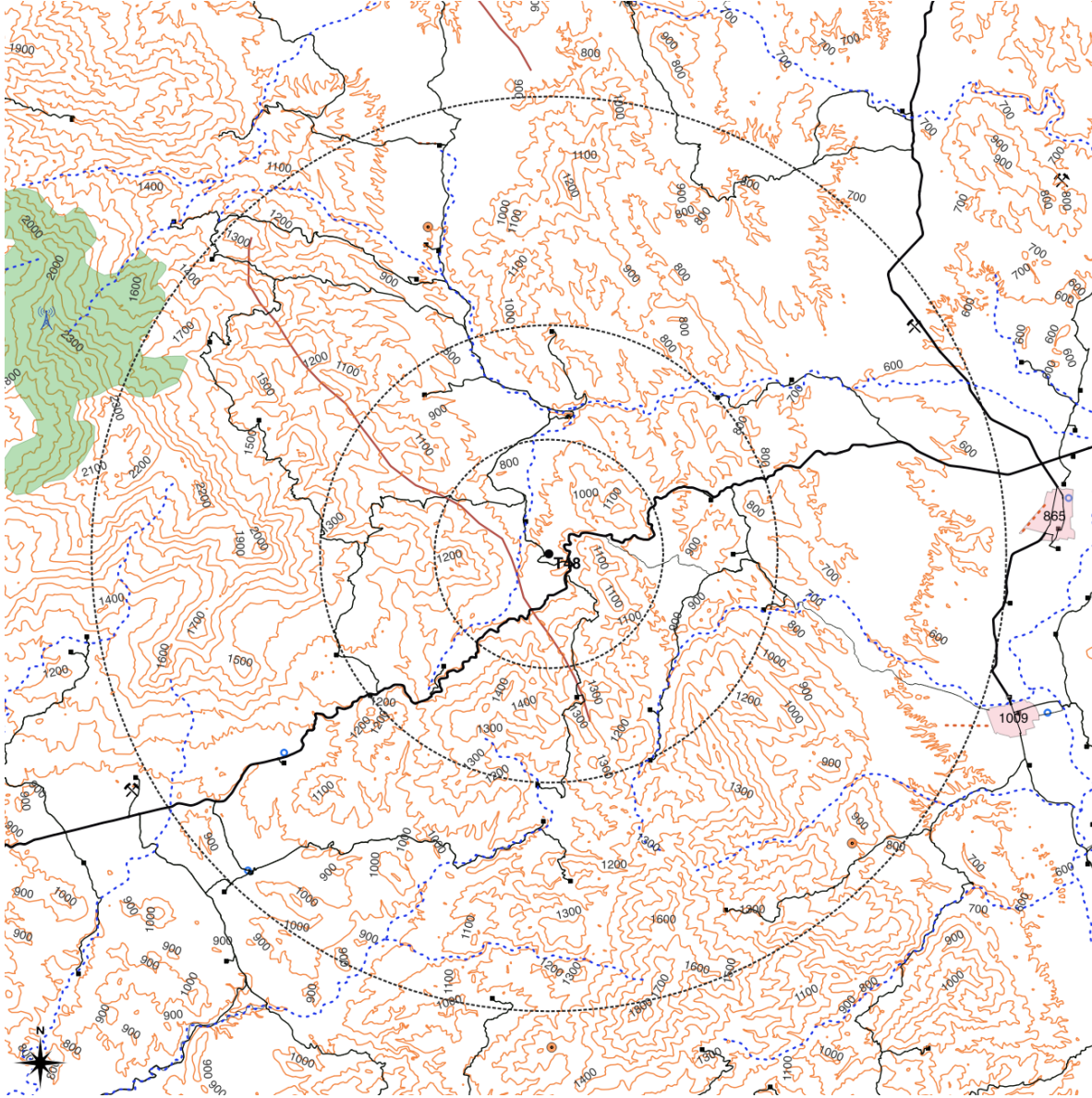


Figure 7: Neighbourhood of the T48 location, fairly isolated in a hilly area but with a paved road nearby.



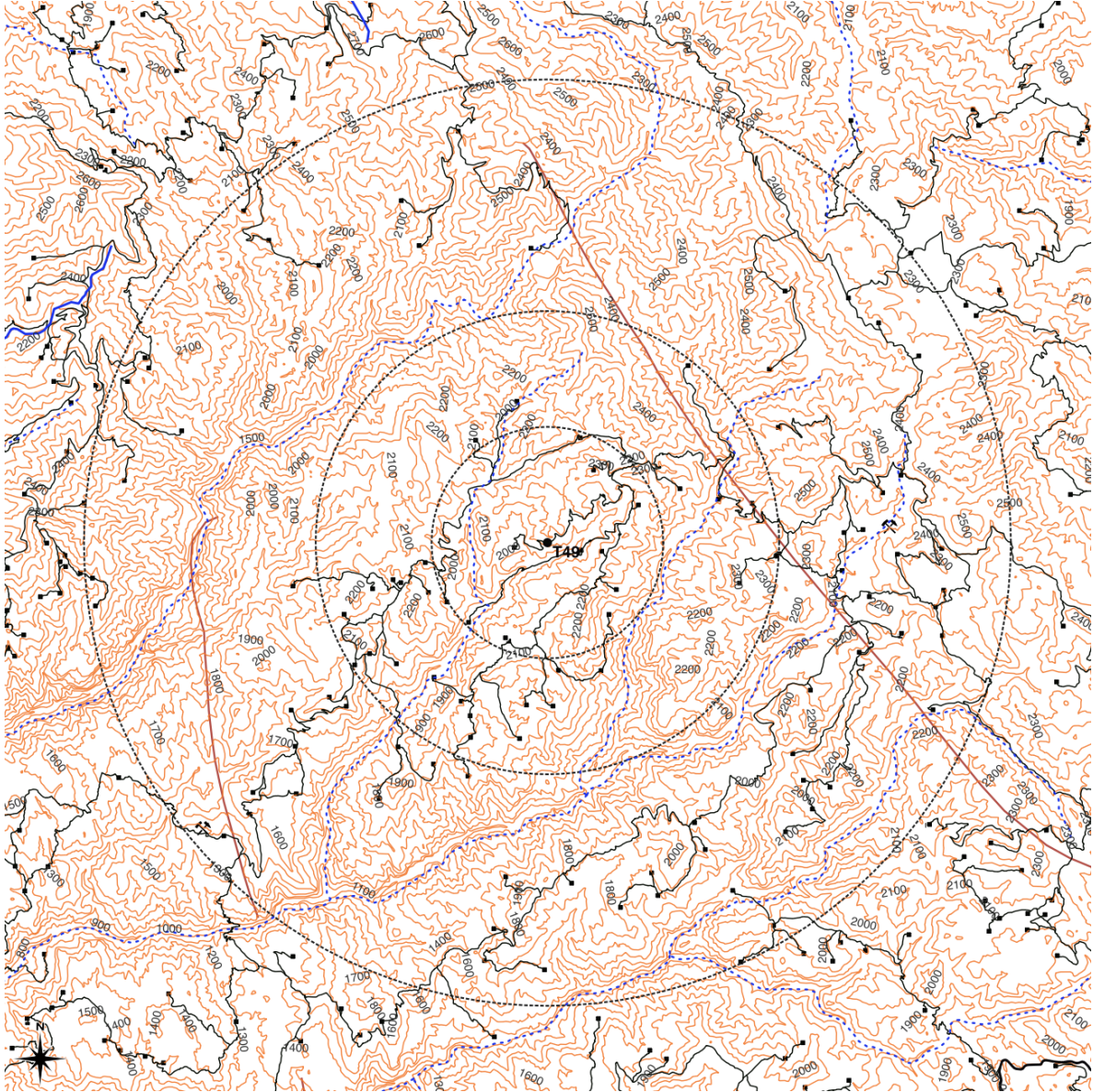


Figure 8: Neighbourhood of the T49 location, the most isolated of the seven, in the middle of hills and no nearby towns nor paved roads.

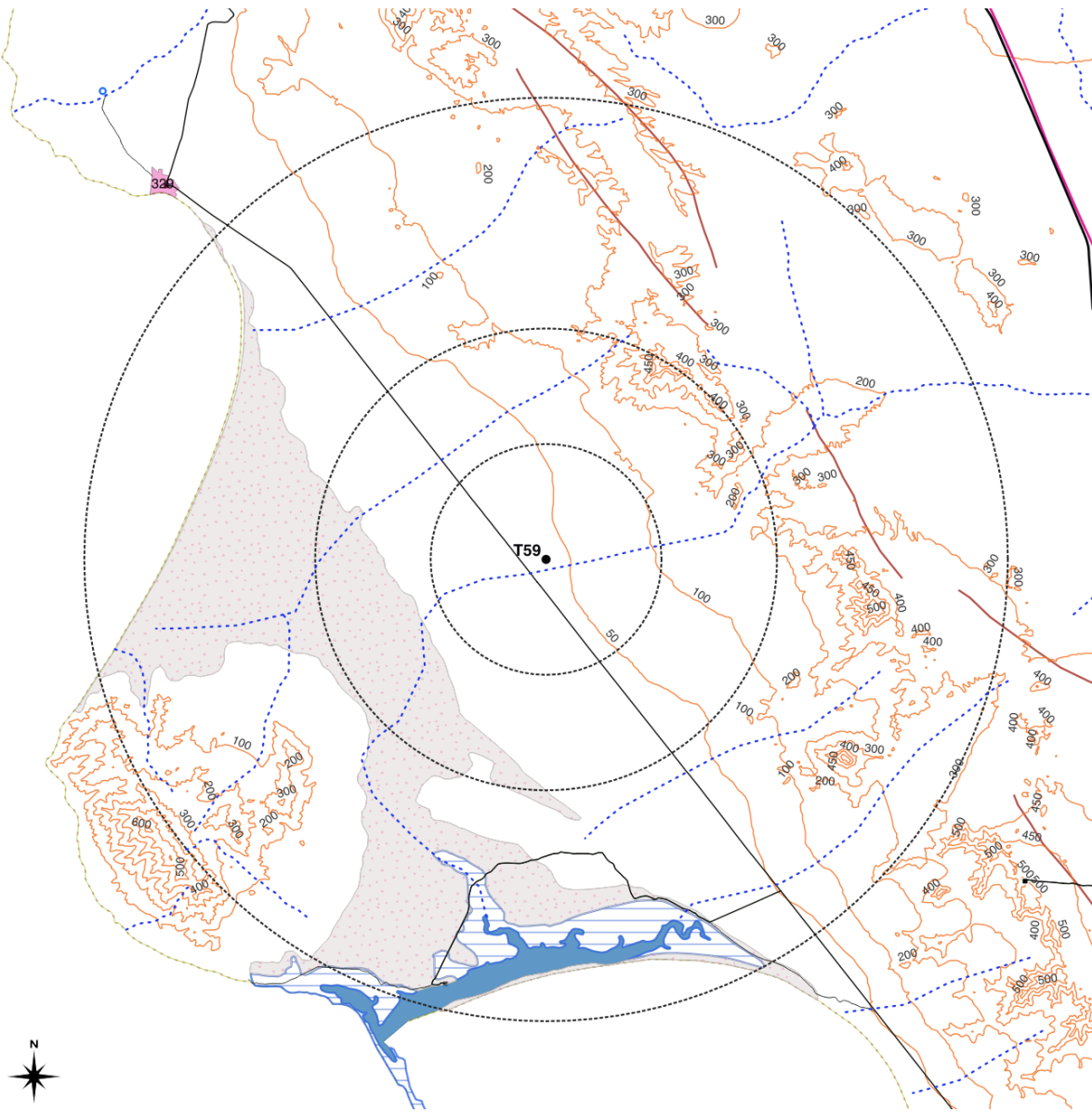


Figure 9: Neighbourhood of the T59 location close to the Gulf of California (West and South).

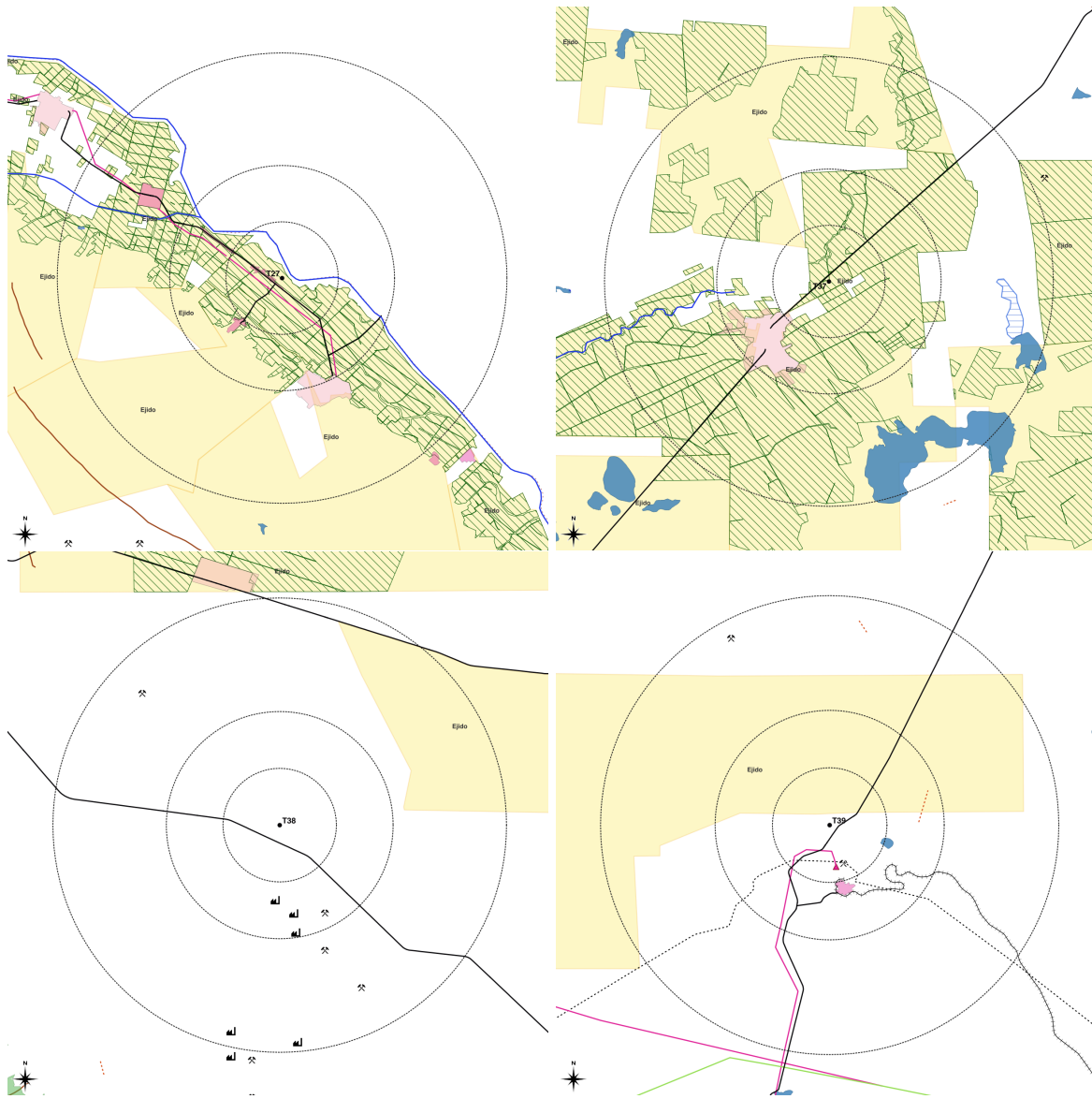


Figure 10: Panels displaying the distribution of Ejidos (yellow color) near the antenna locations. Farming land is also indicated (stripped green).

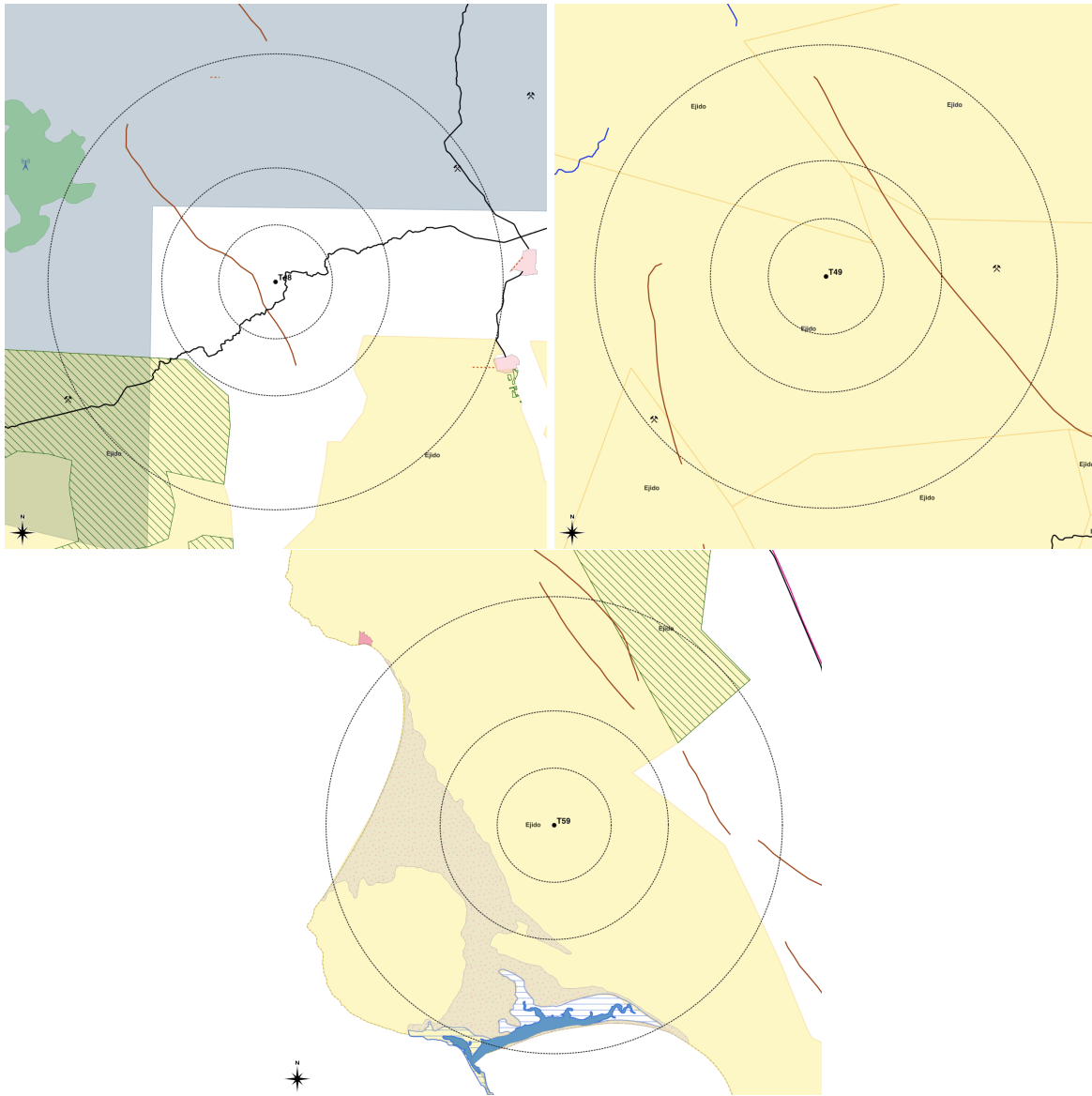


Figure 10 (Cont.): There is a protected natural area (light blue) to the North and West of T48.