The INSPIRE Journal

Volume 13 Number 1

November 2004

In this issue:

Robert Bennett of Las Cruces, New Mexico, describes how he went about finding a new observing site (Page 6).

Assistant Professor Bjorn Gitle Hauge of Østfold University College Norway relates the history of the "Hessdalen Phenomena", strange lights that appear in the Hessdalen Valley in Norway (Page 16).

Assistant Professor Leif Lervick of Østfold University College Norway describes Science Camp held for Norwegian junior high school students in the Hessdalen Valley (Page 29).

Two special offers for those who like to build INSPIRE receivers:

Purchase a VLF2 INSPIRE receiver for $50. This is the version that preceded the LF3.
Purchase a printed circuit board for the RS-4, the original INSPIRE receiver, for $10

Details are on Page 4.

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The INSPIRE Journal
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The INSPIRE Journal is a publication of The INSPIRE Project, Inc., a nonprofit educational/scientific corporation of the State of California. The purpose of the INSPIRE Project, Inc., is to promote and support the involvement of students in space science research. All officers and directors of the corporation serve as volunteers with no financial compensation. The INSPIRE Project, Inc., has received both federal and state tax-exempt status (FEIN 95-4418628). The *Journal* is published two times per year: November and April.
Submission deadlines: October 1 and March 1

Contributions to the *Journal* may be sent to:

Bill Pine
1348 N. Quince Ave.
Upland, CA 91786

email: pine@mail630.gsfc.nasa.gov

Fax: 909 931 0392

INSPIRE VLF2 Receiver Close-out Sale!

A few VLF2 INSPIRE receivers are available for sale. The price is $50 including shipping! The kit comes complete with all electronic components and assembly instructions. If you would like to purchase one, first send an email message to:

pine@mail630.gsfc.nasa.gov

and I will set one aside for you. Send your order to the address shown at the bottom of Page 2 in this *Journal*. When payment arrives, I will ship the kit.

Build a Piece of History: An INSPIRE RS-4 receiver

I have a small supply of RS-4 receiver printed circuit boards (PCBs). The "RS" in the "RS-4" stood for Radio Shack because it was originally designed using parts available from Radio Shack. I cannot guarantee that all parts are still available from Radio Shack, but I think that Mouser would be able to fill any gaps. The PCB comes with a set of assembly instructions and the price is $10 including shipping. If you have experience building electronic devices and some spare parts, you might be interested in this offer. If you would like to purchase one, first send an email message to:

pine@mail630.gsfc.nasa.gov

and I will set one aside for you. Send your order to the address shown at the bottom of Page 2 in this *Journal*. When payment arrives, I will ship the PCB.

Coordinated Observation Program Schedule Available

See Page 4 for a complete description of the new Coordinated Observation schedule.

Field Observations are Another Way to Participate!

See Page 5 for a description of field observation procedures.

Write for *The INSPIRE Journal*

The procedure for contributing articles for *The INSPIRE Journal* could not be simpler! Just send it in! Any format is acceptable. Electronic format is easier to work with. A Word file on disk for either the PC or Mac platform is preferred. An email message will work, too. If that does not work for you, a paper copy will do. Any diagrams or figures can be scanned in.

What about topics? Anything that interests you will probably interest most INSPIRE participants. As long as the topic is related to natural radio or the equipment used, it will get printed. The deadlines for submissions are March 1 for the spring edition and October 1 for the fall edition. Don't worry about the deadlines, though. If you miss a deadline, you will just be very early for the next edition!

We at INSPIRE are looking forward to hearing from you.

Permanent Coordinated Observation Schedule

The Coordinated Observations will be held on the first weekend of October and the last weekend in April. This schedule will apply to all future Coordinated Observations. There will not be a separate schedule published in each *Journal*. All data is welcome and should be submitted even if the conditions are quiet. Any data you can contribute is valuable. The procedure to use for Coordinated Observations will be as follows:

1. Use the Data Cover Sheet and Data Log forms found at the end of the *Journal*. (Make copies as needed.)
2. Put a voice introduction at the start of each session indicating your name, your INSPIRE Team name (and number, if assigned), the date, local time and UT time.
3. Record for 12 minutes at the start of each hour that you can monitor on the specified days. Keep a detailed written log of all signals that you hear and indicate any items of interest. When you submit your tapes, spectrograms will be made of any parts of the tape that you indicate.
4. Place a time mark on the tape on the hour and each two minutes for the next 12 minutes. Use Coordinated Universal Time (UTC) for all time marks.

Local Time to UT Conversion Table

EDT + 4 = UT
CDT + 5 = UT
MDT + 6 = UT
PDT + 7 = UT

Next Coordinated Observations:

April 30 – May 1, 2005

5. Record at 8 AM and 9 AM **LOCAL** time.
6. In addition, record on other hours to compare results with those in neighboring time zones. For example, an observer in the Central Time Zone might record at 7 AM (8 AM EDT), at 8 and 9 AM CDT and at 10 AM (9 AM MDT).
7. Use 60 minute tapes (30 minutes per side) with two sessions per side. It is preferred that you record on one side of the audio tape only.
8. Label all tapes and logs to indicate the sessions monitored and send to:

   Bill Pine
   1348 Quince Avenue
   Upland, CA 91786

9. Your tapes will be returned with spectrograms of your data. An article reporting on the results will appear in the next *Journal*.
10. SPECIAL NOTE: If you are hearing whistlers, replace the data tape after 12 minutes with a "Whistler" tape and continue recording with time marks every two minutes. If we get whistlers, this would be a good opportunity to try to determine the "footprint" of a whistler (the "footprint" is the geographical area where a whistler can be detected).

Field Observation Schedule

Field observations may be made according to the following schedule:

ANY TIME !

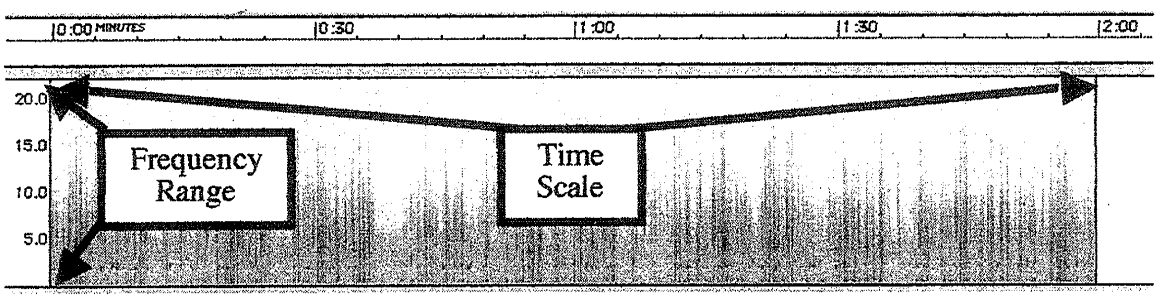
In addition to an article reporting on the Coordinated Observations, will be an article on Field Observations. These observations may be made at any time and submitted for inclusion in the next *Journal*.

Use the same procedure as described for Coordinated Observations (Page 4). Since field observations can be made any time of year, the following table is provided for conversion from local time to Coordinated Universal Time (UTC).

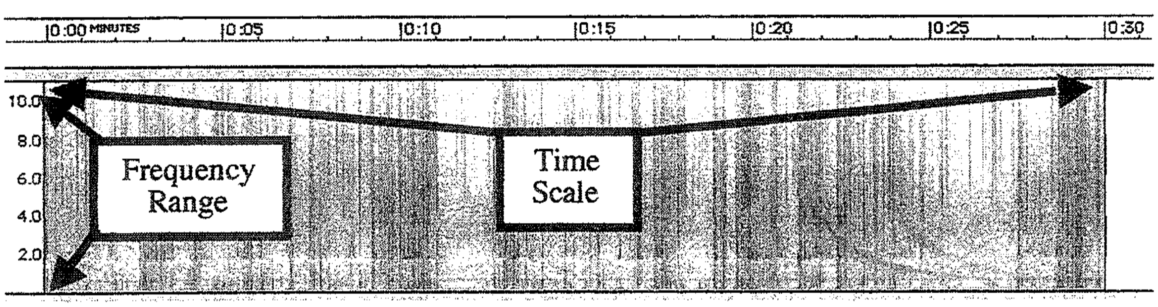
Local Time to UT Conversion Table

EST + 5 = UT	EDT + 4 = UT
CST + 6 = UT	CDT + 5 = UT
MST + 7 = UT	MDT + 6 = UT
PST + 8 = UT	PDT + 7 = UT

Sample Spectrograms:



This spectrogram is for two minutes using a frequency range of 0 - 22 kHz.



This spectrogram is for30 seconds using a frequency range of 0 - 11 kHz.

Site Selection for Monitoring Natural Radio Signals

Robert Bennett
Las Cruces, NM

For the past 15 years, I have used a location on the USDA Jornada Experimental Range about 20 miles from my home for monitoring. Permission to use the site was obtained from the range manager through an informal agreement. However, in 2003, the USDA decided to increase security at all their facilities and I was told that I would no longer be allowed access without formal authorization. I attempted to obtain the necessary authorization but was not successful. I will miss the convenience of this location.

Thus I was forced to search for alternate sites. New Mexico is a very large state and it didn't seem a good idea to try sites at random in a hit or miss fashion. In my former job, I had the opportunity to become familiar with the tools and techniques used by intelligence organizations to search for and evaluate potential radio intercept sites. So, I decided to apply some of these tools to my search for a new monitoring site.

This paper discusses the techniques and tools that I used over the past 12 months to find acceptable places for a natural radio monitoring station. Most of this material is applicable to any region; however, there are a few specific items that apply only to desert locations.

The first step in the process was to develop some criteria that potential sites must meet. The criteria can be derived by answering the following questions:

1. *What do I want to monitor?*
2. *When do I want to monitor and for how long?*
3. *How far am I willing to travel to get to the site?*
4. *What safety issues must I address?*

My answers to the above questions are in the following paragraphs.

1. What do I want to monitor?

There are two natural emissions of interest to me. The first is the INSPIRE observations of lightning induced sferics, whistlers, tweeks and chorus. The second is Radio JOVE observations of the noise bursts generated when electrons spiral in planetary magnetic fields. The frequency bands of interest are the VLF band (about 100 HZ to 20 KHZ) and the upper HF band (20-30 MHZ).

It is well known that natural radio signals are easily masked by various man-made electromagnetic emissions (e.g. interference). The most troubling interference source is the 60-cycle AC power grid. AC Power lines tend to radiate broadband signals that will easily mask natural radio signals for a mile or more. Although it is possible to reduce the 60-cycle interference by filtering and other signal processing techniques, I am of the opinion that the best cure to the AC problem is to monitor from a site that is as far removed from AC power lines as possible.

Other sources of interference that have to be considered are AM broadcast stations, LORAN transmitters, government and commercial VLF/LF/HF communications facilities, ignition noise from motor vehicles, generators, and arc welding.

Additional noise sources exist but are less severe than the above and can usually be dealt with. These include buried pipelines, electric fences, underground telephone cables and people walking near the natural radio antennas.

To find a suitable site, one must know how far away from the interfering sources is far enough. I developed the following separation distance criteria. Some of these are based on my 15 years experience monitoring in desert terrain and others are extracted from the literature (see references).

Table 1 Initial Site Criteria.

SOURCE of INTERFERENCE	DISTANCE (minimum).
AC Transmission lines	5 miles
AC Distribution lines	1 mile
Loran Transmitters	20+ miles
Other VLF transmitters	20 miles
AM broadcast transmitters	10 miles
Arc welding	1-5 miles
Roads with traffic	100 yards
Running motor vehicles	100 feet
Stationary engines (generators and pumps)	100 Yards
Electric fences	100 feet to 1 mile (Depends on type)
Other fences	100 feet
Buried pipelines (Safety Issue)	1 mile
Buried telephone cables	100 feet
Trees	2 times height

Discussion:

a. AC Transmission lines are high voltage (100,000 volts or more) 3-phase lines that are usually supported on metal towers. These lines connect generating plants to major substations (transformer yards) that are normally close to cities. Not all substations are located in cities. I have found substations located "in the middle of nowhere".

b. AC Distribution lines are the lines that connect the substation to the consumer. These lines are normally 10,000 volts or less and supported on wooden poles. One way to identify a distribution line is to follow the line and if you find a pole-mounted transformer with wires going from the transformer to a building, then it is a distribution line.

c. Loran, AM broadcast and VLF/LF transmitters are often a problem and the separation distance given above may not be adequate to eliminate interference. However, the distance given should be adequate to get out of line-of-sight of the interfering station and provide some terrain shielding. Other techniques such as filtering can then be used to reduce the interference.

d. Buried pipelines and telephone cables are listed because I have found that some have AC power lines buried alongside them to operate pumps and repeaters at remote locations. The author unknowingly set up a natural radio whip antenna above a buried telephone line and was surprised to hear not only AC hum but also telephone conversations. Also, pipelines are a potential safety hazard due to possible leaks and they should be avoided. All pipeline companies in this area recommend that people stay well away from their pipeline right of way and all above-ground facilities.

e. Be wary of fences. I have observed increased pick-up of interfering signals close to fences, especially long fences. Be cautious if the fence wires are insulated from ground and their support posts. It might be an electric fence. These will give a nasty shock and depending on the type of fence charger, may radiate interfering signals.

f. Trees. Here the issue is placing the natural radio antenna under the drip line of a tree. This will usually cause a significant drop in received signal levels. This discussion has nothing to do with using the tree itself as the antenna.

2. When do I want to monitor and for how long?

The answer to this question is basically implied by what I want to listen to. In the USA Southwest Desert Regions, the best natural radio-monitoring period is usually from about 0500 to 0900 local time. Radio Jove monitoring is usually from about 2000 in the evening to just before local sunrise.

These times imply that either I arrive on site in the late afternoon or early evening and spend the night or else leave home in time to arrive before about 0400 local time (assuming that an hour will be required for equipment set-up and adjustment). I much prefer to arrive in the early evening and spend the night at the site. I don't enjoy driving over desert trails in the dark.

As for how long I will remain on-site, I usually keep the on-site stays to 12 hours or less due to family commitments. I will normally use the site four to six times per year.

3. How far am I willing to travel to get to my quiet site?

First, I don't like backpacking and prefer to use a truck to get to the site. For my initial search, I set a limit of 150 miles from home. I also set a secondary limit of 4 hours travel time. In my area, almost all potential sites will require a combination of freeway, secondary road and desert trail driving. The desert trail portion often consumes a lot of time, as speeds on the trails are only 5-10 MPH.

4. What are the safety considerations?

Under safety considerations, I lumped several issues. The first is site access. All proposed sites should be accessible by a road that is passable in dry weather by a 4-wheel drive vehicle. Wet weather access is not generally required.

The proposed site should have a clear flat area close to the road to park the truck and set-up the antennas and other equipment. An area of 20x20 feet is adequate. The access road should have no more traffic than one vehicle per hour and preferable none after dark.

The proposed site should not be in a campground, picnic area, or close to hiking trails. These areas normally have a fair amount of man-made radio noise and people walking around. It has been my experience that deploying antennas and cables near where people walk is asking for trouble; someone is likely to trip on a cable or knock over an antenna and possibly injure themselves.

As my radio monitoring often requires late night observations, personal safety must be considered. It is best to avoid areas were people tend to congregate and party. In New Mexico, young people will sometimes congregate in the desert and spend several hours or all night drinking beer and doing other activities. Sometimes these parties can get out of hand and become violent. There are some trails and roads in the desert used by "illegals" to avoid Border Patrol checkpoints. I checked with the Border Patrol to find out which areas, roads and trails should be avoided.

The final safety issue deals with communications. As many of the potential sites are likely to be remote and isolated, some means of calling for help is desirable. It has been my experience that in New Mexico, cell phone coverage is at best spotty and usually unreliabable when one gets more that a few miles from the major freeways and towns. I always check to see if a proposed site is in the coverage area of an amateur repeater and if so will deploy a 2-meter transceiver. If no 2-meter coverage is available, I will take along an HF transceiver. I usually arrange a check-in schedule with a friend or family member. It is very important that someone know the exact location of the site (including GPS coordinates) and the roads being used to access it.

Selecting a Site

The next step in the process was to apply the above criteria and identify some potential sites. On my first attempt at this, I found that two criteria (travel time and vicinity to power lines) have overriding importance and will tend to eliminate many areas. The process that follows is formally called a "site survey". A complete site survey consists of five steps:

1. Map Survey
2. Reconnaissance
3. Identify Potential Sites
4. Sample Monitoring
5. Analysis Phase

1. Map Survey. The first step is to obtain the necessary maps (not easy in small towns). I used three different types of maps: large scale (1:500,000) maps such as the landscape maps found in a state atlas for initial planning, 1:250,000 scale terrain maps such as the USGS N1 series for potential site selection, and, once a potential area for the monitoring site has been found, small-scale digital terrain maps with a scale of around 1:50,000. It is important that all the selected map sheets have the latitude and longitude grid printed on it. Road maps of the area of interest are also useful. I used both paper copy maps and computerized digital maps.

Using travel time and distance criteria information, I began to identify possible areas on a large-scale map. On the map I first excluded any closed areas such as military facilities and impassable terrain (such as sand dunes and lava flows). I identified two regions or areas to investigate further. One area is about 90 miles by 30 miles in size and lies to the north of my home. This area is outlined in Figure 1. I also selected an area of about 50 miles by 40 miles that lies to the northwest of my home. For the sake of brevity, I will only discuss the northern area.

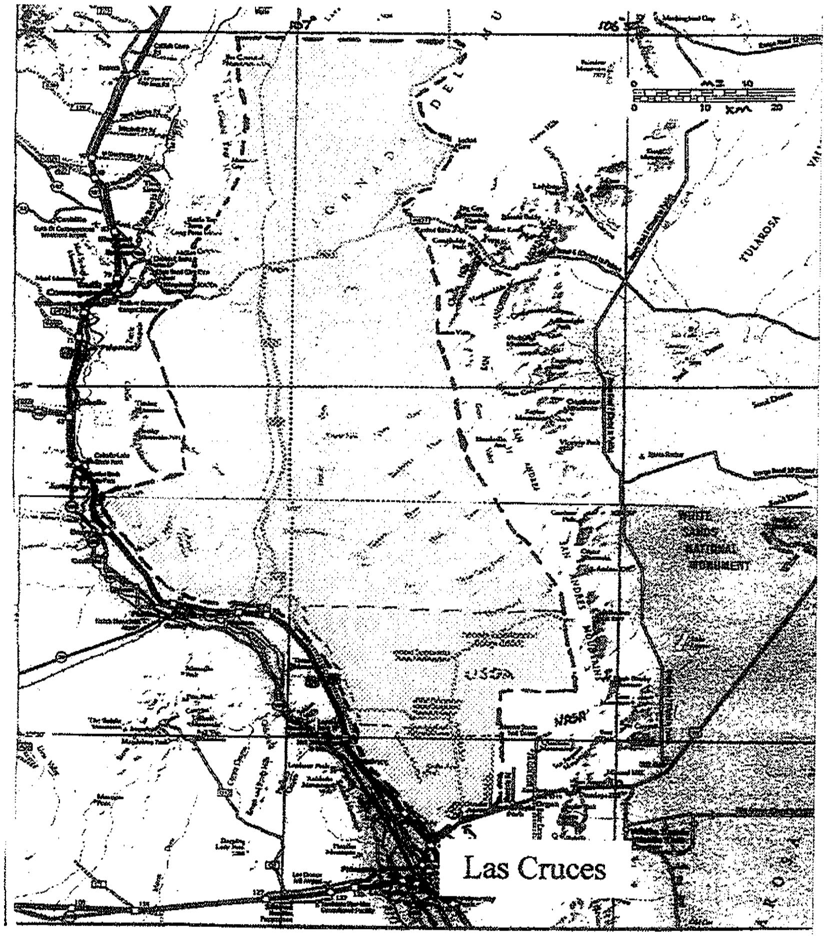


Figure 1

The Northern selected area.

The heavy dashed lines on the map (gray shaded area) identify the area I selected. My home location is shown on the bottom center of the map. There are two areas at the bottom of the map that are closed to the public that I excluded.

2. Reconnaissance. The second step is the initial drive-through or reconnaissance. I started by planning a route through the selected area (using road maps) that utilized as many of the primary and secondary roads as possible. The routes I used are shown in Figure 2. At this point, I attempted to avoid the unimproved roads and trails. The object was to drive the roads and observe the area and its features. I made frequent stops to record observations. During the reconnaissance, I noted the following things and recorded their locations in my log. A GPS unit makes this work much easier.

a. Power lines, both transmission and distribution systems. Also, the location of any substations seen.
b. Railroad tracks.
c. Pipelines. Pipelines can be hard to locate. The best technique is to watch for signs that are placed on both sides of a road where the pipeline crosses.
d. Houses and ranches.
e. Communications facilities. Watch for towers and antennas.
f. Airports and private airstrips.
g. Oil wells and related facilities.
h. All government and military facilities that are not marked on the map.
i. The presence of "no trespassing" signs.

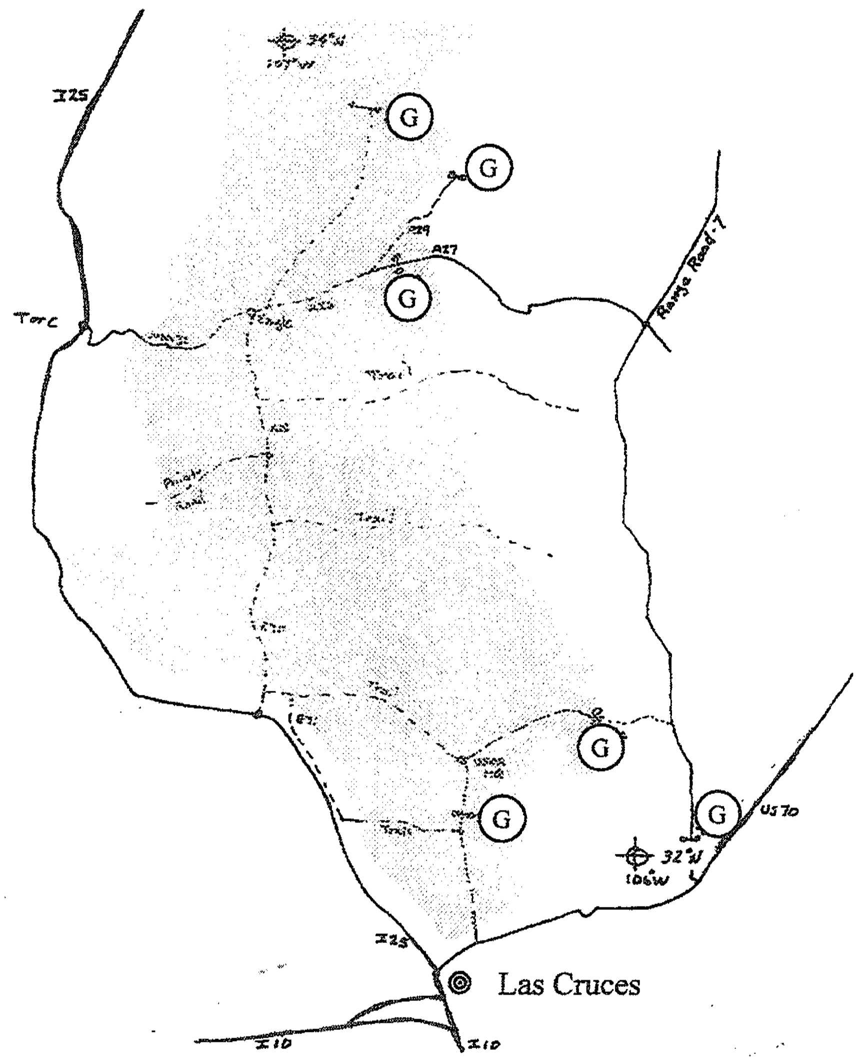


Figure 2

A map overlay showing roads that I explored in the selected area of interest. There is a very large military complex to the west of the chosen area. Note that many of the roads and trails end at locked gates ((G)).

The initial reconnaissance was time consuming. It took me over three days to scout the area shown in figures one and two. The results from the reconnaissance were then used along with the criteria listed above to identify potential locations for the monitoring site. It is sometimes necessary to reject an area if it is full of power lines, has high power radio stations, or contains many oil wells and associated plumbing.

If communications sites or other facilities with towers were observed, then a second reconnaissance trip is indicated. For each site observed, I needed to determine if the site has transmitters that could cause me problems. I used several techniques to do this. First, if I could locate the access road to the site, I would drive to it and check it out. This was sometimes difficult, as the access roads are generally not marked on publicly available maps. When I found an access road, I would either drive or walk and get as close to the facility as possible. Generally, there will be a sign posted at the gate giving a telephone contact number; name of the owner and often the FCC assigned call sign. I usually took a picture of the tower and antennas, and record in my notebook the GPS location of the site and the photo number. (Note: it is **not** a good idea to photograph military or government facilities!).

The one piece of information needed about each communications facility is the frequency band in use. This can most easily be determined with a handheld frequency counter and can often be determined by the antenna configuration. Failing this, a search of the on-line FCC database by call sign will sometimes yield the needed information. If the call sign is not available and antenna classification fails, for non-government facilities the Fryer's Site Guide will often reveal the owner and a telephone number. Calling the listed telephone number will sometimes result in the needed information but often results in seemingly endless transfers to different people. Figure 3 shows the locations of the communications sites that I found. Note, I made additional overlays similar to Figure 3 showing transmission lines, pipelines, ranches, and airstrips.

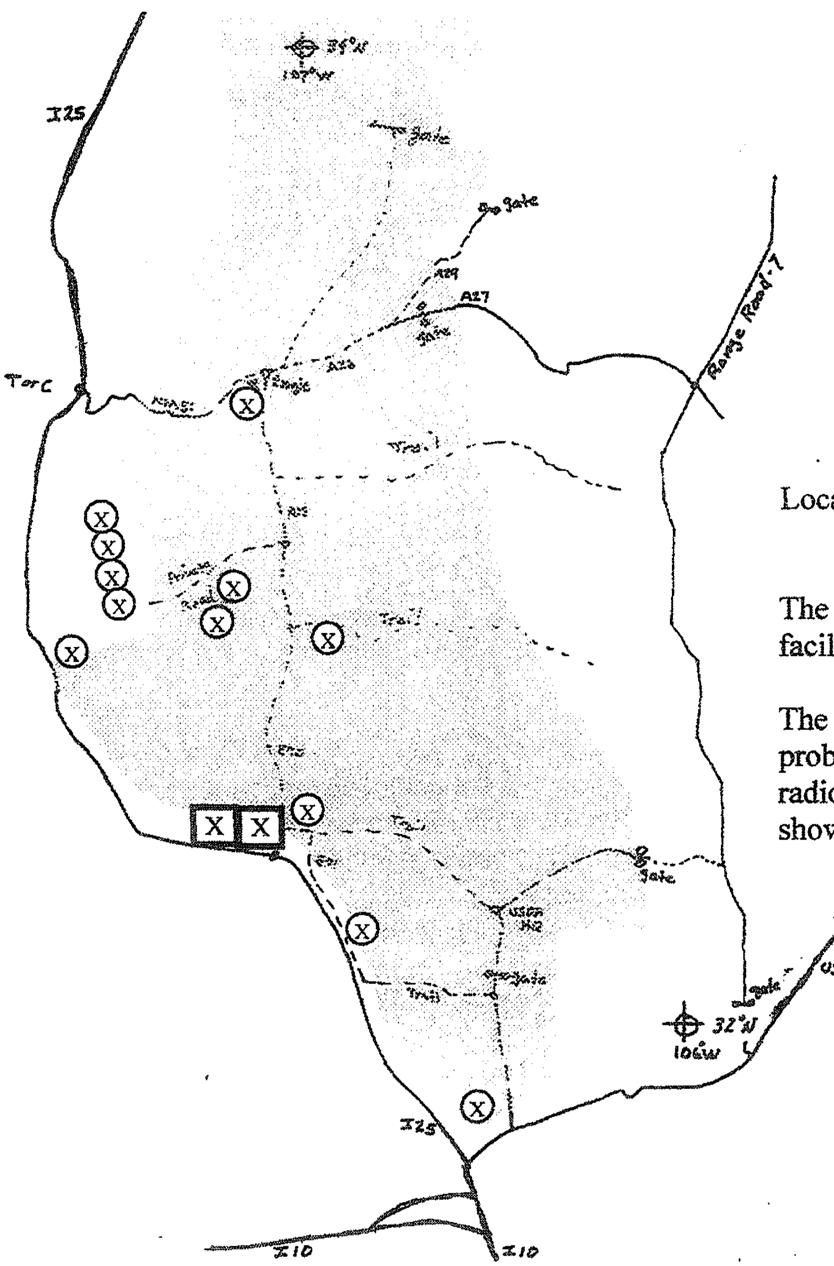


Figure-3

Locations of communications facilities.

The communications facilities are denoted with (X)

The only ones that might be a problem are the two AM radio broadcast stations shown with [X]

3. Identify Potential Sites. The next step is to identify some potential sites that meet the criteria given above. With all the above data in hand, it is possible to select a few potential sites. I selected 15 potential sites for farther evaluation. The number of sites selected was constrained by the time available to evaluate them. The potential sites should, to the extent possible, be scattered throughout the area that was scouted. Figure 4 shows the locations of the potential sites I selected.

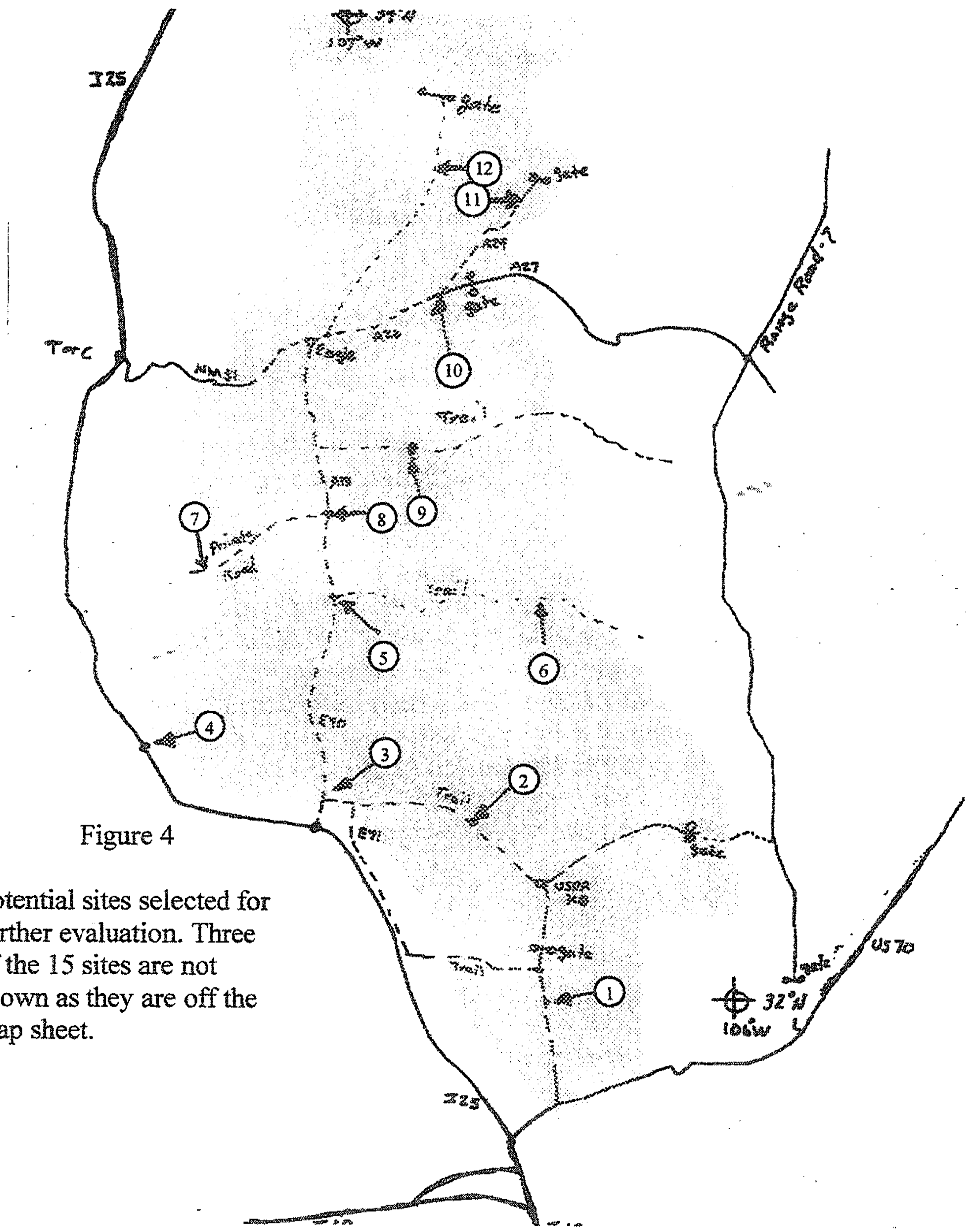


Figure 4

Potential sites selected for further evaluation. Three of the 15 sites are not shown as they are off the map sheet.

With potential sites selected, the next step was to determine the best route to get to each. This was not as simple as it seems. Often, maps will show unimproved dirt roads and trails to potential sites. At least in the local desert, I have found most of the map information to be inaccurate. The roads shown are sometimes blocked or abandoned. The desert is also filled with roads and trails not shown on the map. The best approach is to plan a route using a map and establish GPS waypoints along the roads shown on the map to the potential site. If the map is inaccurate, it will become evident when trying to drive to the GPS waypoints. Also, for personal safety, I always made sure I was properly equipped in case I had to spend the night in the desert and made sure someone knew where I was going and when I would return.

4. Sample Monitoring. When I reached each potential site, or as close as I could get to it, the first thing I did was look around the area for "no trespassing" signs and for a clear spot wide enough to park my truck and set up. If I found any "no trespassing" signs, I would immediately leave the site. If everything looked ok, I set up my natural radio receiver, WWV receiver, and recorder and made at least one 30-minute recording. I also set up a handheld frequency counter (Optoelectronics Scout) to check for nearby transmitters. I usually remained at the site for an hour or two. In additional to the natural radio recording, I observed any traffic along the access roads and looked for signs that the area is being or has been used by other people (beer and soda cans, and other trash might indicate a party site). I also looked for freshly spent gun cartridges and looked for evidence of old mining activity. In New Mexico, many old mines have not been properly closed and are a hazard.. I rejected any potential site that is posted, has evidence of party activity, has old mine shafts nearby or had more than one vehicle per hour along the access road.

5. Analysis Phase. Of the fifteen potential sites that I selected, I succeeded in collecting data at 11 of them. The others were not suitable on first examination (too difficult to get to, power line too close or access roads blocked). The data I collected at each of the 11 sites consisted of audio recording of natural radio signals, hand written log sheets with miscellaneous observations and some photos. Over about a two week period, I analyzed each audio recording using both GRAM and SpectraPlus programs. I did a quantitative assessment of the relative amplitude of 60-cycle and Loran interference and did a qualitative assessment of the general natural radio environment at each site. I found two very quiet sites with no 60-cycle interference and very weak Loran. I also selected the next two best sites that had acceptable levels of Loran and 60-cycle interference. Of course, the best site is also the most difficult one to reach. The site easiest to reach has just acceptable levels of 60-cycle interference.

Next actions. Starting in December 2004, I intend to conduct both daytime and nighttime monitoring sessions at the four northern sites and try to select two sites, a primary and an alternate, for future monitoring.

I have not completed my test monitoring of the western area and hope to do that in December/January. Hopefully, by the time of the next INSPIRE Coordinated Monitoring, I will have several good sites to choose from.

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References.

The following books, reports and documents contain material relevant to site surveys and the siting of monitoring stations. I have also included some references that can aid in the identification of communications facilities. Many of these may be difficult to locate as they are not the kind of materials that most public libraries will have. The best place to find them is in the engineering section of a large university library.

1. Spectrum Monitoring Handbook, International Telecommunications Union (ITU), Geneva, 1995.

2. Spectrum Monitoring and Utilization, CCIR, ITU, Geneva, 1986

3. Radio Science Observing, Volume 1, Carr, Prompt Publications, 1998.

4. Site Survey Guide, NSA Technical Manual, US Department of Defense, 1958.

5. Naval Shore Electronics Criteria for Communications Station Design, NAVELEX 0101-102, US Navy, 1973.

6. Naval Shore Electronics Criteria for VLF, LF and HF Communications Systems, NAVELEX 0101-103, US Navy, 1972.

7. Radio Frequency Interference Handbook, NASA SP-3067, NASA Goddard Space Flight Center, 1971.

8. Fryers Tower Site Guide, NM, AZ, TX, and CO edition, 2001, Fryers Inc.

9. Manual of Regulations & Procedures for Federal Radio Frequency Management, NTIA, US Dept of Commerce, 2002. (Lists the frequency bands used by the federal government).

10. Federal Communications Commission WEB Site, HTTP://wireless.fcc.gov/uls

11. THE LOWDOWN, journal of the Long Wave Club of America (LWCA), and their WEB Site- HTTP://www.lwca.com

12. The VLF Group, WEB Site http://groups.yahoo.com/group/VLF_Group/