

# LaGrange Amateur Radio Club Coordinated RF Search and Rescue Procedures



LaGrange Amateur Radio Club, Inc

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## Overview

In some situations, there is a need to search for an RF signal in a coordinated, group effort in which the searchers all work together under a net control operator. This is different from standard foxhunts in that search teams are not competing with each other but rather cooperating with each other in order to quickly find the source of the RF signal.

This document will explain the procedures for conducting a Coordinated RF Search and Rescue (CRFSAR). At the end of this document is a sample CRFSAR along with maps at each stage of the effort.

It should be noted that this is a living document, and if any procedure described herein is determined to be incorrect, inefficient, or otherwise impractical, the document will be updated with the corrected procedure.

## Minimum Requirements

At the very least, there should be four search teams (with radio direction-finding equipment and compasses), a net control station (NCS), a master map which has the search area broken down into quadrants, and a method of drawing triangulation lines on a map. The more search teams available, the better, but at least four is a must for efficiency. GPS units can add some benefits if the search area is a wooded, non-developed region, otherwise, street and building locations should suffice. Area Packet Reporting System (APRS) is more beneficial than a stand-alone GPS unit, because the net control station can directly use the reported position on the APRS map at the NCS. The APRSPoint mapping system allows the user to draw lines on the map for the purpose of triangulation. Examples of this are shown later in this document. It is also recommended that each search team have a map of the search area.

## Basic Procedure

The NCS should have the APRS receiving system already operating and displaying the search area before any teams are dispatched. The search area will be broken up into at least four quadrants. See Figures 2 and 3 for quadrants of Troup County and LaGrange. All teams should become somewhat familiar with the search area and the quadrant boundaries. If a general vicinity of the RF source is not already known, then one team should be dispatched to each of the quadrants via the NCS, and all radio traffic should be directed through the NCS. Teams are free to maneuver around their assigned quadrant in attempts to locate an RF signal from the source after their reading from the quadrant's prime point (see **Practical and Tactical** for definition of prime point).

When a team receives a signal from the RF source, the team must report to net control the team's location (if APRS is not in operation) and the heading in degrees in which the signal is coming. For example, a typical transmission would contain the following: "I am at McDonald's on Commerce Avenue and I have a signal reading coming from 210 degrees." Net control should confirm the traffic by quickly repeating it: "I copy 210 degrees from McDonald's on Commerce Avenue, is this correct?"



With this information, the net control operator will plot the RF signal on the master map and/or the APRS map. It is important that the net control station extend the plotted line *through* its reported position. I.e., the line should not end at McDonald's; it should extend equal-distance in both directions through McDonald's (210 degrees and 30 degrees).

Although triangulation can be performed with only two readings, it is desirable to have more to help eliminate any false signals as a result of reflection. It is up to net control to determine when enough signal reports have been made. At this time, net control will re-dispatch the teams to the triangulated region and begin closing in on the RF source. The search will continue in exactly the same manner as before but on a smaller defined area. ***At no time should a team leave their assigned quadrant without being instructed to do so.***

## Practical and Tactical

As usual, the NCS will be referred to as "Net Control" or just "Control." Each search team will be assigned a tactical call sign for the quadrant in which they *start* the search. The call sign for the team in quadrant 1 will be "Team 1-A." If there are more teams assigned to the same quadrant *at the beginning of the search*, then the alpha character will increment (ex. "Team 1-B"). Similarly, the alpha character can be eliminated if it is known that there will be one team per quadrant. Teams will keep this same tactical call sign for the entire duration of the search, even if they are reassigned to a different quadrant during the search.

Some teams will have different capabilities than other teams. Some may have APRS running, some may have a GPS-based navigation system, while others may only have digital or paper maps. When searches are operating within developed areas, street names or other indicative information may be given. For example, it is much quicker and less error-prone to give your location as "in the parking lot of Wal-Mart" than it is to give your latitude and longitude coordinates from the GPS system. For situations where the RF source may be mobile, time is critical. For searches in rural scenes with no streets or roads, GPS coordinates are the only suitable means of depicting location. For those running APRS, a quick verification of net control's depiction of the team's location is required.

It is desired that a known initial location in each quadrant be dedicated for the first RF reading. These locations will be known as the **prime point** for each quadrant. The four prime points shall be oriented such that any three readings can not have parallel bearings. It is very possible that the RF readings from these prime points give enough information for immediate triangulation and therefore a quicker conclusion to the search. For searches in the LaGrange area, the prime points for each quadrant shall be:

1. The top parking lot at Highland Country Club
2. Top of parking deck at the court house building
3. The old Mountville Mills building at 1729 South Davis Road
4. The Fuller E. Callaway Monument

These locations are selected because they provide a wide scanning area. Some are chosen because they are somewhat elevated, while others are in largely open surroundings. It is possible that these prime points may be changed to locations which are more effective.



## Net Control

The format of the radio communications shall be of a formal emergency net controlled by a net control station. It is desirable that the net control station have at least two operators so that tasks other than radio communications can be performed. Examples of these tasks are charting and plotting vectors on maps, logging, communicating with public safety officials, and strategizing.

The net control operator shall maintain control of the net at all times. Whenever he or she feels that the net has become unorganized, the net control station must regain order politely and impress upon the field stations that only important, pertinent traffic is needed. Any superfluous comments or opinions are not needed for the search and rescue operation. All traffic is to be directed through net control.

The environment around net control must also be controlled. Any search team or member that is at net control must remain calm and conduct themselves in a quiet, orderly fashion so that net control can continue his duties efficiently.

All stations should be aware of the status of the net control station. At no time shall a station call net control if she is already engaged with traffic from another station. All stations must wait until net control is ready to accept traffic. This also applies when net control announces that all stations should standby. During this time, the radio should be clear with no communications in progress until NCS is ready to receive calls.

When calling net control, a station must wait to be acknowledged before saying their traffic. Never should a station do the following: “Net control, this is Team 1, we’ve got a reading of 180 degrees at ... .” In this example, the radio operator for Team 1 should have waited for net control to recognize him, because the NCO may not have been prepared to receive the traffic.

If net control is having trouble copying a station due to interference or weak signal, the station should be given a maximum of three attempts to pass their traffic. At this point, net control should indicate that the station is unreadable. At the discretion of net control, he may ask if any station was able to copy the unreadable station’s traffic and relay the information. ***No station shall interrupt any attempts of the unreadable station for the purpose of relaying the information; all stations must wait for net control to either ask for relays or clear the air for traffic.***

If emergency traffic needs to be passed, the station with the traffic should transmit the word “break.” For extreme emergencies, the standard terminology for being recognized among amateur radio operators is “break-break-break.” If radio traffic is already in progress, the station with the emergency traffic shall wait for pauses in between the current communication before transmitting the “break” code. If net control is already processing emergency traffic and another station also has emergency traffic, the second station is to wait until the first emergency traffic is handled. At no time shall emergency traffic be interrupted with new traffic, emergency or otherwise.



## Logging

Keeping a hand-written log of events is important. Not only does keeping a log provide a chronological timeline of events, it also allows one to use it for a quick reference. Sometimes it is necessary to track previous triangulation points to track the direction of travel of a mobile RF source. The net control station should maintain this log, however any team can request information from the log to prevent duplicate RF readings from the same location. When keeping a log, keep track of the time, the team id, the team's location, and the traffic passed.

## Magnetic North and True North

Although this document is not intended to be a comprehensive course on orienteering, it should be noted that Magnetic North given by a standard magnetic compass is not the same as True North. True North, also known as Geographic North, is the point where all longitude lines meet in the Northern hemisphere. This is where Santa Clause lives, a.k.a. the North Pole.

Unfortunately, Magnetic North is a different phenomenon. The Earth is surrounded by a magnetic field. Since the Earth's core is molten, this magnetic field is constantly changing. The rate of change for Magnetic North is approximately  $\frac{1}{2}$  to 1 degree westward every five years. The angular difference between True North and Magnetic North is known as the **magnetic declination**, and this value in the United States can vary from 20 degrees West to 21 degrees East. As you can imagine, this can produce quite a wide margin of error when plotting between a compass (Magnetic North) and a map (True North). Here in LaGrange, at the time of this writing, the declination angle is approximately 3.75 degrees West. This means that if you were using a compass to determine True North, you would *add* this declination value to the indicated Magnetic North. If you had an Easterly declination, then you would *subtract* this value from Magnetic North, remembering that 360 degrees is the same as 0 degrees.

For the purpose of the CRFSAR, all bearings should be given in Magnetic North readings. It is up to the NCS to make the corrections when plotting on the master map and/or APRS map.





Figure 1- Magnetic North versus True North

The map shown in Figure 1 has a Magnetic North overlay compass. The map itself is in True North, and as you can tell, the streets of LaGrange are closer to True North orientation than Magnetic North. The overlay compass is -3.75 degrees off of True North.

How much is 3.75 degrees? The margin of error if Magnetic North is used on a map that is True North oriented can be up to over 900 feet *per mile*. If a station that was three miles away from the RF source was plotted incorrectly on a map, the margin of error could be over 2,700 feet – more than half a mile. For a city the size of LaGrange, this could be several city blocks.

## Locating the RF Source

When the RF Source is found with a positive identification, use the word “contact” to distinguish this traffic from all others. Once acknowledgement is made, report the source’s location to net control. Unless specified, members of the LaGrange Amateur Radio Club are not to directly make contact with the RF source. If the RF source is an emergency beacon from a downed airplane, then hazardous materials could be in the area and LARC members should not



endanger themselves. If the RF source is a transponder bracelet for Alzheimer's patients, then only trained personnel should attempt to assist the subject.

## When There are Less Than Four Search Teams

Sometimes there are situations when there are not enough volunteers to cover each quadrant simultaneously. Does this mean that the search procedures are different? The answer is no. The search shall be conducted in exactly the same manner as if there were four teams. The difference is that one or more teams may be asked to cover more than one quadrant. These teams will first go to the prime points of their assigned quadrants. When three or more RF readings reveal an intersection, the net control station will reroute teams around the triangulated area.

## When There are More Than Four Search Teams

In very fortunate situations, more than four search teams may be available. This can help ascertain the RF source more quickly. In some scenarios it may be desirable to send multiple teams to a single quadrant. However, in some cases where time is of the absolute essence, it may be better to have the remaining search teams standby and wait for a triangulation area to be defined. At this point, these "extra" teams can be dispatched directly to the new search area, possibly much quicker than those teams already out in the other quadrants. Whether to have multiple teams in a single quadrant or to have the extra teams standing by is dictated by the severity of the situation. Net control should have some idea about the situation so that the best tactical decision can be made.

## Late Arrivals

In long searches, there may be times when new search members become available. This is good for relieving teams or members that need a break. When new search members arrive, they are to call in to net control and ask for assignment. Unless needed immediately, the new member will be asked to report to net control. At no time will a team or member that is new to the search begin reporting signals without first checking in to net control and she has asked them to do so. All "not-in-service" search units will remain around the net control station and be prepared for quick assignment.



## Example Search and Rescue

The following is a sample CRFSAR with each of the steps illustrated on the master map. All radio traffic are examples of acceptable communications procedures (without actual call signs). For the purpose of this example, we'll assume a stationary RF source and four search teams (Team 1, Team 2, Team 3, and Team 4). Before reading the communications dialogue, become familiar with Figures 2 and 3. Figure 2 is a map of Troup county divided into quadrants. The origin (the point at which all quadrants meet) is Lafayette Square (the fountain in the square of LaGrange). Figure 3 is the same map zoomed in to a closer level showing the streets of LaGrange. During this mock search, these maps will be zoomed in or out for the purpose of clarity.

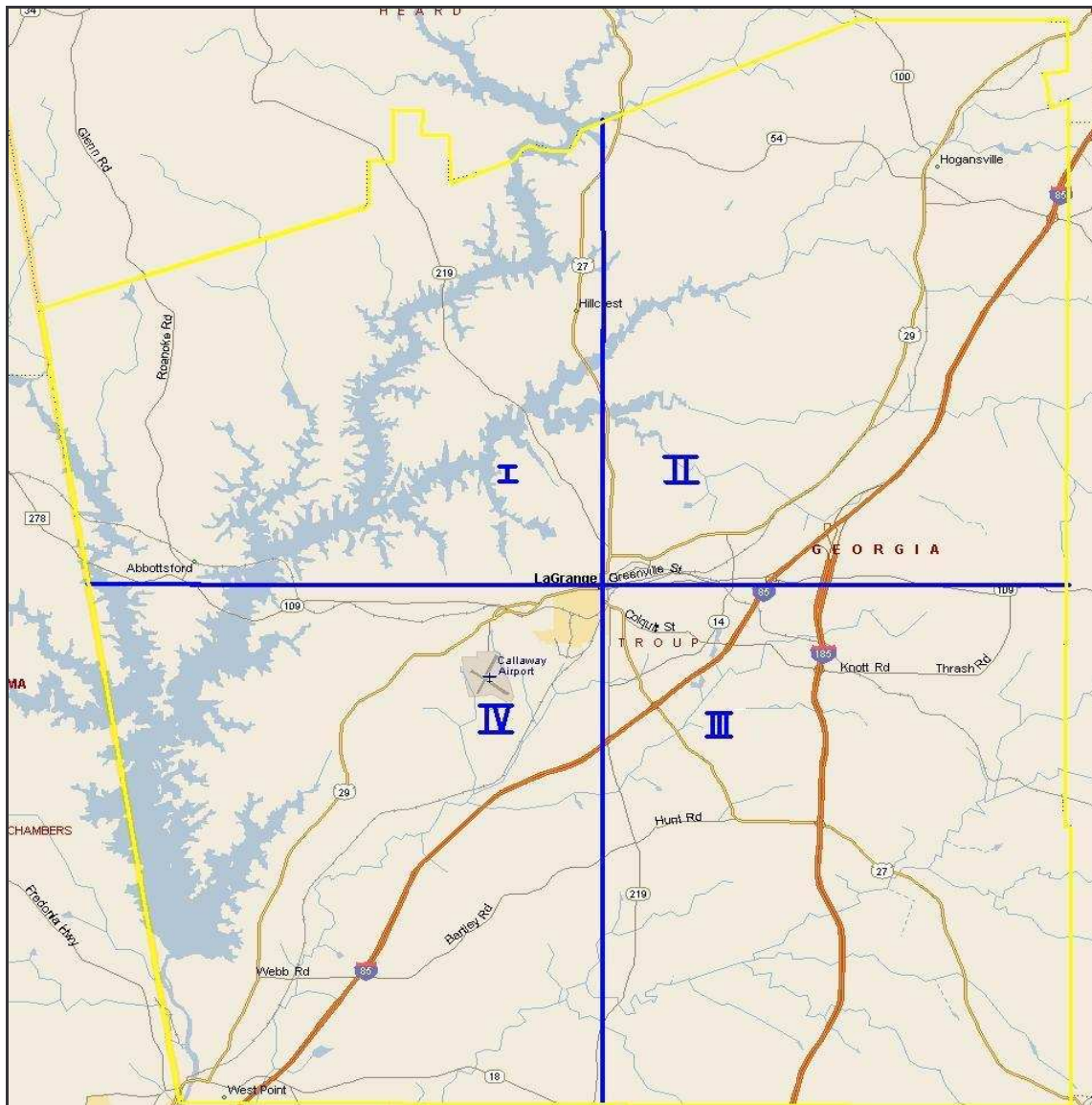


Figure 2 - Troup County Quadrants

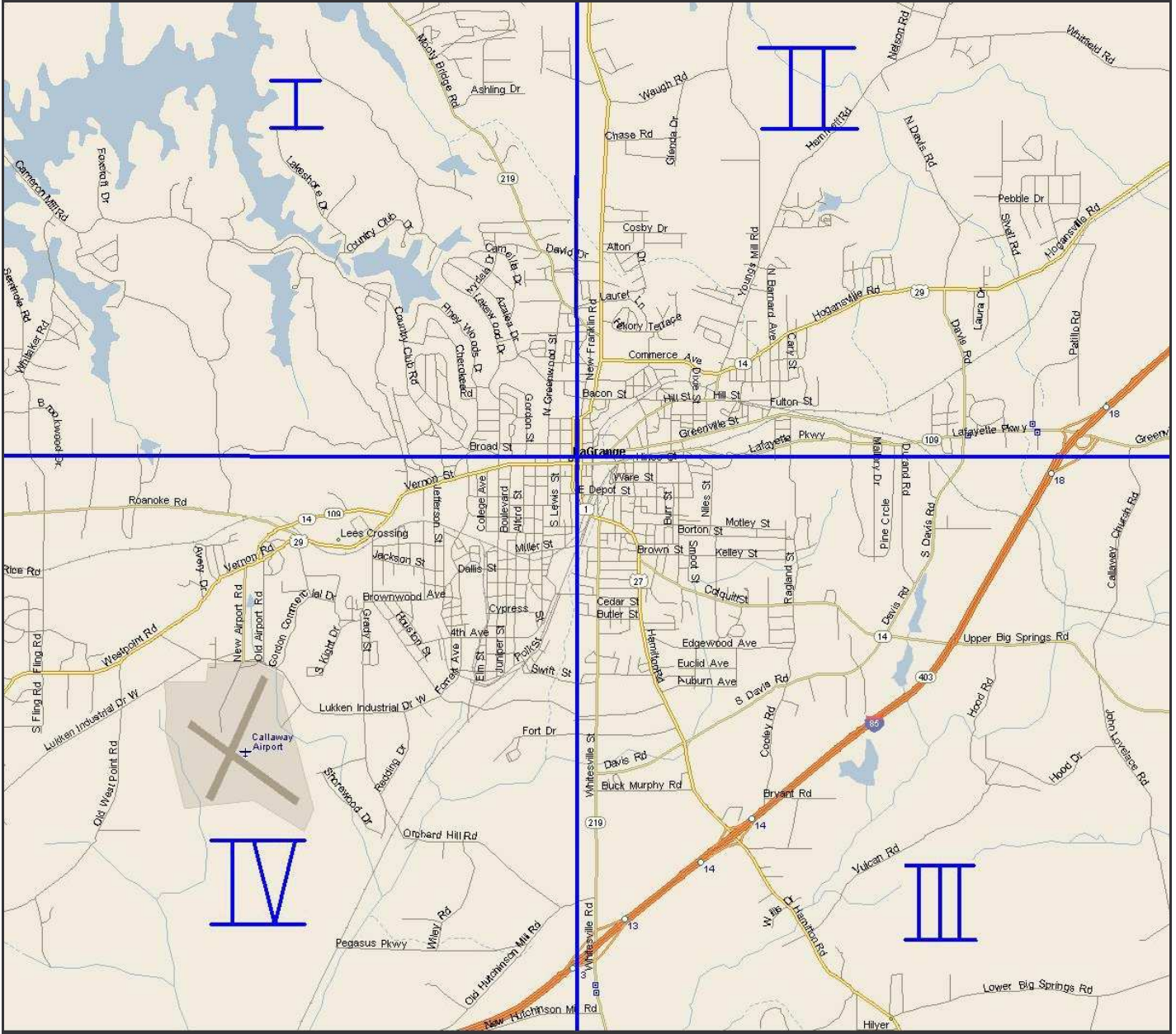


Figure 3 - LaGrange Quadrants

### Sample Dialogue

- This is net control. All teams are to be in route to the prime point in their assigned quadrant. Report back to net control whether or not you have an RF reading. Be familiar with your quadrant’s boundaries and do not leave your quadrant unless told to do so by net control. This is net control standing by.
- Net control, Team 2.
- Go ahead Team 2.
- We are at quadrant 2’s prime point with an RF signal bearing 187 degrees.



- Copy, prime point in quadrant 2 with a reading of 187 degrees. All stations standby.

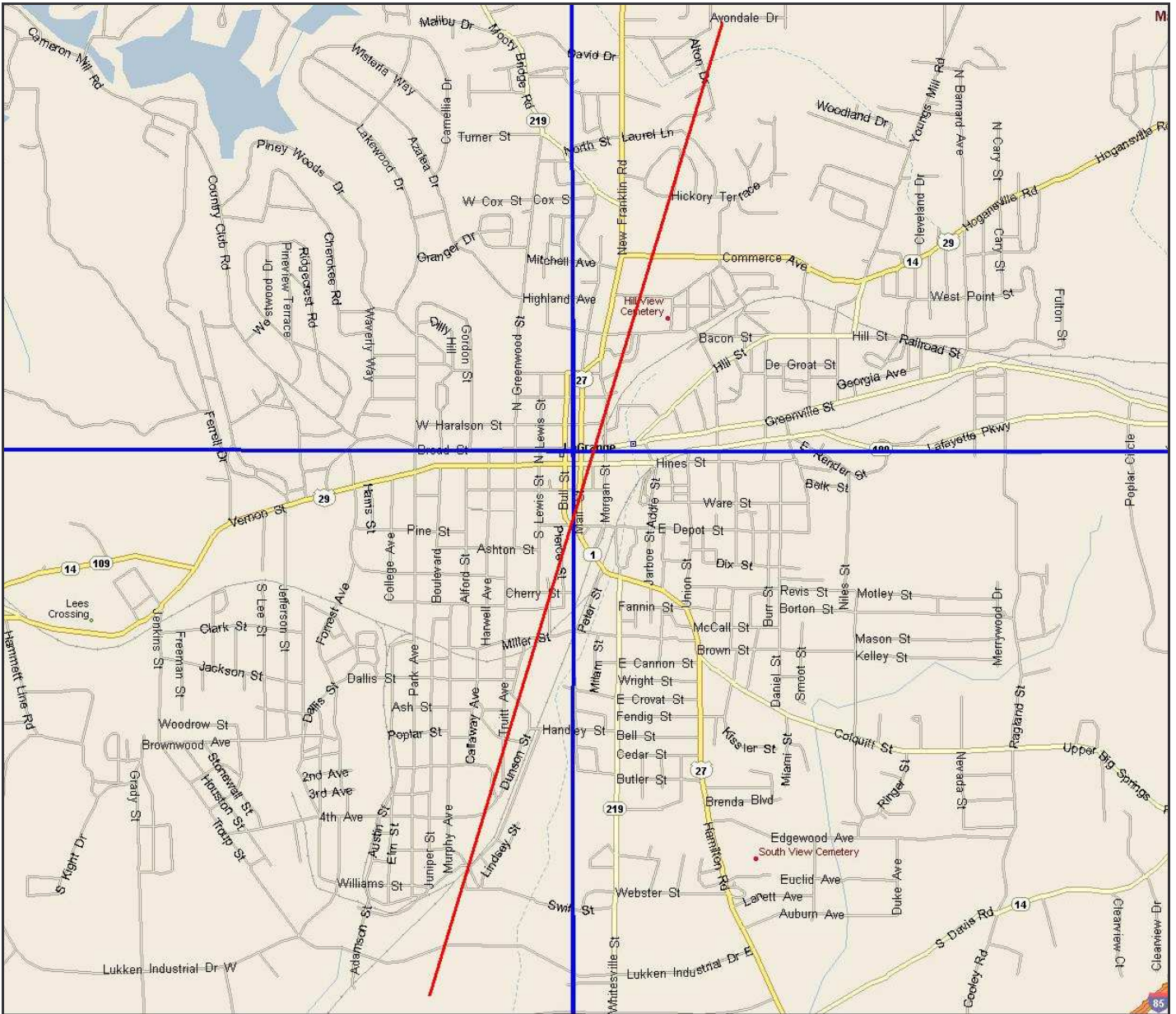


Figure 4 - Team 2's plot of 187 degrees from Court House

- Team 2, net control – Your bearing is plotted. Standby for the remaining prime point readings.
- Roger, Team 2 clear
- Net control is clear for traffic
- Net control, Team 4
- Go ahead Team 4.
- We're at quadrant 4's prime point. I have a reading on the RF signal at 170 degrees.

- Okay, I copy you're at the prime point of quadrant 4 with a reading of 170 degrees. All stations standby while this bearing is plotted.

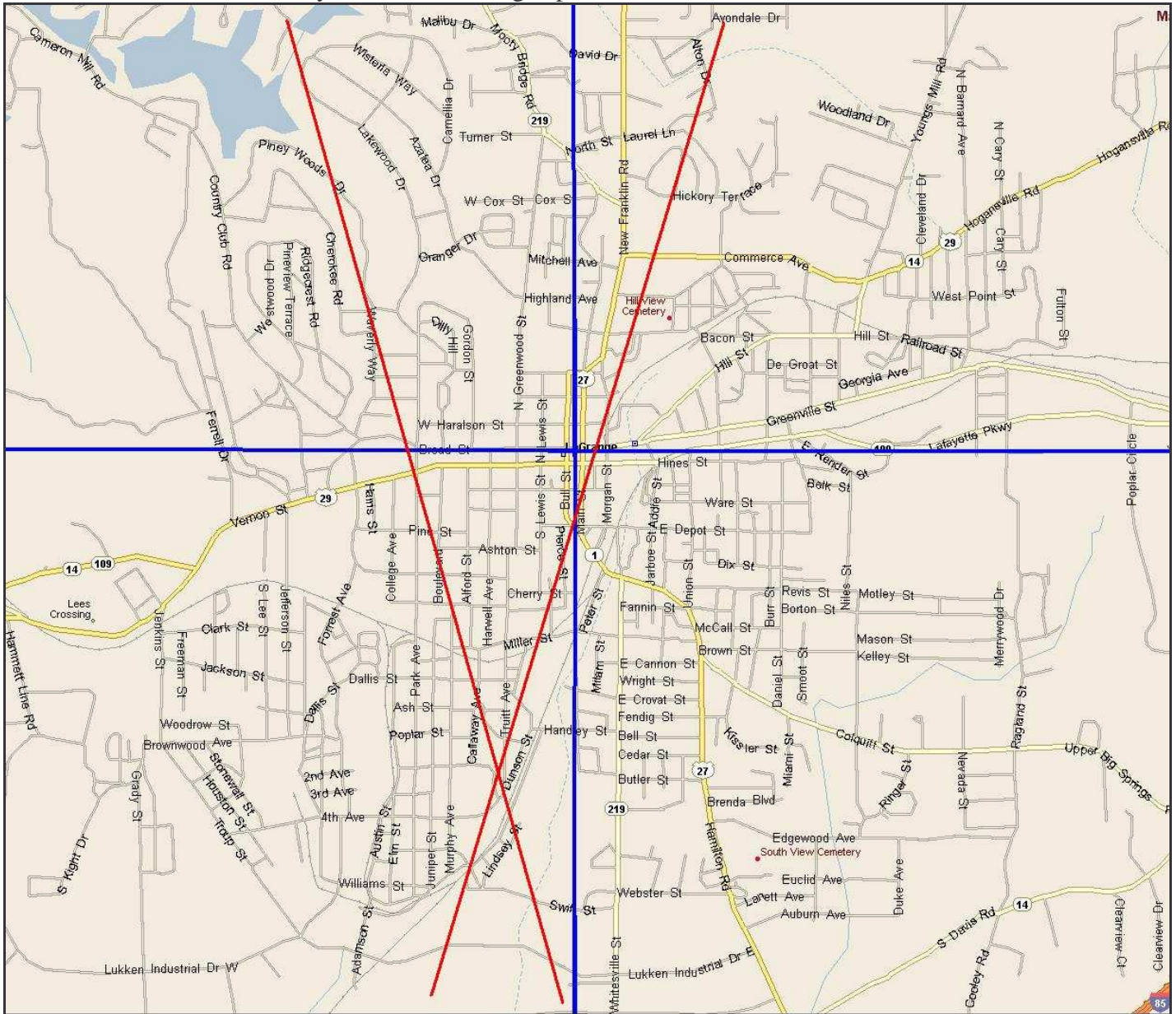


Figure 5 - Team 4's Plot of 170 Degrees from Callaway Monument

- Team 4, Net control – Your bearing is plotted. If we can get one more reading from either Team 3 or Team 1, we may be able to move the search area closer.
- Team 2 copies and is clear.
- Net control is clear for more traffic.
- Net control, this is Team 3
- Team 3 go ahead with your traffic.
- We have an RF signal from our prime point at a heading of 207 degrees.

- Roger Team 3. I copy 207 degrees from your prime point. All stations standby.

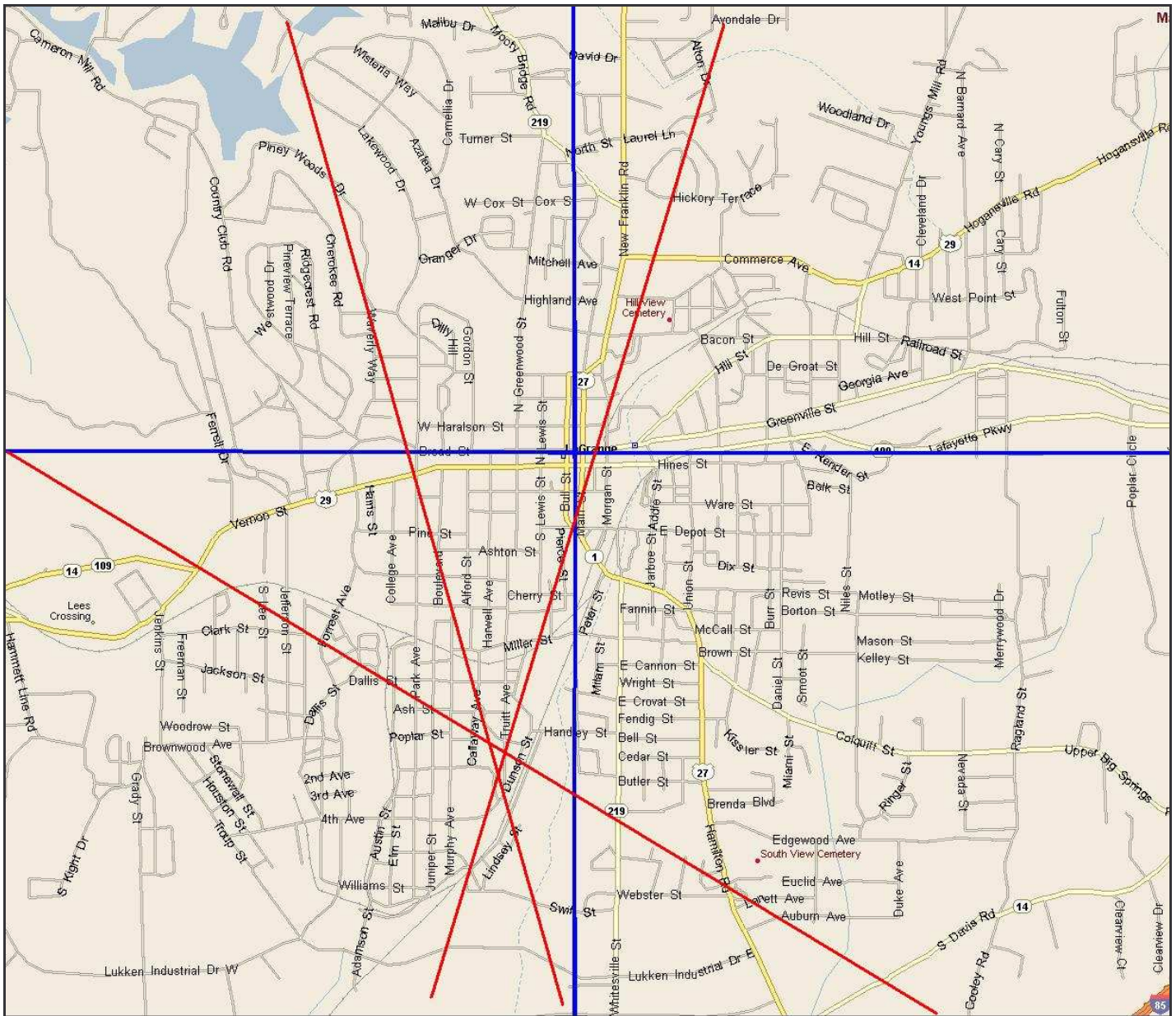


Figure 6 - Team 3's Plot of 207 Degrees From Mountville Mills

- This is net control to all stations, we are now moving the search area to the vicinity of the Callaway Monument. Repeat, search area is now in the vicinity of the Callaway Monument. All stations be in route to that general area while I zoom the map around that location. Station 4, since you are already there, move to the intersection of Fourth Avenue and Murphy Avenue – Fourth Avenue and Murphy Avenue and take a reading if possible, you copy?
- Team 4 copies – intersection of Fourth and Murphy. Team 4 clear.

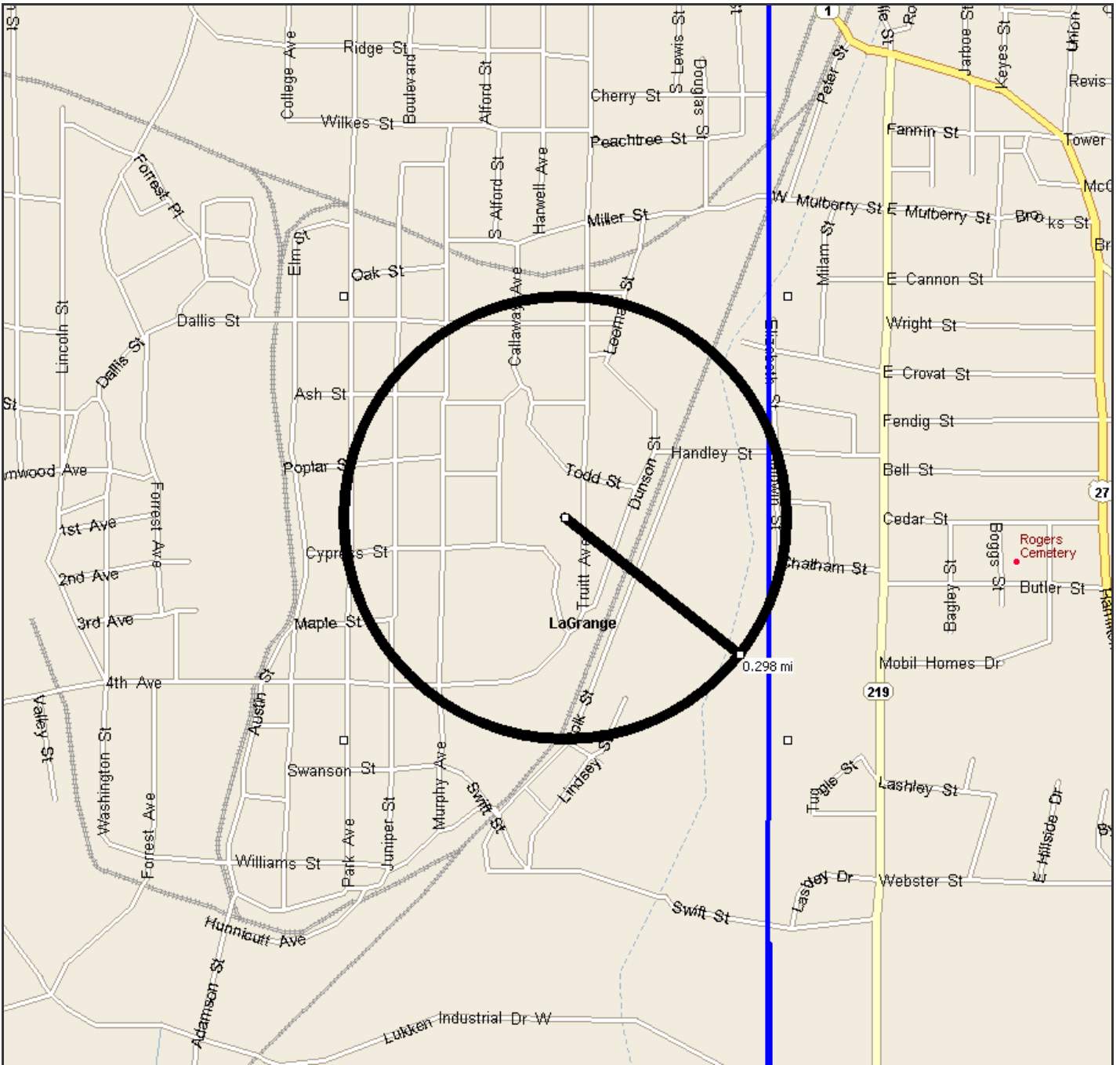


Figure 7 - 3/10 Mile Radius Around Triangulation Area

- Team 1, net control
- This is Team 1
- We need you to proceed to the intersection of Callaway Avenue and Dallis Street. Callaway and Dallis. This is three blocks North of the Callaway Monument.
- Roger, Callaway and Dallis. Team 1 Clear.



- Team 2, net control.
- This is Team 2.
- Your new location will be Handley and Dunson. Handley and Dunson – this is one block to the Northeast of the Callaway Monument.
- Okay. I'll let you know when I arrive. Team 2 clear.
- Net control clear.
- Net control Team 4.
- Go ahead Team 4.
- Here at the intersection of Fourth and Murphy, I have a reading of about 65 degrees. You copy?
- I copy 65 degrees from Fourth and Murphy. All teams standby.

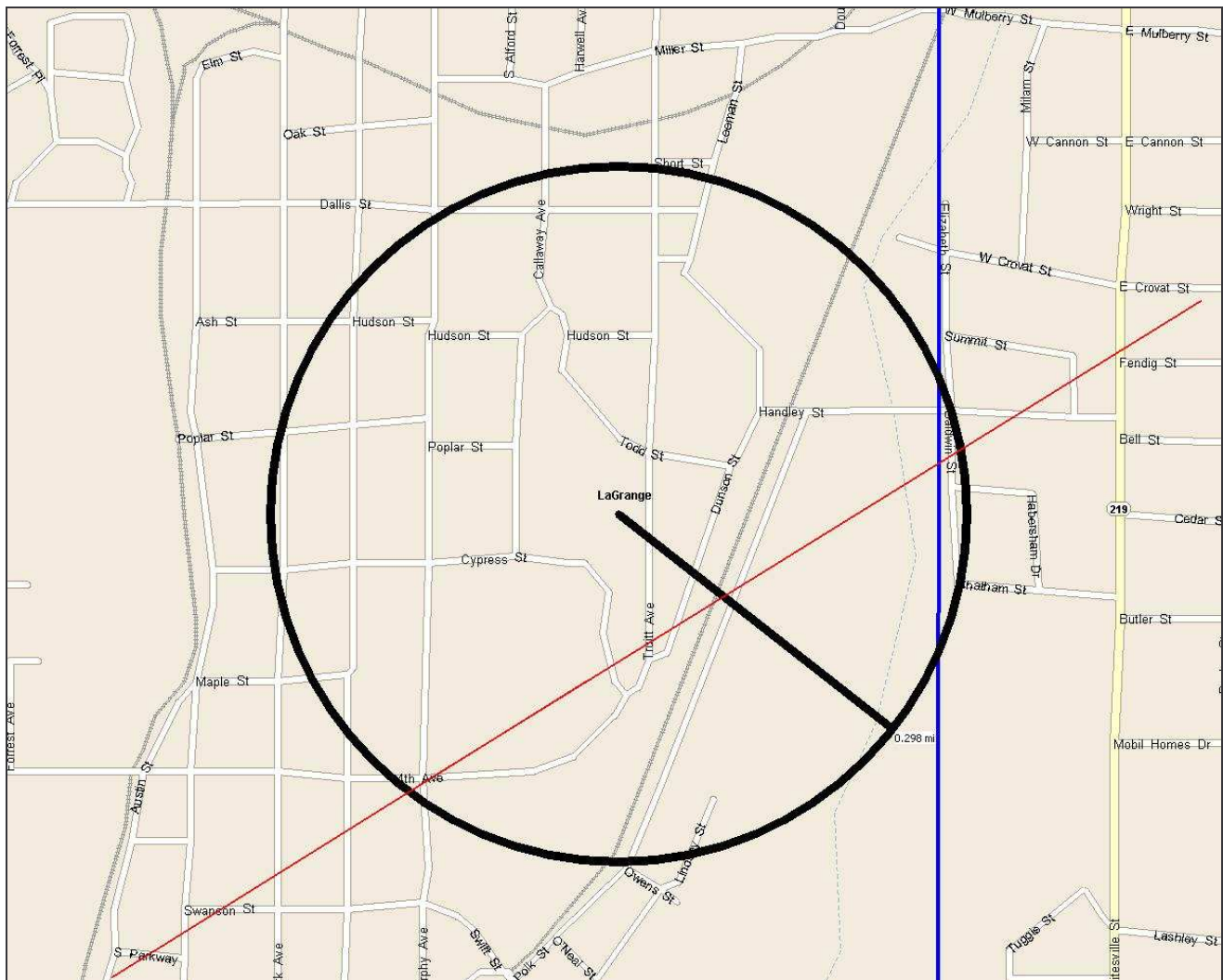
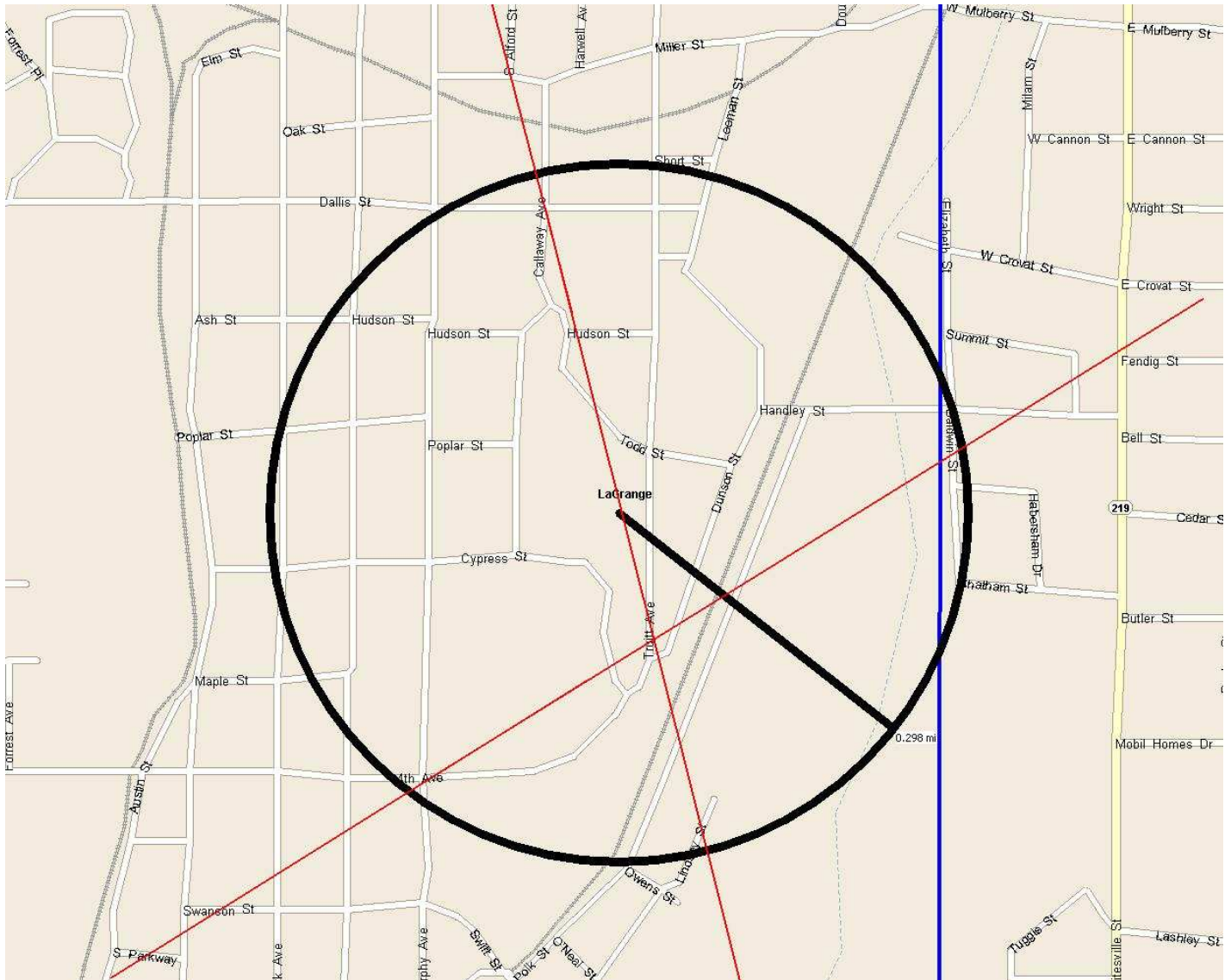


Figure 8 - Plot of Team 4's Second RF Reading

- Team 4, net control, your information has been recorded. Net control is clear for traffic.
- Net control, this is Team 1.



- Go ahead Team 1.
- We're at Callaway and Dallis and we have a reading of 160 degrees.
- Roger, 160 degrees from Callaway and Dallis. All stations standby.



**Figure 9 - Team 1's Second Reading**

- This is net control. It appears that the signals are converging in the area directly East, possibly Southeast of the Callaway Monument around the Fourth Avenue and Truitt intersection area. At this time, I am going to ask Team 4 to report to that intersection. Team 2, if you will continue to Handley and Dunson for your reading, that will give us a confirmation. Team 4, do you copy?
- Team 4 copies.
- Team 2, do you copy?
- Team 2 copies.

- Team 3, have you arrived in the general vicinity of the Callaway Monument?
- This is Team 3, We're about a mile out or so.
- Okay, if you would, go to the intersection of Cypress and Fourth Avenue and take a reading please.
- Roger, Fourth and Cypress. Team 3 clear.
- Team 3, if you would, when you get to your location, report back to net control a general description of the area regarding residential and public buildings - anything that will help us create a narrower search field.
- Will do. Team 3 clear.
- Thanks Team 3. Net control is clear for traffic.
- Net control, this is Team 2.
- Go ahead Team 2.
- Roger, I am here at Handley and Dunson with a signal bearing 192 degrees.
- Okay Team 2, I copy 192 degrees at Handley and Dunson, is that correct?
- That's affirmative.
- All stations standby.
- Team 2 clear.



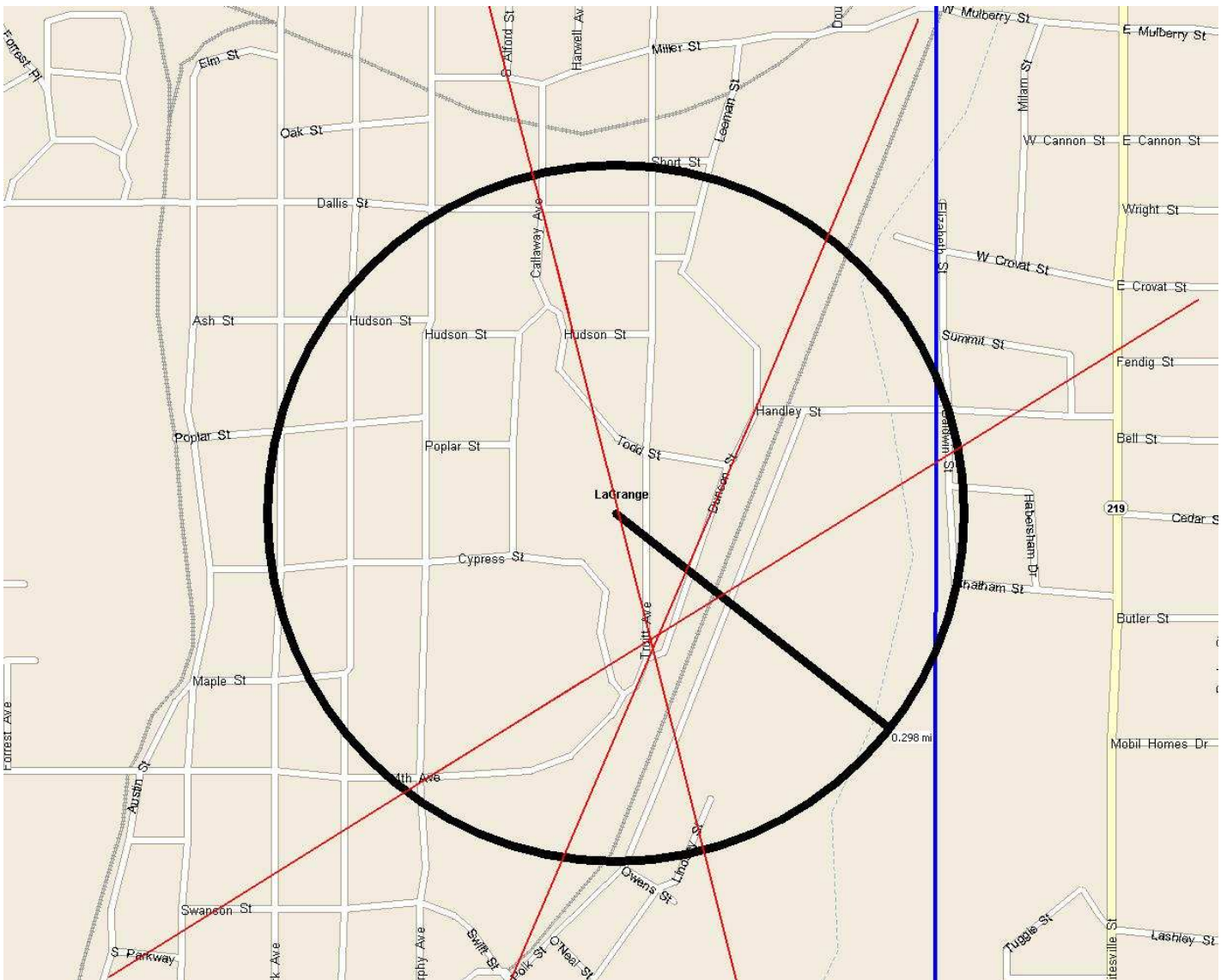


Figure 10 – Team 2’s Third Reading

- Net control is now clear for traffic
- Net control from Team 3
- Team 3 go.
- I don’t have a reading yet but I have a general description of the area when you are ready.
- Okay, I am ready to copy.
- The area is mostly residential with 5 or 6 houses on Truitt Avenue. The Callaway monument is here with an open, grassy area with no one visible on the property. Callaway Park Church of God is also here in the area.
- Thanks Team 3. The triangulation pattern doesn’t indicate that the source is from the Callaway Monument but more over closer to the intersections of Fourth, Cypress, Truitt, and Dunson. Why don’t you take a quick look around that area, be sure to check all parking lots of the church and any other public locations there.

- Okay, will do. Team 3 clear.
- Thanks Team 3. Teams 1, 2, and 4, will you converge to the area of the intersection of Fourth, Cypress, Truitt, and Dunson and do a quick visual search.
- Team 1 copies
- Team 2 copies
- Team 4 is on the way.
- Contact
- Go ahead contact
- This is Team 3. I have visual contact with the source in the back parking lot of Callaway Park Church of God, repeat visual contact.
- Excellent Team 3. Standby and we'll dispatch the proper authorities to that location. Do not approach any further but keep visual contact. Good work.
- This is net control, the source has been found and we are now closing this session of The LaGrange Amateur Radio Club's Coordinated Foxhunt. Everyone did a great job and we had excellent results. This is net control clear.

