Ground Penetrating Radar Survey Report:

Montgomery Botanical Center
Miami, Florida
March 2003

Report Updated and Revised July, 2003

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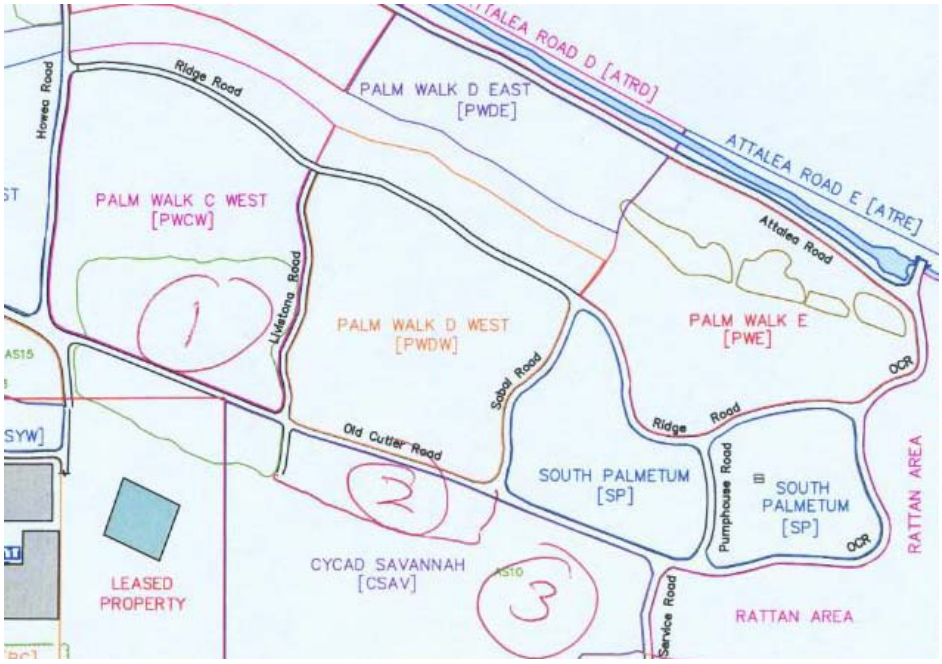
Introduction

Mnemotrix Systems, Inc. was asked to provide a preliminary GPR Survey at the Montgomery Botanical Center in a specified area of critical interest, where as much information as possible is desired for the purpose of providing an ideal habitat for palms and cycads. It was indicated to the survey team that among other things, locating a natural sinkhole in one of a few specified locations would be of interest towards the purpose of creating a grotto area for vertically growing cycads.

Three priority Project Areas on the premises were proposed as target projects. These Project Areas are marked as such on the following section of the Montgomery Botanical Center map and are shown in *Figure 1* below as Project Areas 1, 2, and 3. Project Area 3 is the one which was chosen for this preliminary survey.

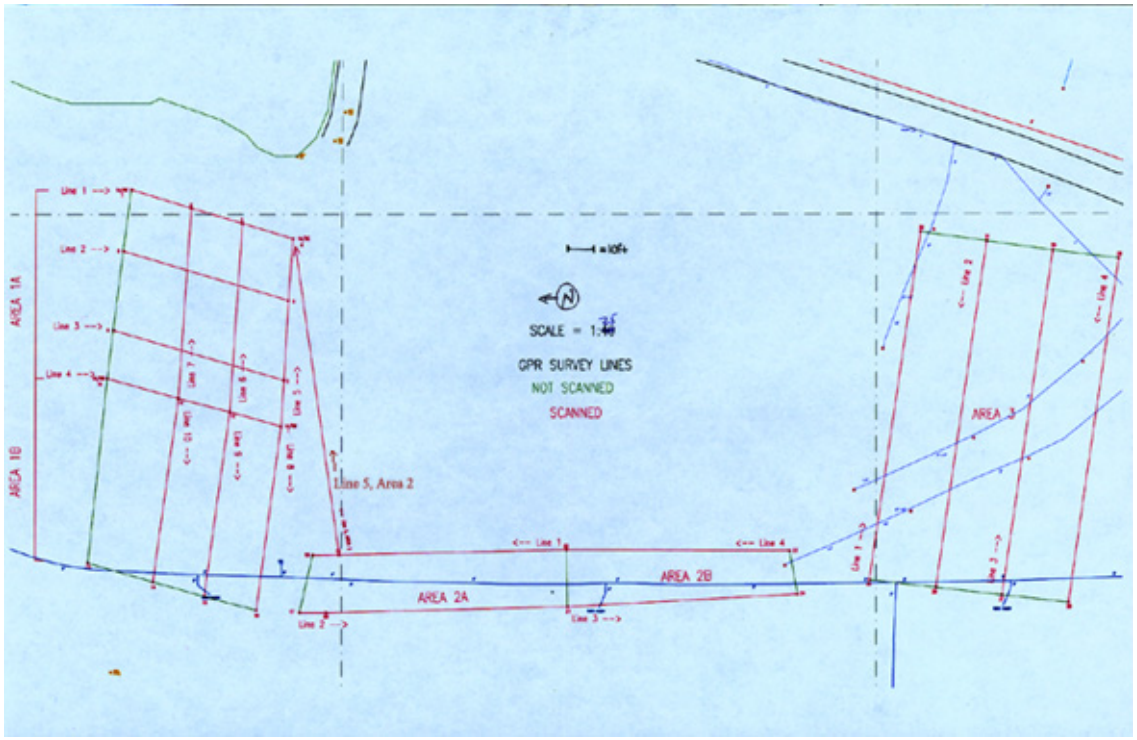
Figure 1: **Map of Project Areas 1, 2, and 3.**



Project Area 3, as marked on the figure above, was stated to be third priority; however, since it was the most accessible of these three areas, it was chosen for this initial pilot project. It was agreed that doing a GPR survey on Project Area 3 would allow for a more accurate estimation of effort for future projects through familiarity with the terrain and creation of instrument calibration and profiles, as well as securing the information about the chosen area itself.

Having decided to approach Project Area 3, we divided it into three more approachable subsections. The contiguous subsections shown as Areas 1A and 1B, Areas 2A and 2B, and Area 3, were marked out for surveying. On March 10th and 11th, 2003, an onsite GPR survey of these contiguous areas, as shown in Figure 2 below, was completed.

Figure 2: **Survey map of all lines acquired in Project Area 3.**



As this comprises a very large area and no previous subsurface data existed to this point, it was decided that broad spot checking of survey lines across the breadth of all areas would be done rather than to attempt a detailed grid of the entire area. 3D clusters of portions of these areas were created, as will be shown in this report.

Equipment and Profiles Used in GPR Survey

A SIR-2000 (Subsurface Interface Radar) system was used with a 200 MHz antenna. Geophysical Survey Systems, Inc. (GSSI) manufactured the system, antenna, and survey wheel used. A 200 MHz shallow profile was used where the target window was 150 nanoseconds, with a target depth of approximately 25-30 feet.

Using velocity analysis, a standard post-processing procedure, we were able to calculate accurate depths and dimensions for features of interest after the survey was completed. These depth notations can be seen on the figures shown in this report.

Actions Taken for the GPR Survey

Survey data was acquired in each of the following subsections in the directions shown.

1. Area 1A: N-S – *See Figure 3*.
2. Area 1A: W-E – *See Figure 4*.
3. Area 1B: E-W – *See Figure 5*.
4. Area 2A: S-N/N-S – *See Figure 6*.
5. Area 2B: N-S/S-N – *See Figure 7*.
6. Area 3: E-W – *See Figure 8*.

Post-Processing and Analysis of the GPR Survey

The figures below show vertical profiles of each sector surveyed. As will be shown, features of interest were found chiefly in Area 1 and possibly in Area 2, while Area 3 was relatively homogenous and not of particular interest to the goals of this project. Irrigation pipes can be seen most clearly in *Figure 5*.

Figure 3: **Area 1A, North-South survey lines. (See *Figure 10* for more detail on possible sinkhole in this subsection.)**

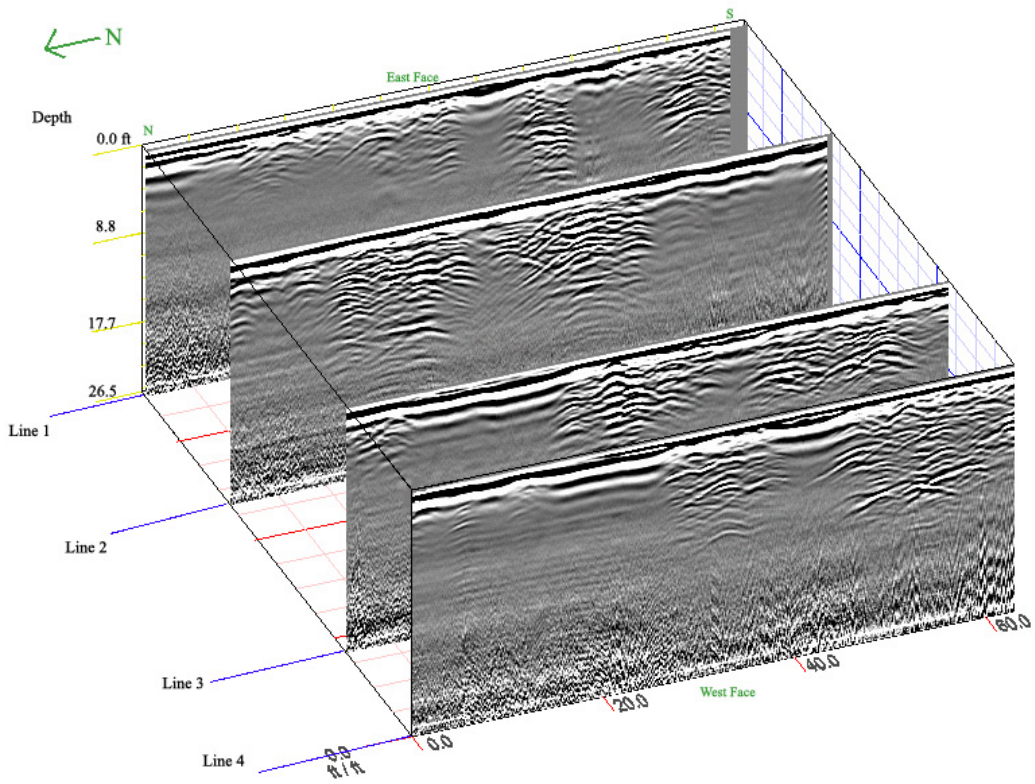


Figure 4: **Area 1A, West-East survey lines**

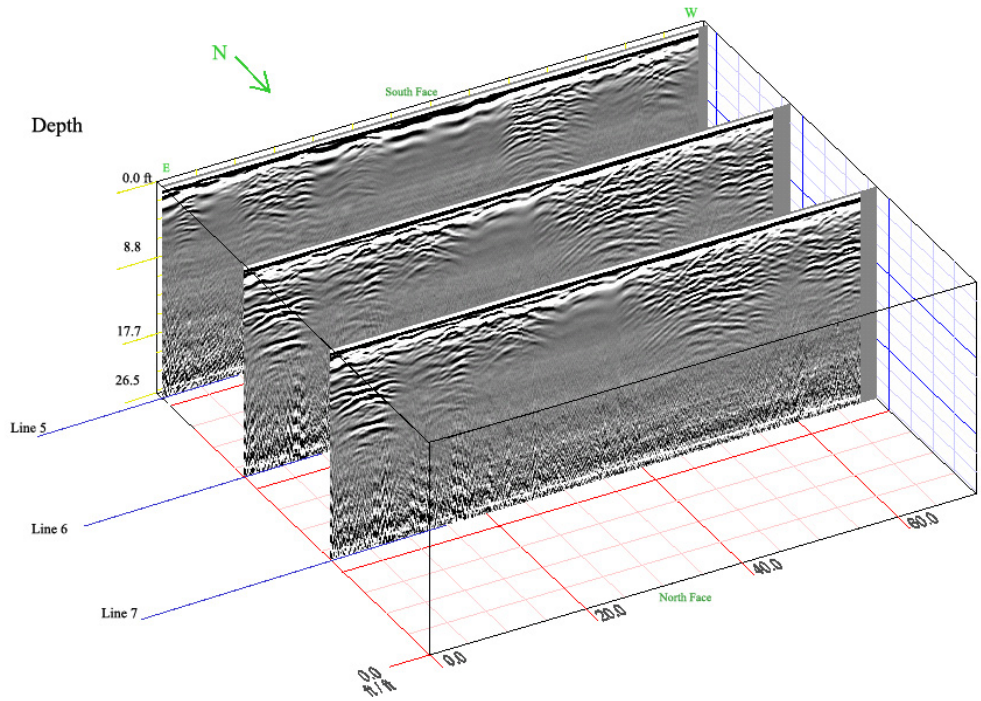


Figure 5: **Area 1B, East-West survey lines. Irrigation pipes are seen as arcs at top right of each line.**

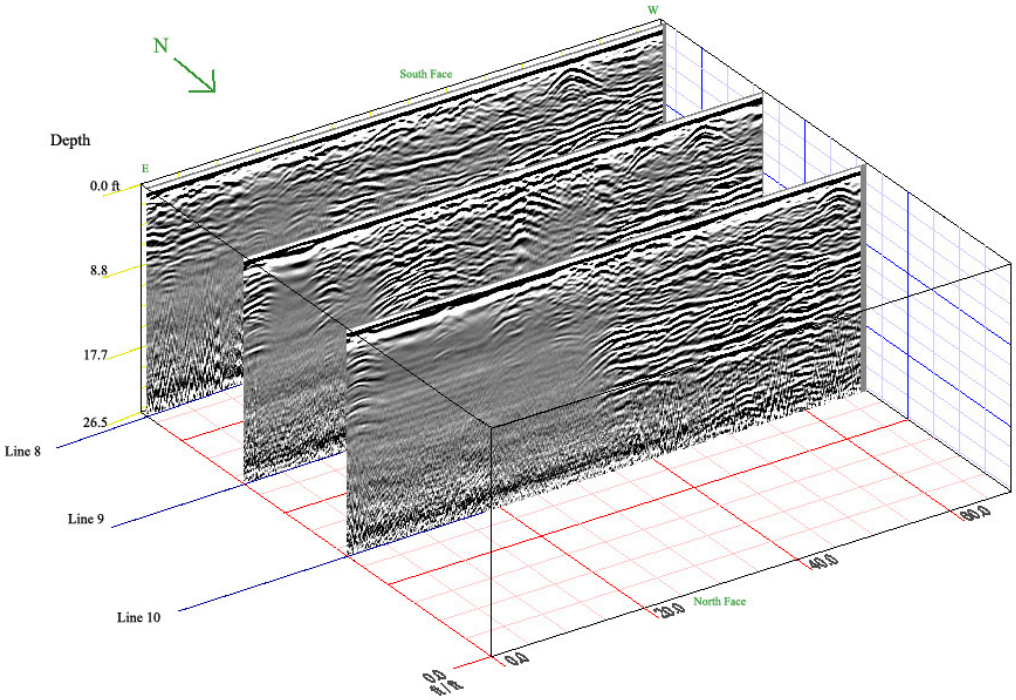


Figure 6: **Area 2A, South-North/North-South survey lines**.

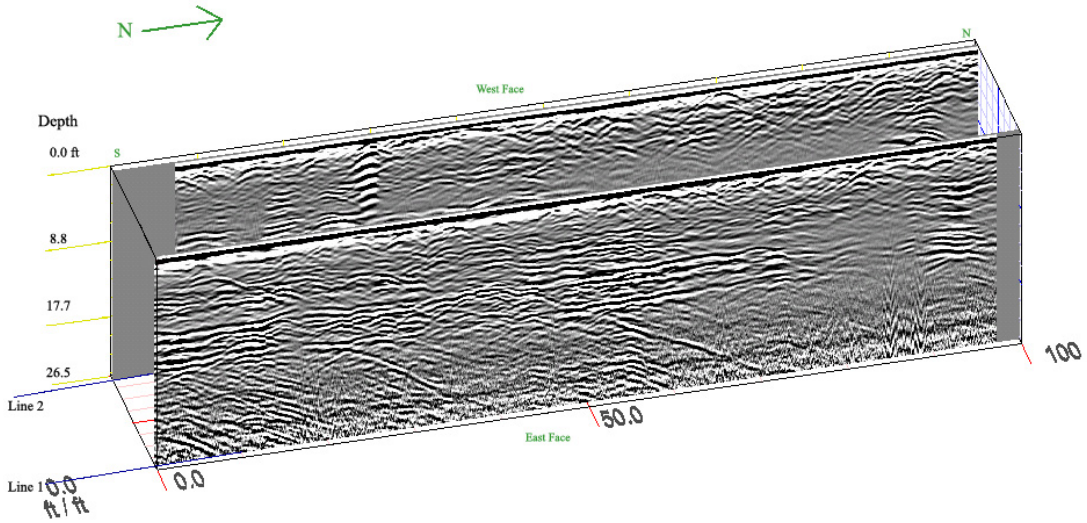


Figure 7: **Area 2B, North-South/South-North survey lines**

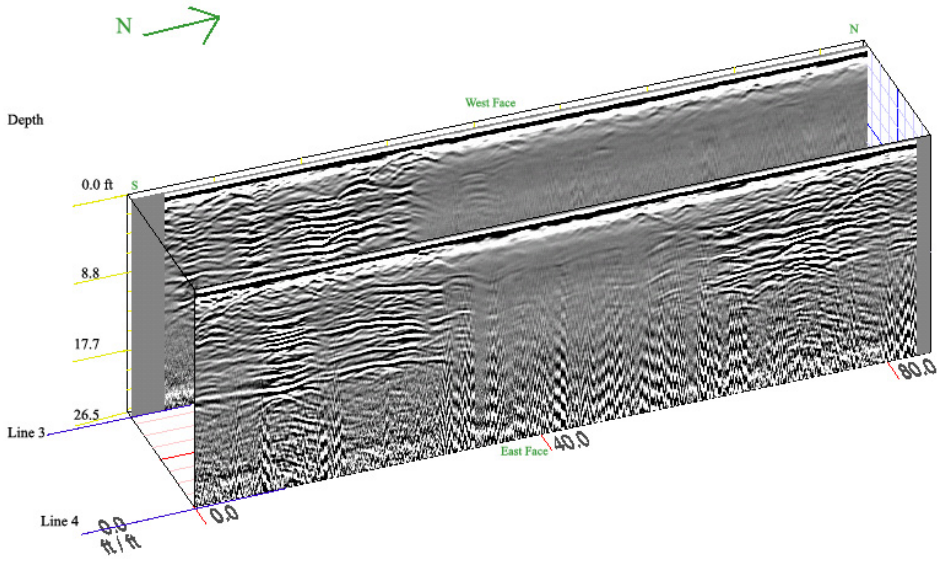
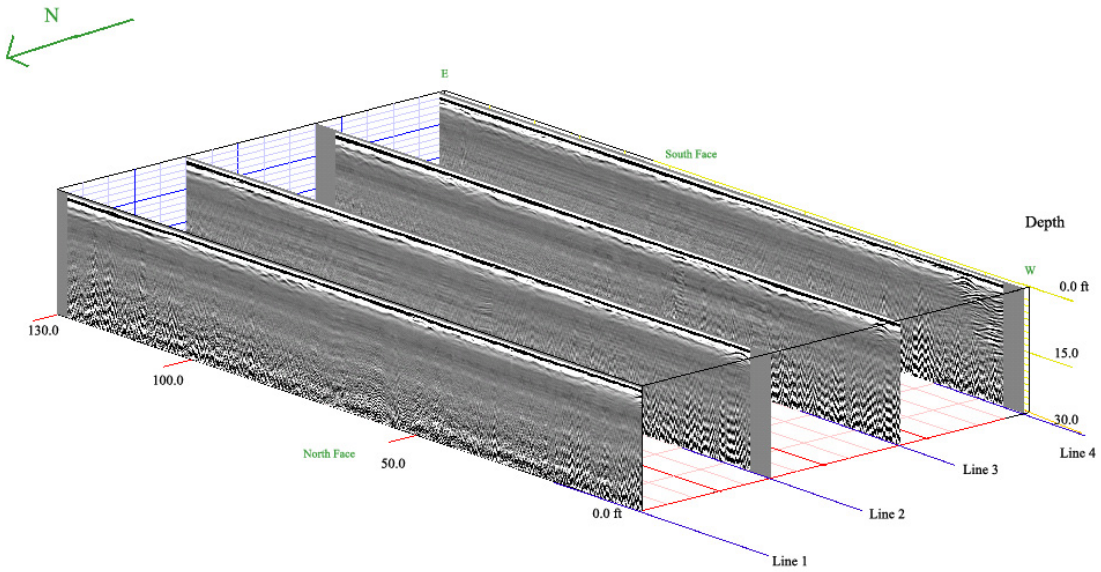


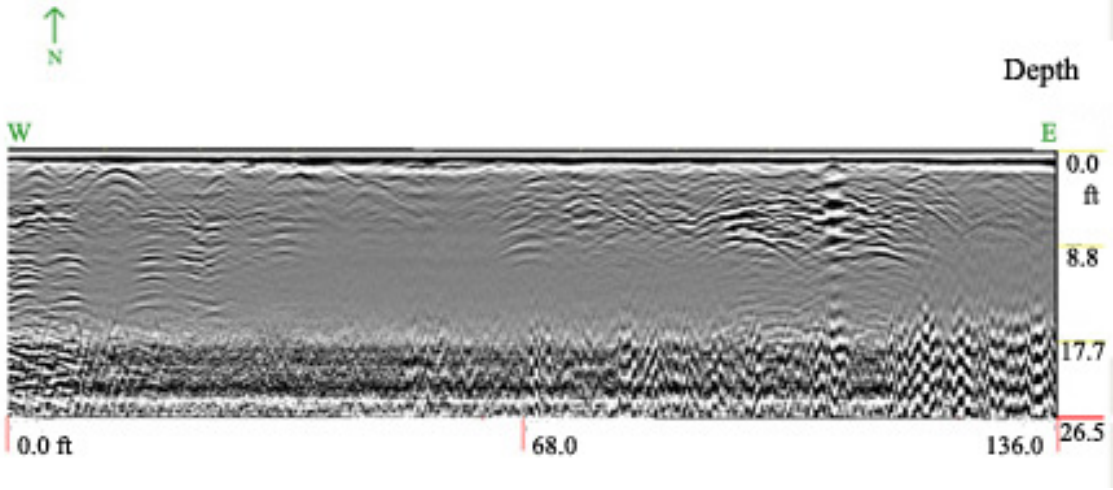
Figure 8: **Area 3, East-West survey lines. Irrigation pipes are seen in the upper-right corner of each line.**



Exploratory Test Line

Having seen areas of possible interest in Areas 1 and 2, an additional Test Line was done across these areas, reaching from Area 2A and continuing along the southern borders of Areas 1B and 1A. This was marked on the *Figure 2* Survey Map as Line 5 in Area 2. A 3D profile of this survey line is shown below in *Figure 9.*

Figure 9: **West-East survey line from Area 2 to Area 1. Test Line over possible areas of interest. The western end begins on the edge of Area 2A.**



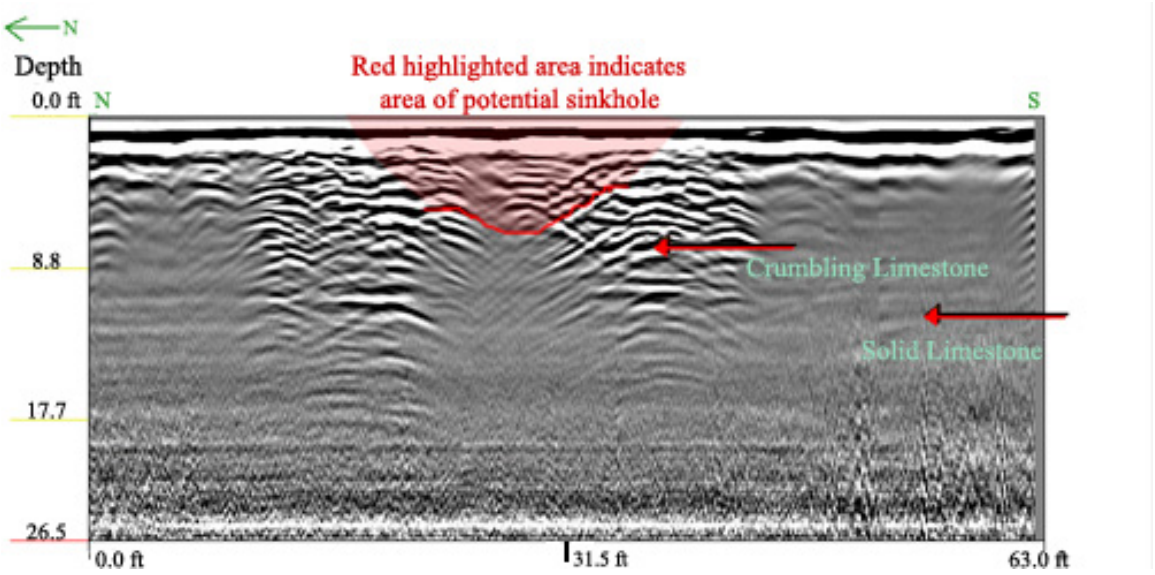
Further Discussion

We believe that the subsurface areas of the surveyed regions are likely to be mostly limestone and sand based on a limited surface examination from a dug trench. The very top layer looks to be grass and soil, followed by a thin layer of sand, which sits on limestone. There are large areas seen in the data that appear to be solid limestone, and some areas which appear to be crumbling limestone, which is evidence of sinkholes and other karst topography. As is amply defined elsewhere, karst topography is a broad term for the phenomena resulting from limestone being dissolved over time by acidic groundwater.

Upon close inspection of the regions of Area 1 which contained what we believe to be crumbling limestone, we found at least one clear depression which could very likely be a sinkhole. According to the dimensions on our scan, the possible sinkhole looks to be

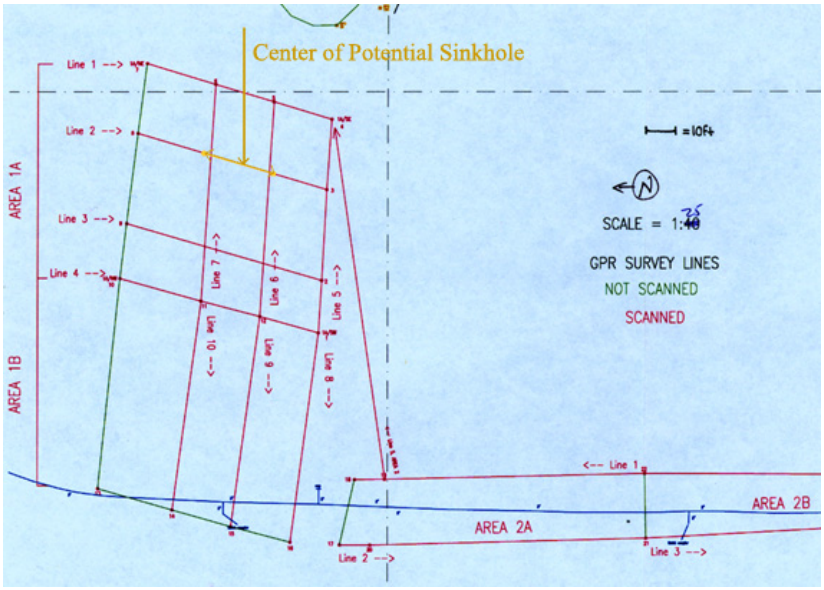
about 25 feet in diameter, extending to ~7.5 feet below the surface. It appears to begin about 1-2 feet below the surface, so should not be difficult to excavate for confirmation. This is illustrated in *Figure 10* below.

Figure 10: **Enlarged View of Possible Sinkhole Area as found in Area 1A (Line 2 of the North-South survey lines).**



The scan in which we see the depression is located 47 feet east of the western boundary of Area 1, where markers were left (Line 2 of Area 1A as marked on *Figure 2* of this report). The northern boundary of the depression which we believe may be a sinkhole is ~19 feet from the 0.0 ft distance marker, while the southern boundary is ~37 feet from the same point, with the center located at ~28.5 feet. The exact location would have to be confirmed on further inspection of this specific area.

Figure 11: **Approximate location of potential sinkhole.**



Area 2 (specifically 2B) shows some indications of similarly crumbling limestone which could indicate the formation of shallower minor sinkholes. Further GPR investigation would be required to confirm this postulate. Even so, any such features do not appear to be as prominent as what we are seeing in Area 1.

Area 3 was relatively homogenous, where we could see indications of the irrigation system only. No features of geologic interest were shown in this cursory study.

Conclusions and Recommendations

If the location and dimensions of the potential sinkhole we have identified are of adequate proportion to satisfy the Botanical Center's requirements, we would definitely recommend further investigation of this area. If it would be desirable to minimize any invasive disruption of property, we can come in and survey the identified area more intensively in order to locate the most precise point in which to excavate, and to determine the appropriateness of this feature for your needs.

It is our understanding that the areas discussed in this report comprise only a third priority to Montgomery Botanical Center. Therefore, we cannot say that the evidence of this potential sinkhole is necessarily the most pronounced that exists on Montgomery's property. In that regard, similar GPR surveys can be undertaken in the other two higher priority Project Areas to ascertain whether or not there might be another area which fits your desired specifications.

Disclaimer

The information and conclusions presented in this report represent the best efforts on behalf of Mnemotrix Systems, Inc. based on data and equipment available at this time. We make no warranty or representations concerning our recommendations and assume no liability for effects resulting from these conclusions.

Some Descriptive Photos from Survey

In the photo below, survey Area 3 is in the distance, while survey Area 2 is in the foreground. Area 1 is to the left, containing the potential sinkhole area.

The photos below show Mnemotrix Survey Team operating the GPR equipment onsite at Montgomery Botanical Center, March, 2003. Montgomery staff assist.