# Three types of remote sensing and their utility for identifying unmarked graves in historic cemeteries

Three types of remote sensing are typically used to try to find unmarked graves in cemeteries and suspected cemetery locations: ground-penetrating radar, gradiometery, and resistivity. Choosing the best method for a project requires consideration of the ground conditions at the particular location. A combination of methods is likely to yield the most reliable result, though this will be considerably more expensive than relying on a single survey type. Older graves can be more difficult to detect than more recent burials.

When making the decision to arrange for such work to be done, it should be understood that none of these remote sensing methods actually finds graves or human remains. Each of these methods identifies specific underground locations that are different from the surrounding soil. These individual locations are often referred to as “anomalies” or “targets.” When a remote-sensing device operator finds several of these “anomalies” in a row, at a consistent depth, in a known or suspected cemetery, these locations are considered potential graves. There is no way to be certain whether or not potential graves are truly graves without performing some type of ground-truthing work. Ground-truthing can involve anything from soil coring or shallow trenching to look for the tops of grave shafts to full excavation of burials. **No ground-truthing work of this type can be performed at the location of a known or suspected burial ground without the permission of the Iowa Office of the State Archaeologist (for graves believed to be greater than 150 years old) or the Iowa Department of Public Health (for graves less than 150 years old).**

## GROUND-PENETRATING RADAR (GPR)

### About

The equipment used in GPR surveys transmits high-frequency radar pulses from a surface antenna into the ground. The machine collects measurements of the time that passes between the emission of the radar pulse and its return to a receiver device. Differences in the time measurements can indicate variation in the density of the materials below ground. The reflection of the radar pulse off a buried object (like a coffin) or looser soil (as at the bottom of a grave shaft), for instance, will be different from the signal reflected to the receiver from the normal, undisturbed soil around it. Devices used for cemetery surveys can usually penetrate between two and four meters (6.5 to 13 feet) into the ground.

GPR surveys are conducted by pulling the radar emitting device across the ground along regularly spaced lines, forming a grid. The receiver stores all the collected time measurement data for later processing. An operator may be able to point out a few noticeable variations in the data while in the field, but usually results are not immediately available. Mathematical processing is necessary to interpret the results, identify anomalies, and determine their depths. Some operators will produce a final report showing potential graves overlying a map or aerial photograph of the cemetery area. When results are less definitive, the report may only show the computer map of signals within the survey grid.

### Pros

GPR is the type of remote sensing most commonly used for the detection of potential graves in historic cemeteries. In ideal soil conditions, potential graves can be clearly identified.

**Cons**
The effectiveness of GPR for cemetery survey depends on a number of conditions. In areas with dense clay, stony soil, or waterlogged soils, GPR can be ineffective. Areas with heavy brushy vegetation or dense tree growth are difficult to survey because of the inability to establish straight grid lines or to position the device antenna at the ground surface. In situations like this, vegetation must first be cleared before survey.

## MAGNETIC GRADIOMETER SURVEY

**About**
A magnetic gradiometer works by measuring variation in the earth's natural magnetic field. Metal objects, soils with greater magnetism (which can be induced by human activity), and soils with negative magnetism (where higher magnetism topsoil has been removed or mixed with lower magnetism subsoil) can all be detected using a gradiometer. The magnetic readings of coffin hardware and grave shafts, then, can help to identify possible burials. Gradiometer data are collected by walking straight transects across an area with a handheld device held above the ground surface. As with GPR, the data are processed after field collection to interpret the results. Results shown in gradiometer survey maps may or may not be obvious to non-professionals. Operators will usually add illustrations to a report to clarify the results.

**Pros**
Since it is recording measurements that exist around it, rather than emitting a signal that must penetrate the ground, a gradiometer can be used in clay or stony soils, frozen ground, or saturated soils that would hamper GPR surveys. Of the three survey types discussed here, gradiometery allows for the most rapid data collection.

**Cons**
Iron-containing metal objects on or near the surface interfere with readings, making data collection difficult near metal fence lines or in areas with buried utilities or substantial amounts of historic or modern trash. Large obelisk and pedestal-style grave markers often contain iron supports, which can also cause interference. In order to perform gradiometer survey, an area must be reasonably cleared of vegetation to allow for the establishment of straight transects.

## ELECTRICAL RESISTIVITY

**About**
This technique uses electricity from a battery, which is sent into the ground through pairs of electrodes. The electrical signal transmitted between the electrodes is recorded by a resistivity meter. This type of survey identifies changes below the ground based on resistance that is higher or lower than that of the natural, undisturbed ground. Metal coffin hardware, for instance, will show as a low resistance signal, since metal conducts electricity. Grave shafts and other disturbed areas may appear as areas of higher or lower resistivity. Electrodes are spaced fairly close together when searching for graves, which allows for greater clarity of results.

This type of survey collects data in the form of two-dimensional vertical “views.” The recorded readings can be processed in the lab to create a standard map or a three-dimensional representation of possible graves in the survey area.

**Pros**

This method is effective in clay soils that cannot be surveyed using GPR. Under ideal conditions, resistivity produces very clear results.

**Cons**

Like the other survey methods, electrical resistivity requires an area to be relatively free of vegetation so that straight survey transects can be established. Resistivity is a more time-consuming survey method because the operator must insert the electrodes at specific intervals, rather than walking transects at a steady pace. Because electrical resistivity often detects disturbances based on the presence of greater or lesser soil moisture, this method would not be effective in waterlogged soils. During survey, the electrodes must be pushed into the ground surface, so this method cannot be used to detect graves below asphalt, concrete, or thick gravel.