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This document has been created to provide a broad overview of Ground Penetrating Radar for communities searching for children who never came home from Indian Residential Schools. It is intended to help inform communities about the technology, and provide some resources for training and support within Alberta. This document discusses ground-based remote-sensing techniques, and does not include drone-mounted (aerial) GPR. This is a living document and will be updated as new information becomes available.

What is Ground Penetrating Radar?

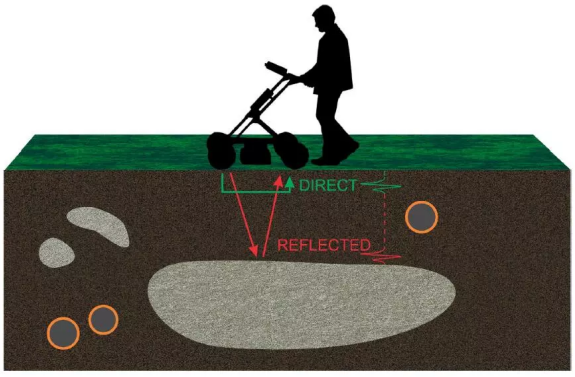
Ground Penetrating Radar (GPR) is a geophysical method that **uses radar pulses** to image underneath the surface of the ground. It is a **non-disruptive** method of surveying the ground and is commonly used to look for utilities or pipelines.

A GPR system is made up of three main components:

- Control unit
- Antenna
- Power Supply

How Does it Work?

GPR works by sending **high-frequency radio waves** into the ground in short bursts. A series of bursts over a single area make up what is called a **scan**. When the energy emitted by the GPR encounters a buried object or a boundary between different materials, the signal gets reflected to the surface. A receiving antenna then records the variations in strength and the time required for the signal to return. When interpreting GPR data, a technician will ‘read’ these variations in the return signal and interpret them to determine if there is anything of interest in an area.



Data is collected in parallel lines in a **grid layout** using tapes and ropes to guide the operator and to ensure the entire area is covered. Ground-based GPR units are dragged or pushed along the ground,

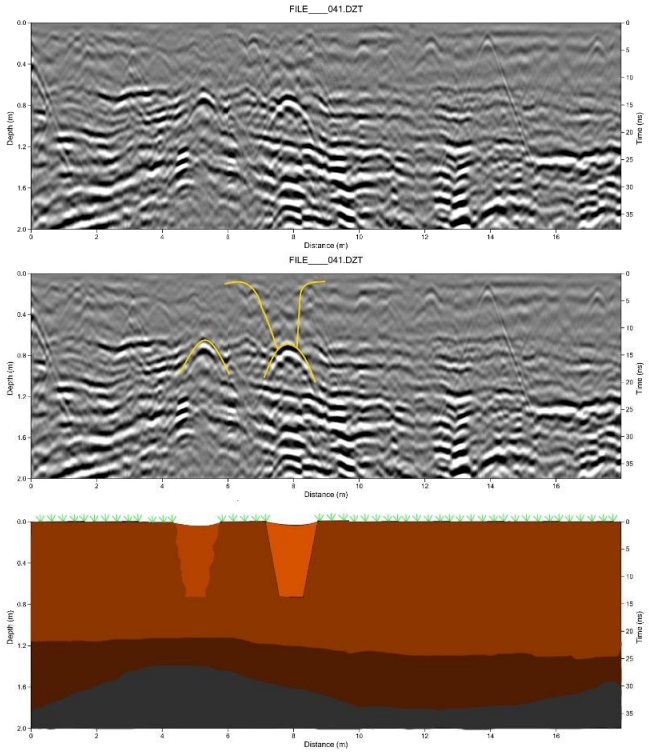
much like you would mow a lawn. The areas need to be relatively clear of obstacles, including grass and trees, for the survey to be effective. The data is then put into a specialized software program for computer processing. The computer then produces a horizontal surface at a particular depth in the record, called a **depth slice**, which allows operators to interpret a planview of the survey area.

Where Does It Work?

There are some conditions where GPR does not work well. If the soil is **waterlogged** or there is **not enough difference** in the soil composition, GPR may not work as well as it could. Fortunately, **there are many other techniques** that have also had success in identifying unmarked graves. While one approach may be enough, the best results are often achieved when multiple techniques are used together. The Institute of Prairie and Indigenous Archaeology (IPIA) can help establish which approach is best suited for a particular area.

What Does It See?

GPR scans look like wiggly lines as pictured here. These wiggly lines are the variations in the radar signal that the GPR sends into the ground. A technician then reviews the data after it has been processed in specialized software and looks for anomalies in the pattern, like the second photo. If the anomalies in an area are consistent with what a grave shaft is expected to look like (in terms of depth, width, and length), there is a high probability that the area contains unmarked graves, and can be modelled like the third photo.



Who Can Do A Scan?

Most remote sensing companies work in industry, identifying utilities or surveying buildings and highways. However, the application of GPR to cemeteries is uncommon and **requires specific training**. It is usually conducted by archaeologists or forensic scientists. The identification of graves requires specific data collection methods and interpretive knowledge. We recommend that communities consider developing their own remote sensing teams with the support of local archaeologists or technical experts to do the work of locating unmarked graves.

Some companies in Alberta are actively engaging with archaeologists and forensic scientists to train their staff in applying GPR to unmarked grave contexts. However, other companies may wish to take advantage of communities by offering these services, despite not having appropriate training. **Please exercise extreme caution when choosing a private company to locate unmarked graves.** Ensure

that the company and team have the appropriate training, and are following the recommended guidelines at all times.

How Long Does It Take?

A GPR survey can take anywhere from 1 day to 3 months to conduct. It is always dependent on how much ground there is to cover. On a good day, most teams will be able to cover 0.25 acre, or 1000 sq. ft. We recommend choosing specific places on a landscape based on Survivor testimony and archival research to investigate with GPR to increase the chances of locating unmarked graves. Often, communities will choose to conduct a GPR survey in a Phased approach, starting with a few small areas, and then conducting larger subsequent surveys as desired.

A GPR survey can only be done when there is no snow on the ground. That means that a survey can only be done **between late March and late October** in any given year. Because vegetation should be cleared prior to GPR work, early Spring or late Fall are ideal times to do this work.

How Much Does It Cost?

The cost of a GPR survey **varies widely**, and is highly dependent on who is conducting the work, and how much ground there is to cover. It takes a minimum of four people to work with one GPR unit. At least one member of the four needs to be trained in GPR work for unmarked graves and have sufficient experience to lead the team. You could expect costs to range from $3,000-$5,000 per day of work to cover expenses and compensation, but this is highly dependent on the rates of any given company.

Often **costs can be reduced** by partnering with public institutions, recruiting volunteers, in-kind donations, federal or provincial funding, or conducting the work internally (training membership on GPR for unmarked graves). Some public institutions (like the IPIA) can help cover some costs of a survey for communities who do not have access to funding, or have limited budgets. Some companies may also provide this service for free to communities, though caution is recommended, as free services may not be the same quality as paid services.

If you want work done quickly, a private company will be able to conduct surveys on relatively short notice, but often will cost much more than a public institution. Similarly, public institutions (like the IPIA) are limited in how much resources they have to support communities. If you partner with a public institution, the process will be slower than a private company. **Good work done quickly is expensive. Good work done cheaply is slow.**

Frequently Asked Questions

Can GPR see bones?

- No, GPR is not an X-Ray and will not be able to see bones underneath the surface of the ground. It only sees the outline of a pit or grave shaft that was dug. Sometimes, it can also pick up the outline of a coffin.

Do I need to do a geophysical survey?

- No. As the Truth and Reconciliation Commission reported in 2015, and as all survivors and their families know, there are many missing children located across the country at former Indian Residential Schools and in other school contexts. There are also missing loved ones who were sent away for medical treatment and never returned. Geophysical survey is only necessary should Indigenous communities wish to better identify the locations and distribution of unmarked graves to either protect and memorialize these areas or to conduct further investigations.

Do I need a permit or permission to conduct geophysical work?

- Currently, in Alberta, no permit is required to conduct geophysical work when searching for unmarked graves. There may be land access permissions or other permissions required when conducting the work on privately owned lands, so always check with your local government and land owners.

Are there any risks with this type of work?

- There are no physical risks to the graves or the individuals conducting the survey. The main risk is the potential for triggering and re-traumatizing community members, so it is extremely important that appropriate mental health supports are in place prior to work commencing.

Will GPR always work?

- No. Sometimes, the results of a GPR survey can be confusing, or provide no answers. This does not necessarily mean there are no unmarked graves in an area, but could mean that the technique just wasn't successful at finding the unmarked graves. In this case, other techniques could be used to reinvestigate the area, which may have better results.

If the GPR survey indicates that there may be grave shafts in an area, does that mean there is a grave there?

- There is no way to determine the presence or absence of graves with 100% certainty when using GPR. Good researchers will assign different levels of confidence to the survey results in much the same way as a weather forecaster predicts the likelihood of rain. The only way to be 100% certain that there are unmarked graves in an area is to excavate, which some communities may prefer not to do.

Who owns the data?

- A GPR survey creates a large amount of data. Communities should always consider entering into **data agreements** with anyone who does GPR work to ensure that the community has control over if, when, and how the data is shared and stored.