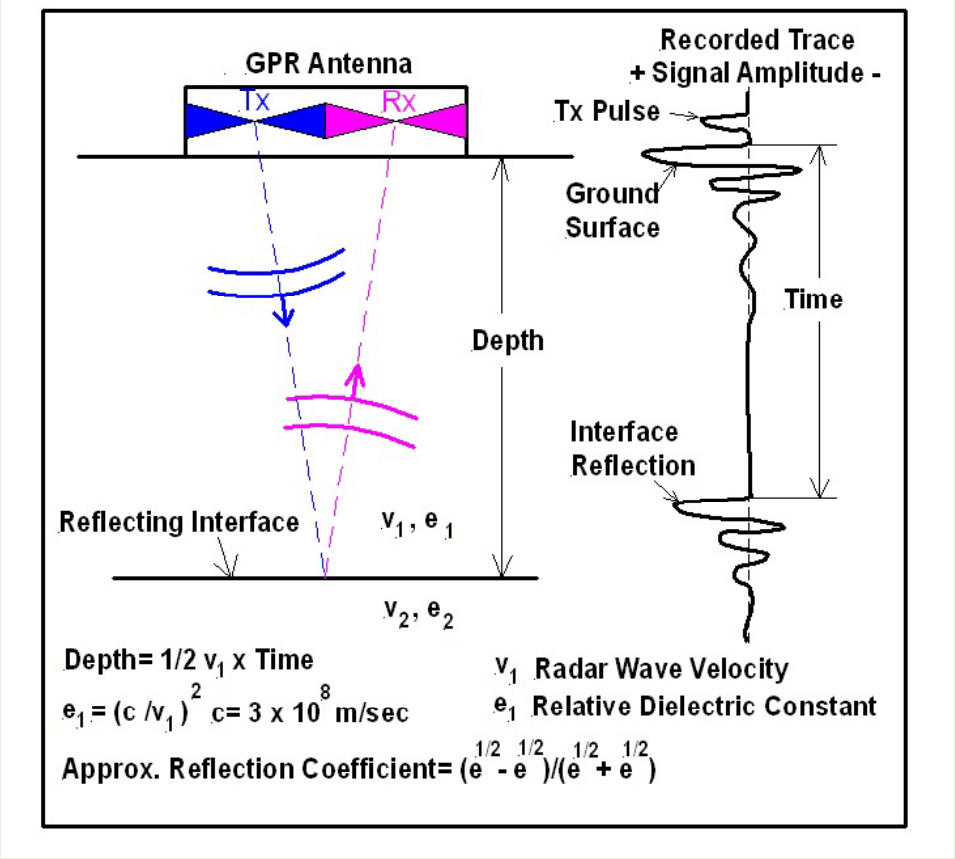
Ground-Penetrating Radar (GPR)

GPR works by pulsing micro-wave frequency electromagnetic waves into the ground to record two dimensional (2D) profile images of the subsurface.

Reflections are returned from interfaces separating materials with different electrical properties (dielectric constant). Earth interfaces with large differences in dielectric constant such as ground materials overlying metal or concrete structures, air or water-filled voids, and differing rock layers exhibit higher amplitude reflection patterns.



The estimated depth to the reflecting interface can be calculated using empirical determinations of the radar wave velocity (speed) through the overlying ground. Depth= 1/2 Velocity x Travel Time.

Ground-Penetrating Radar (GPR) Limitations

Depth of Penetration- Radar wave penetration into the ground is mostly a function of radar wave frequency and the electrical conductivity of subsurface materials. Higher-frequency antennas which offer greater target resolution emit electromagnetic waves that penetrate less deeply. Higher-conductivity soils such as bentonite clays absorb electromagnetic waves and result in less depth of penetration. Sandy soils absorb less and penetrate radar waves deeper into the subsurface.

Target Resolution Depth and Size- Smaller objects buried at greater depth are more difficult and sometimes impossible to detect. This limitation can sometimes be overcome by using higher-frequency antennas that emit higher-power electromagnetic waves. However, FCC regulations now limit the amount of power that can be emitted by newer GPR systems.

Target Resolution Orientation- The subsurface orientation of linear targets such as pipelines can greatly influence GPR profile detection. For optimum resolution and identification of linear targets antenna survey lines should be orientated nearly perpendicular to target orientation.

GSSI SIR-2000 GPR Recording System Deployed from Cart with 400-MHz Antenna with 100-foot Cable

Deeper GPR Survey with Lower Frequency 80-MHz Antenna

Deeper-Looking, Lower-Frequency 40 to 100-MHz GPR Antennas Deployed by Hand from Above the Ground Surface

(Not Licensed for Purchase in USA by FCC- But Available for Project Rental)

GPR Survey Procedures

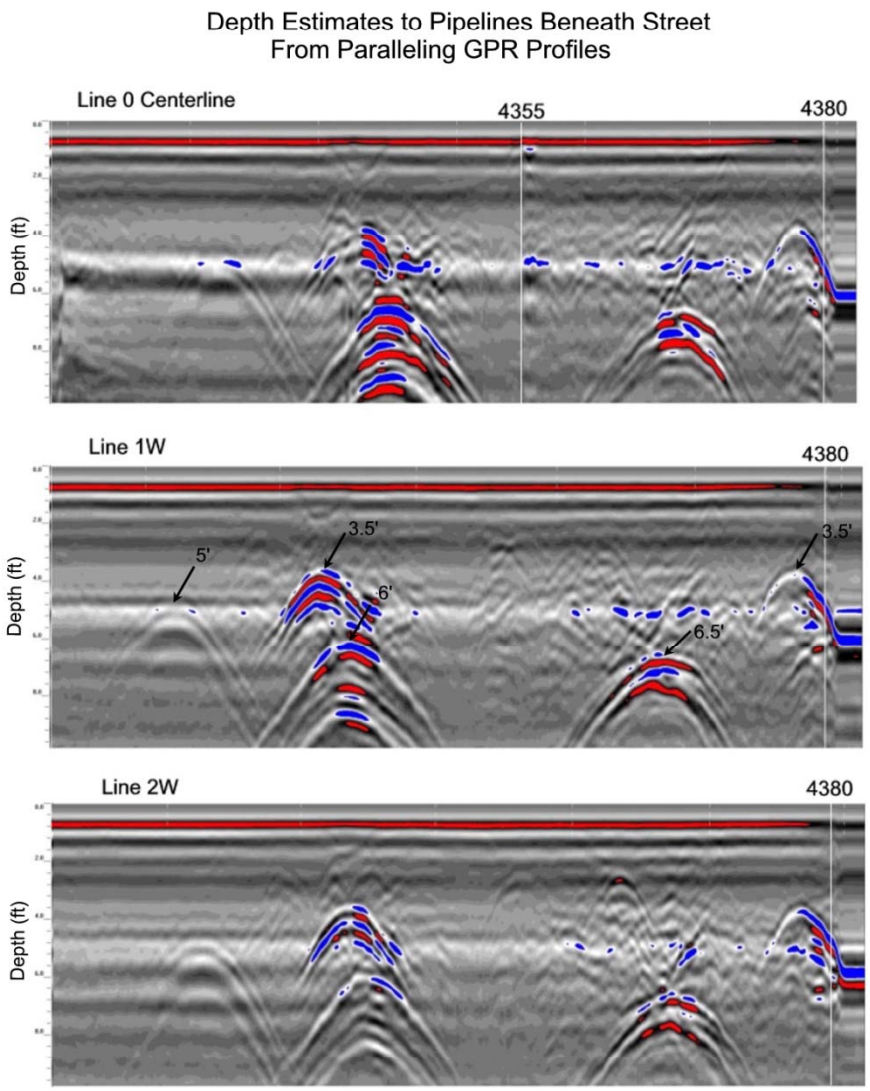
Initial Testing- GPR profiles are first recorded at a site to test various frequency radar antennas and select recording parameters such as gain and digital filtering. If possible, GPR profiles are first recorded across areas where target subsurface features with known depth are located.

Survey Line Positioning- A series of closely-spaced paralleling survey lines are first marked on the ground surface with distance stationing. The survey line locations are referenced to features at the site to develop a site map showing the survey line locations. Survey line orientation is often optimized based on target orientation (perpendicular to linear features such as pipelines).

Data Recording- GPR profiles are recorded along paralleling survey lines with tick marks recorded as the antenna crosses over distance stationing points. The profiles are digitally recorded for later computer processing and also displayed in real-time during the field survey for in-field data evaluation.

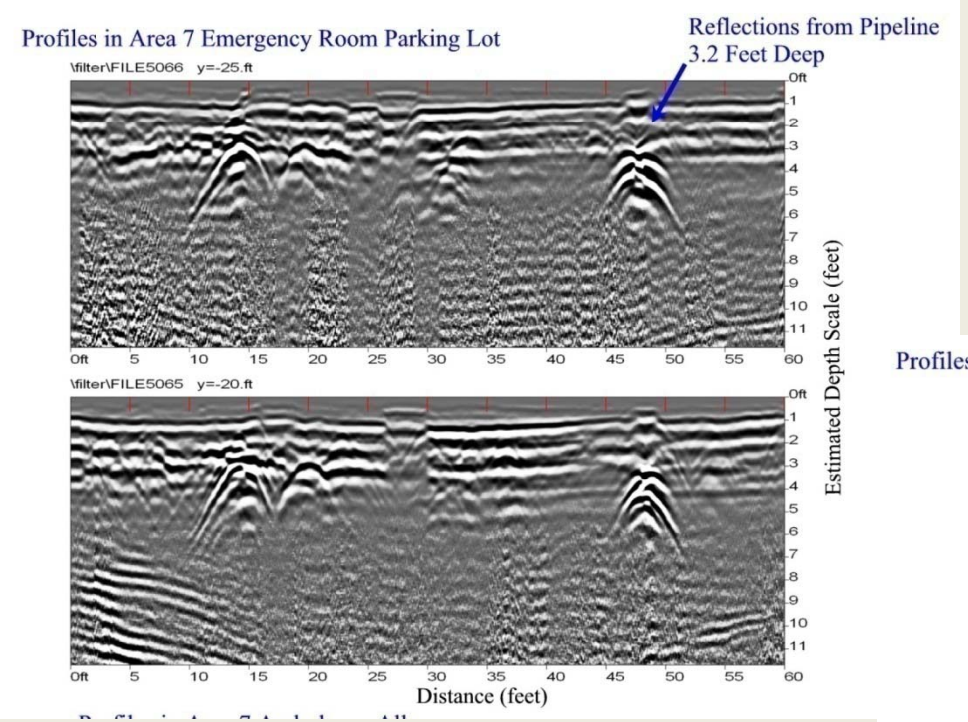
Data Processing and Evaluation- GPR data is downloaded to GSSI Radan or GPR-Slice computer processing software to prepare enhanced 2D GPR profiles for final evaluation and mapping. If GPR profiles are recorded along dense patterns of closely-spaced survey lines 3D GPR processing and imaging can be performed to develop detailed map-view images of reflection amplitude variations.

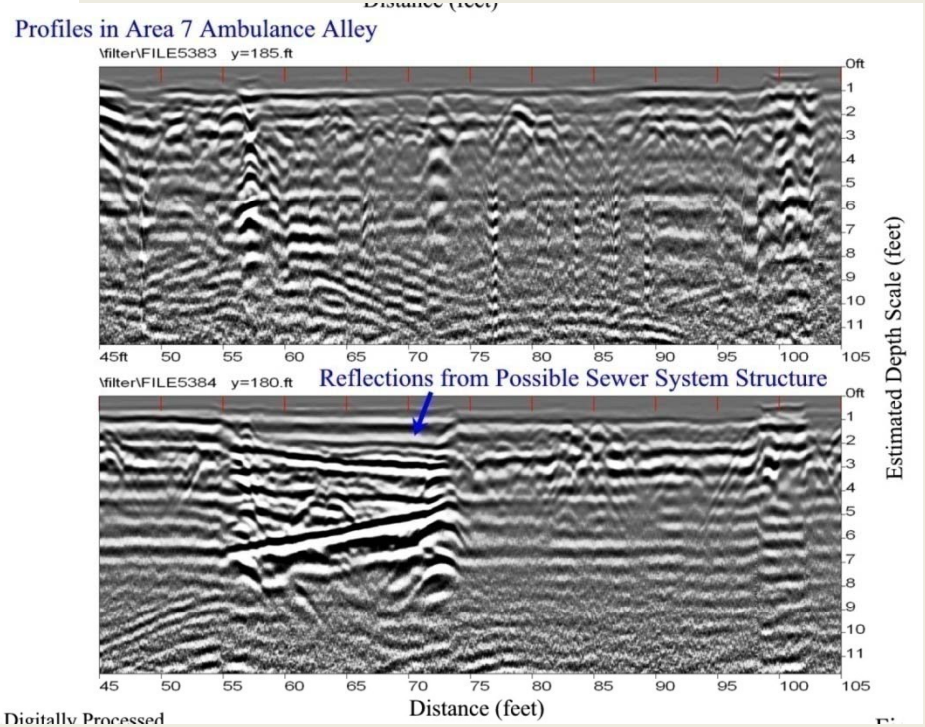
Data Processing Displays- Enhanced 2D GPR Profiles



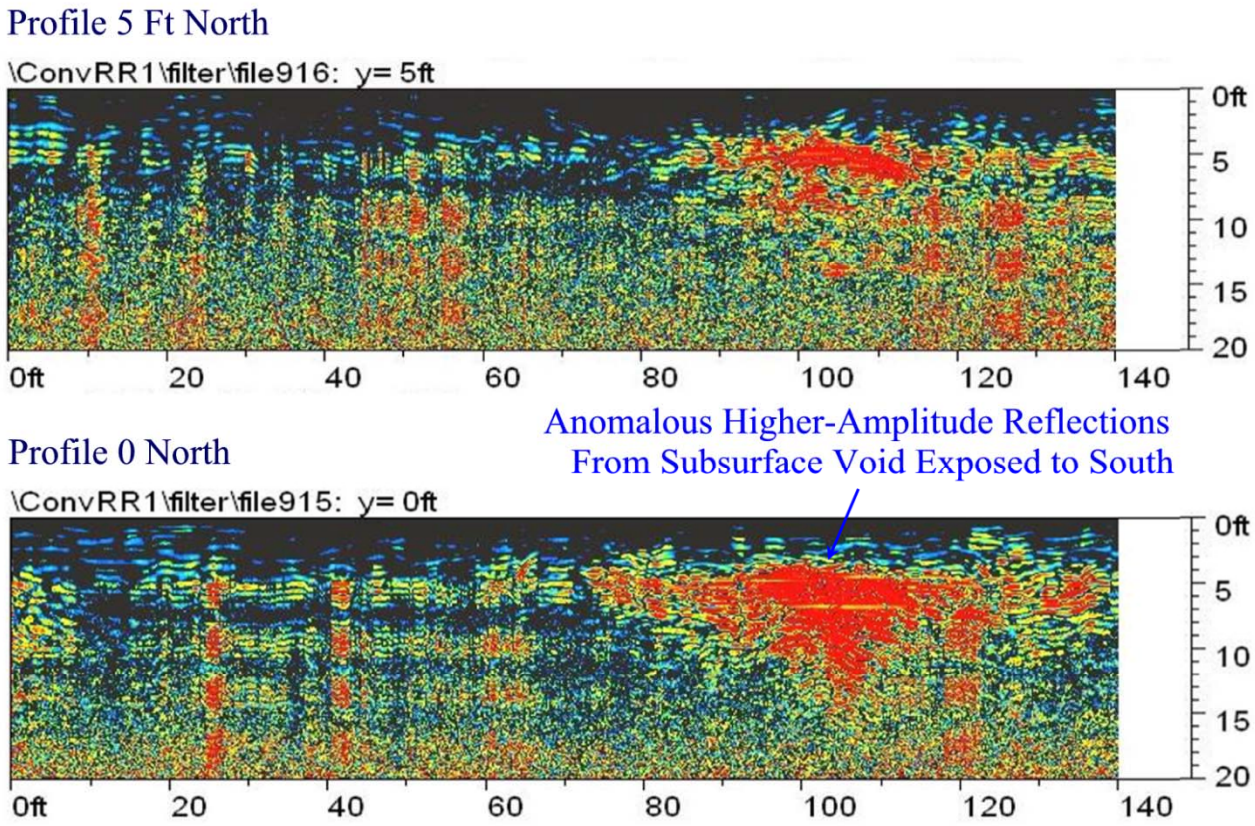
Shows Paralleling 400-MHz GPR Profiles Spaced 1-foot Apart Recorded Along Proposed Pipeline Alignment Estimated Depth Scale on Profiles is Calculated from Radar Wave Travel Time using Dielectric Constant of 4

Ventura County Hospital- 2D GPR Surveys on Asphalt Paved Streets for Investigation of Subsurface Utility Lines and Structures
Example of 400-MHz GPR Data Enhancement



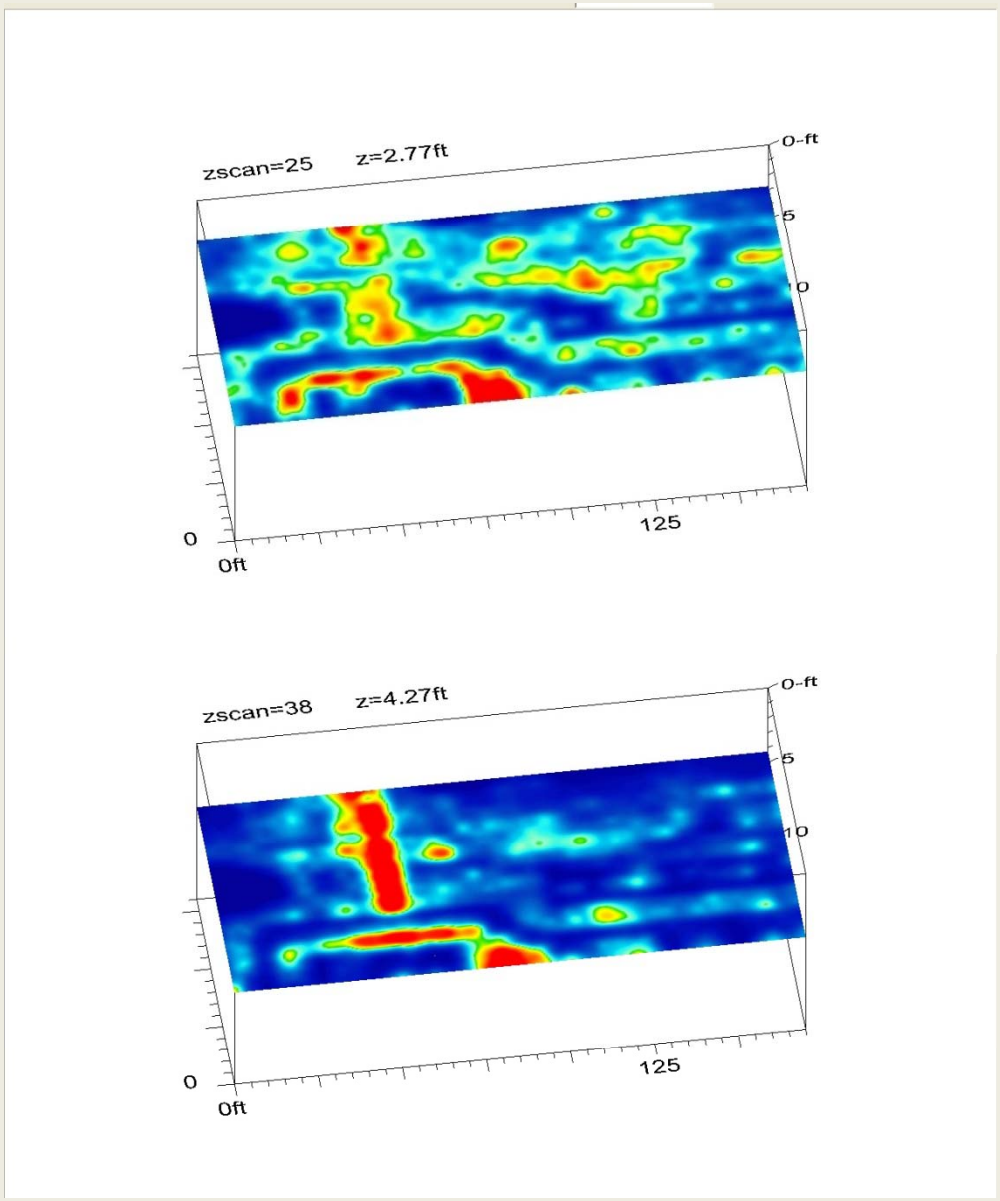


Las Vegas Building Site- 2D GPR Profiles Recorded Across Subsurface Void Areas in Bedrock Discovered in Graded Building Area

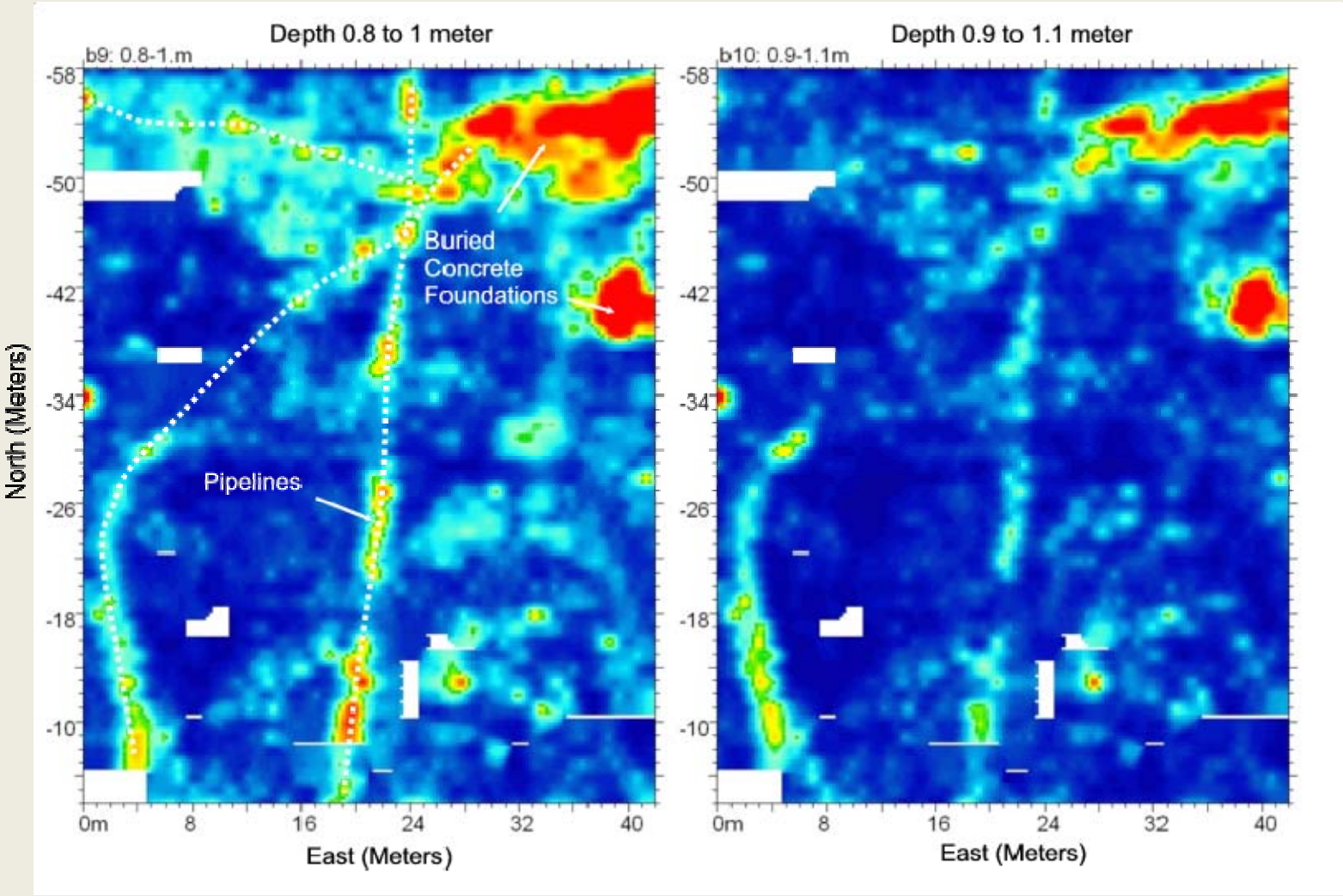


Shows 200-MHz GPR Profiles Recorded with 120 nanosecond Record Length
Depth Scale Based on Estimated Radar Wave Speed of 0.32 ft/sec
Horizontal Background Filter Applied in Processing
Red Indicates Higher Amplitude Reflections from Roof of Air Cavity

Data Processing Displays- 3D GPR Data Processing and Imaging of Reflection Amplitude Variations in Map View



Vasquez Rocks Park Archeological Site- 3D GPR Imaging in Map View Showing Reflections from Buried Features



Concrete-Scanning Radar

Using Higher-Frequency, Smaller-Scale GPR Technology

Applications:

- Detection and Mapping of Steel Reinforcement within Building Structures, such as Rebar, Conduits, and Post-Tension Cables.
- Investigation of Structural Steel Elements in Building Walls, such as Columns and Beams
- Investigation of Voids and Lower Density Conditions within Concrete Structures and Foundations
- Investigation of Thickness of Concrete Structures

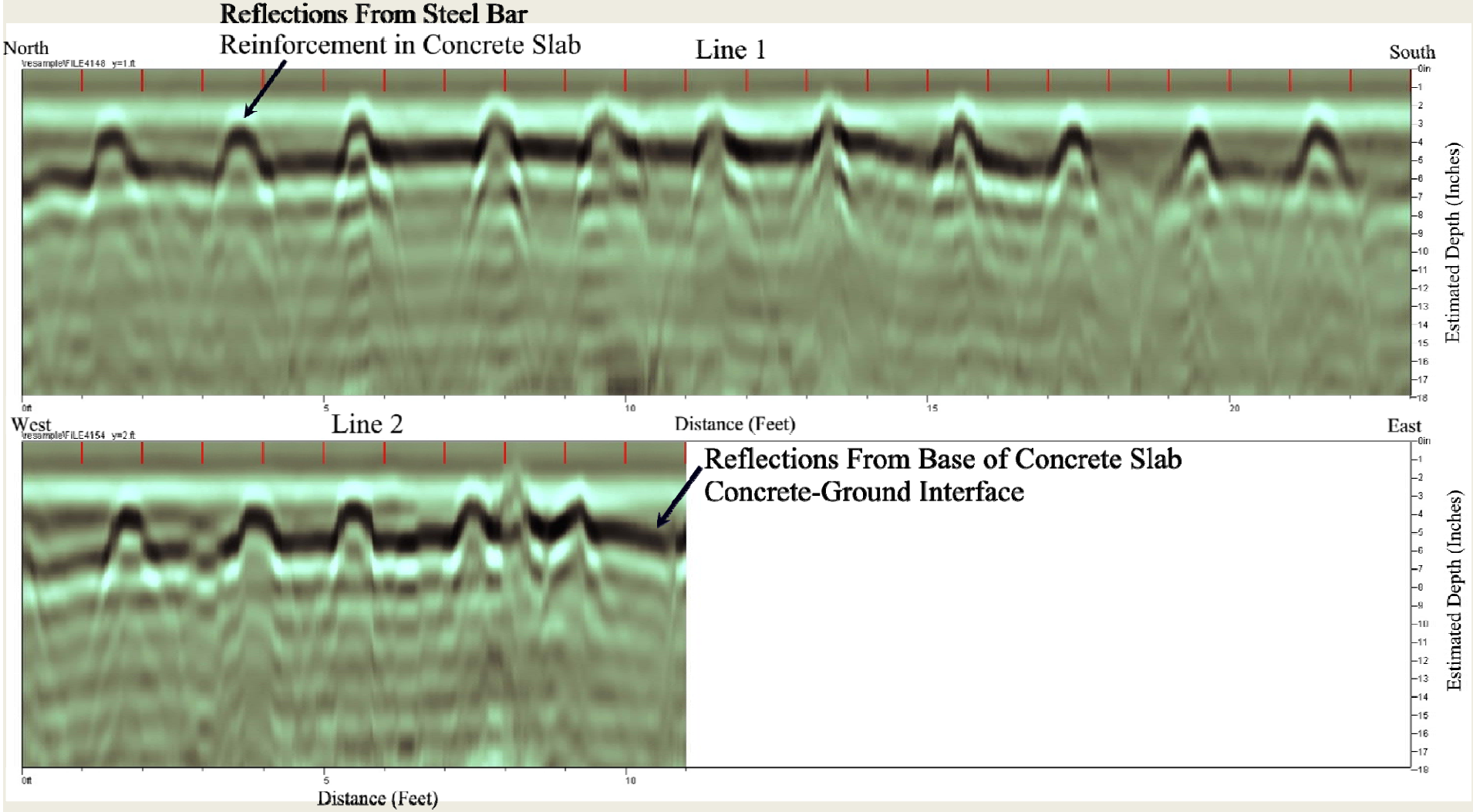
Specialized Equipment:

- Hand-Size, Enhanced Data Recording Systems with Wheel-Activated Forward and Reverse Display Across Radar Targets
- Enhanced Near-Surface Resolution with Radar Antenna Frequencies Ranging from 900 MHz to 2.7 GHz

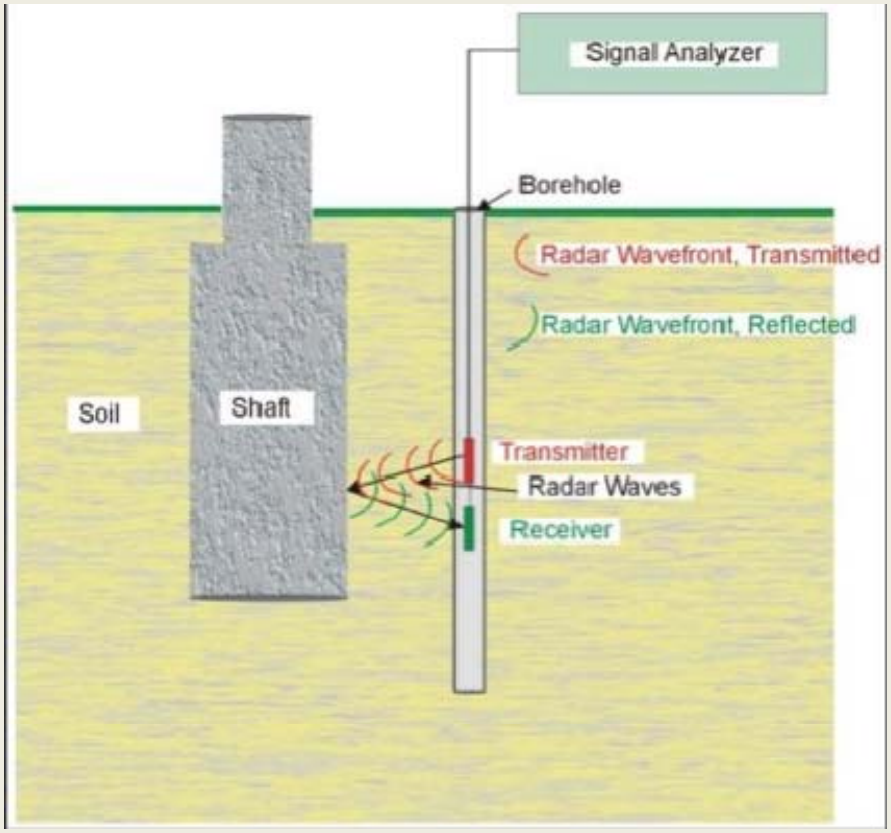
Hand-Held Concrete Scanning Radar

Geophysical Survey Systems, Inc. (GSSI) 1500 to 2700-MHz “Structure Scan” and SIR System-3000 with 900-MHz Antenna

900-MHz Concrete-Scanning Radar Profiles Recorded Across Building Floor Foundation



Borehole Ground-Penetrating Radar
For Investigation of Building Caissons and Piles



Cedars Sinai Medical Center- 120 MHz Borehole GPR Profile for Investigation of Existing Belled Caissons