Subsurface 3D Diagnostic Imagery

Ground-penetrating radar for prudent management of sports fields, park grounds and ice rinks

By Zeke Hurd and Sean McConnel, Ph.D.

New developments in subsurface imaging technology allow the detection of smaller objects and greater details than ever before. Geophysical investigations can be used to create maps of underground features, including a variety of pipes, drains, sinkholes, and even soil changes and permafrost. Using breakthroughs in computer modeling, it is now possible to integrate data from ground-penetrating radar (GPR) and electromagnetic conductivity meters into a 3D environment. With proper analysis, these tools can be used to highlight minute changes in the subsurface where pipes and drains have been compromised, resulting in pooling and uneven moisture distribution, and to locate where heaving is starting to occur.

In the case studies that are shown here, the technology was used to detect damage that compromised recreational properties. Each example was found to be of tremendous value to asset owners with minimal financial impact and powerful, actionable insights.

Westminster School Athletic Field

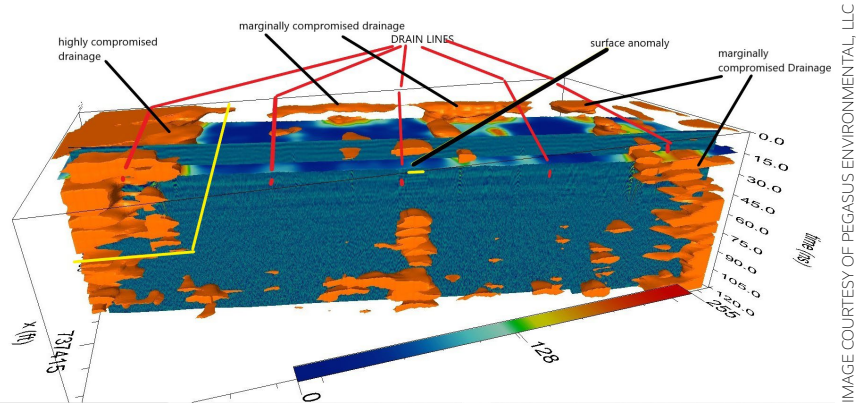
Pegasus Environmental partnered with Bigman Geophysical to perform a geophysical survey of an athletic field at Westminster School in Atlanta. The goal was to obtain geophysical data and produce a full subsurface 3D imagery evaluation. The project utilized IDS Geosystem's new equalized scramble technology; a breakthrough in radar imaging technology that allows the detection of smaller features at greater depths than previous GPR platforms.

Throughout its history, the field had numerous makeovers, and administrators were already aware of several problematic areas, yet they lacked information indicating the cause and extent of the observable irregularities.

A system-wide survey was designed to cover a targeted area with the goal of producing a series of images that would enable the personnel to "see" below the ground's surface and make accurate judgments and prudent decisions to manage the property. One unusual feature was tagged as a "target of concern." The feature was found along an active drain line and appears to be related to the present compromised drainage system. The telltale raised soil horizons are a classic indication of the soil "heaving," where forces like leaking water can push soils up toward the surface to create raised mounds, which often collapse and create depressions. The feature is not yet visible at the ground surface, but the location along a drain line indicates a rather obvious remedy would be to patch the damaged pipe section. The ability to map compromised features before they damage the surface of athletic fields shows tremendous promise for the technology.

A "Master 3D Subsurface Evaluation" was conducted to target the features and utilities present below the athletic field surface, as well as gather geological information such as moisture distribution and evidence of soil heaving.

The project used only a few hours of data collection and was produced on a small budget to serve as proof of concept. Although small, plastic drain lines can be considered difficult or even impossible to image with traditional radar investigations. Recent technological breakthroughs and advanced pro-



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The goal of the Westminster School Athletic Field survey was to obtain geophysical data and produce a full subsurface 3D imagery evaluation.

The Ion Training Center Ice Rink investigation discovered that the structure was not built with an appropriate heating zone or drainage system.

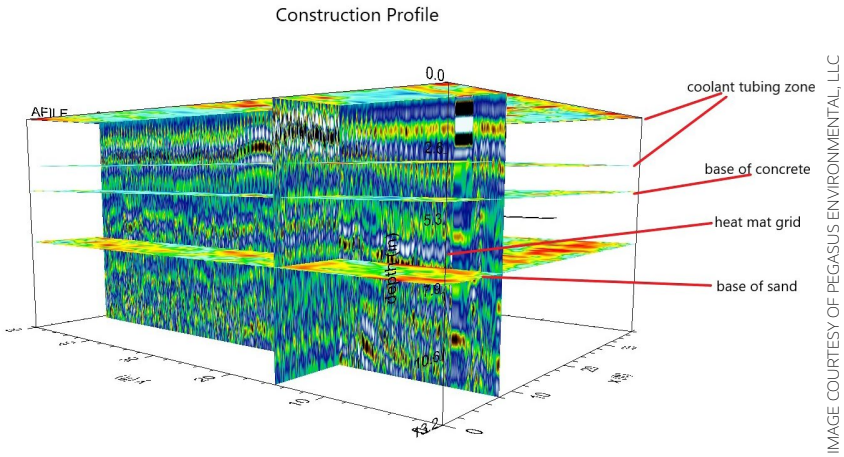
cessing techniques allowed this investigation to detail dozens of such features with great clarity, including abandoned lines that may still be affecting moisture flow.

Ion International Training Center Ice Rink

In Leesburg, Virginia, the administration had observed one small area of heaving on the ice surface of the Ion Training Center Ice Rink but was concerned about other potential heaving areas and desired a general evaluation of the subsurface. An investigation was designed using a GPR system equipped with both a 400 MHz antenna and a much smaller 2,000 MHz antenna to image the deep and shallow subsurface, respectively. GPR data was analyzed and projected in a 3D computer model, which highlighted a number of important observations about the subsurface environment and construction of the troubled ice rink.

The 3D imagery produced was used for a complete subsurface evaluation and successfully detected several other areas that showed signs of potentially generating heaving. Even more importantly, however, the investigation discovered that the structure was not built with an appropriate heating zone or drainage system.

Following the evaluation, the consulting engineer for the project recommended a complete rebuild of the ice rink due to unusual original construction. The asset owners and managers were disappointed in the construction of their structure but tremendously grateful for having accurate, actionable information that likely helped to avoid years of frustration with structural failures, rink closures and costly repairs.



Taos Ice Rink Investigation

The city council in Taos, New Mexico, was concerned that the ice rink was presenting significant irregularities and an uneven surface. They worked with Pegasus Environmental and Bigman Geophysical to produce a full subsurface diagnostic scan using GPR and advanced computer modeling. Similar to the previous case study, the survey was conducted with both a 400 MHz antenna and a smaller 2000 MHz antenna to collect radar data across the whole ice rink, and GPR-Slice was used to process that information and create an interactive 3D model of the subsurface environment. Full bidirectional scanning was employed to produce cross-sectional data at regular intervals, as well as top-down maps of the subsurface at specific depths and a full computer model with isometric shapes projected to show underground anomalies.

The rink in Taos was another example of a structure having been built to specs far below industry standards. Like the previous case study, temporary ice rink mats designed for toboggan runs and ski jumps had been encased in concrete with little to no heating zone or drainage system beneath. The owners of the asset had been unaware that construction had used inadequate, perhaps even fraudulent practices to cut corners and sell a wildly underbuilt structure. While the news of their poor-quality asset was certainly disheartening, the city council was glad to have been spared the embarrassment of watching the structure fail and be made unusable.

The cost of the investigation was insignificant relative to what they would have spent attempting to repair and remodel a doomed asset. The subsurface 3D diagnostic evaluation had brought to light the full scope of their problems and enabled them to make confident, informed decisions and prevent catastrophe.

Modern geophysical tools can be used to create powerful, highly detailed visuals that are of tremendous value for evaluating the health of athletic fields, park grounds and ice rinks. Computer modeling allows these sophisticated systems to create understandable imagery, and thus, empower informed decision making and accurate risk assessments. The careful evaluation of full 3D imagery is much more powerful than ever before thanks to new tools and better software, and the overall cost of such investigations is often insignificant compared to the value of the information that they produce. After all, a picture is worth a thousand words.

Zeke Hurd is the Owner of Pegasus Environmental, LLC. **Sean McConnel, Ph.D.,** is Senior Project Manager at Bigman Geophysical, LLC.