INNOVATIVE TECHNOLOGY
Summary Report

DOE/EM-0617

Wireline Cone Penetrometer System for Multiple Tool Usage

Industry Programs and
Subsurface Contaminants Focus Area

Prepared for
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INNOVATIVE TECHNOLOGY
Summary Report

Wireline Cone Penetrometer System for Multiple Tool Usage

OST/TMS ID 2222

Industry Programs and
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Demonstrated at
Savannah River Site, Aiken SC
Hanford Site, Richland WA

Purpose of this document

Innovative Technology Summary Reports are designed to provide potential users with the information they need to quickly determine whether a technology would apply to a particular environmental management problem. They are also designed for readers who may recommend that a technology be considered by prospective users.

Each report describes a technology, system, or process that has been developed and tested with funding from DOE's Office of Science and Technology (OST). A report presents the full range of problems that a technology, system, or process will address and its advantages to the DOE cleanup in terms of system performance, cost, and cleanup effectiveness. Most reports include comparisons to baseline technologies as well as other competing technologies. Information about commercial availability and technology readiness for implementation is also included. Innovative Technology Summary Reports are intended to provide summary information. References for more detailed information are provided in an appendix.

Efforts have been made to provide key data describing the performance, cost, and regulatory acceptance of the technology. If this information was not available at the time of publication, the omission is noted.

All published Innovative Technology Summary Reports are available on the OST Web site at http://www.em.doe.gov/ost under "Publications."

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SECTION 1
SUMMARY

Technology Summary

Problem

Collecting soil samples at multiple depths with conventional cone penetrometer technology (CPT) requires the CPT rods (known as the rod-string) to be retracted and repenetrated for each sample collected. Interchanging CPT "tools" also requires the entire rod string to be retracted from the subsurface and repenetrated. This process is time-consuming and inefficient.

Solution

Applied Research Associates, Inc. (ARA), has developed an innovative Wireline CPT system that offers increased utility and cost savings over conventional CPT. The Wireline CPT system consists of an innovative retrieval system and an assortment of characterization "tools" that can be retrieved and interchanged from any depth without retracting the rod-string from the ground. The Wireline system utilizes slightly larger rods than conventional CPT, allowing passage of tools through the hollow center of the rod.

The Wireline CPT system consists of three main components:

- Specialized, high strength, fast coupling rod string,
- Tool locking and retrieval mechanism, and
- Individual characterization tools

Individual, interchangeable Wireline CPT tools developed to date include:

- Small-diameter (1.125-inch) piezocone,
- Retrievable soil sampler,
- Soil gas sampling module,
- Dummy tip (for quickly advancing to desired sampling depth), and
- Grout-out module,

An illustration of the Wireline CPT tools is provided in Figure 1.

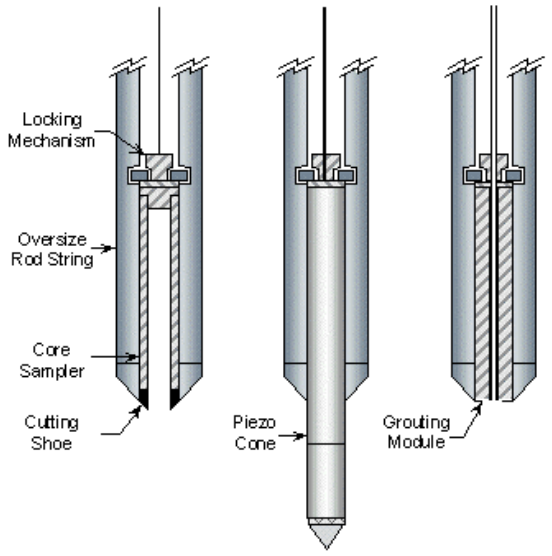

Figure 1. Wireline CPT tools; Soil Sampler, Piezocone and Grouting Module

Advantages of Wireline CPT Over Conventional CPT

- Significant reduction in the time and cost to accomplish various site characterization tasks
- Allows nearly all characterization work to be accomplished in a single penetration
- Wireline CPT "tools" can be exchanged without retracting the rod-string
- Soil samples can be retrieved from multiple depths without retracting the rod-string

Demonstration Summary

The Wireline CPT was demonstrated at the Savannah River Site (SRS) in May 1999, and in April 2000. A demonstration was conducted at the M-Basin and a deployment was conducted at the Chemical, Metals and Pesticides (CMP) Pits. At SRS, the reliability of the locking and release mechanism was tested, the validity of the piezocone measurements was assessed, and production rate of the system was

benchmarked against conventional CPT. A demonstration was also conducted at the Hanford site in July and August 2000. The soil sampler was tested extensively at Hanford's Sisson and Lu Site of 200 East, in direct comparison with conventional CPT. The Wireline system was also tested in conjunction with the Sonic CPT at Hanford. The Wireline system performed exceptionally well at both sites.

The site acceptance of the Wireline system has been quite positive. SRS has purchased a Wireline system for ongoing characterization work at the site. ARA is continuing to develop and integrate new characterization tools for the Wireline system.

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Other

All published Innovative Technology Summary Reports are available on the OST Web site at http://www.em.doe.gov/ost under "Publications." The Technology Management System (TMS), also available through the OST Web site under Tools, provides information about OST programs, technologies, and problems. The OST/TMS ID for Wireline Cone Penetrometer System for Multiple Tool Usage is 2222.

SECTION 2
TECHNOLOGY DESCRIPTION

Overall Process Definition

ARA's Wireline CPT system is an advancement of conventional CPT that allows nearly all characterization work to be accomplished in a single penetration. The technology allows multiple tools to be interchanged and multiple soil samples to be collected with out retracting the rod-sting from the ground. To understand the full advantage of the Wireline system, a brief explanation of conventional CPT is provided, including its advantages over drilling.

CPT is a direct push technology that utilizes hydraulic force to push, rather than drill, an instrumented probe into the subsurface. A conventional CPT system typically consists of an enclosed 20-40 ton truck equipped with a vertical hydraulic ram that forces an instrumented probe into the ground. The enclosed CPT truck houses electronic signal processing equipment, and computer equipment for data management. CPT serves as a platform for various technologies or "tools" that are used for geotechnical, hydrogeological, and chemical characterization of the subsurface. CPT has gained widespread acceptance due to its advantages over drilling:

Advantages of CPT Over Conventional Drilling

- Typically faster and less expensive than drilling (Booth 1993);
- Provides higher quality data with significantly more detail in defining subsurface conditions (Bratton 1992); and
- Generates very little waste, thus offering significant cost savings for operations in contaminated soil (Schroeder 1991).

The increased use of CPT has been accompanied by the development of new, CPT-deployed, characterization tools. Commercially available CPT tools include, but are not limited to the following:

- piezocone (measures tip stress, sleeve friction stress, and pore water pressure),
- Gamma Radiation Sensor;
- Grouting Module;
- Fluorescence Detectors;
- Soil Samplers,
- Groundwater Samplers;
- Soil Gas Samplers;
- Soil Moisture/Resistivity Sensors;
- Down-hole Video Camera;
- Seismic Modules;
- Ground Penetrating Radar (GPR); and
- Oxidation-Reduction Potential (ORP)/pH Module.

ARA's Wireline CPT system retains all of the advantages of conventional CPT, but has increased utility, speed, and cost effectiveness. The Wireline CPT system, unlike conventional CPT, is capable of retrieving and interchanging CPT "tools" without retracting the rod-string from the ground. Retracting and repenetrating the rod-string is a time consuming process because the rod string is made up of one-meter sections connected by threaded couplings. Retraction and repenetration involves dissasembly and reassembly of the entire rod-string. The Wireline system utilizes slightly larger rods than conventional CPT, allowing passage of tools through the rod's hollow center. Wireline rods are 2 inches in diameter compared to the 1.75-inch diameter of a standard CPT rod. The Wireline system also has a unique locking/release mechanism that allows interchange of tools by a retrieval wire.

The Wireline CPT system consists of three main components:

- Specialized, high strength, fast coupling rod string,
- Tool locking and retrieval mechanism, and

- Individual characterization tools.

Individual, interchangeable Wireline CPT tools developed to date include:

- Small-diameter (1.125-inch) piezocone,
- Soil core sampler,
- Soil gas sampling module,
- Dummy tip (for quickly advancing to desired sampling depth), and
- Grout-out module.

The benefits of the Wireline system will increase, as additional tools are adapted to the Wireline system. A photograph of the Wireline soil sampler is provided in Figure 2.

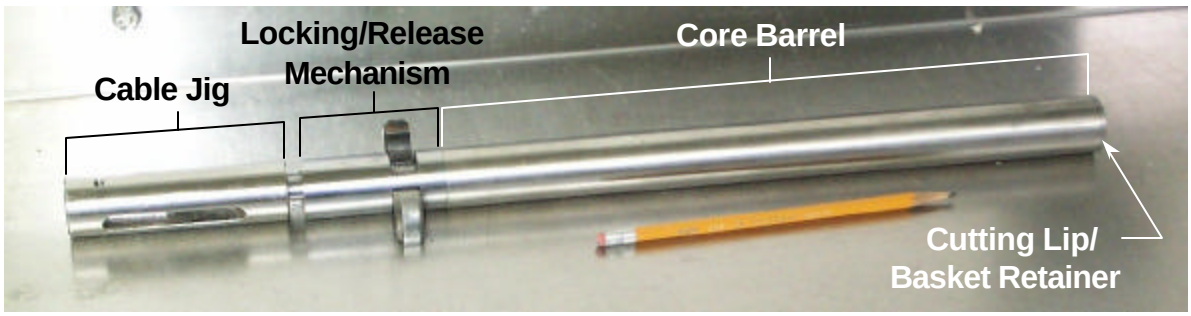

Figure 2. Photograph of Wireline soil sampler.

System Operation

The Wireline CPT probe can be advanced into the subsurface by a standard medium–duty CPT rig. The operator can retrieve the tool from the bottom of the rod string at any depth by unlocking the tool and pulling it up through the hollow center of the rod-string. A different tool can then be dropped down and locked in place. Retrieving and replacing tools using the Wireline method is much quicker and more efficient than conventional CPT.

Retrieval and exchange of CPT tools is possible because of a unique locking mechanism. The locking mechanism is identical for each individual Wireline tool, to allow interchangeability. The lock mechanism utilizes two horizontally opposed, horizontally rotating locking "dogs" which, when engaged, occupy a slot formed in the interior of a rod segment. When upward force is applied to the locking wedge via tension on a retrieval wire, the wedge slides upward allowing the dogs to move freely inward. The dogs retract into the lock housing which allows the tool to be retrieved to ground surface. The locking wedge is spring loaded, so outward pressure is applied to the dogs. An illustration of the locking and retrieval mechanism with the soil sampler in place is provided in Figure 3.

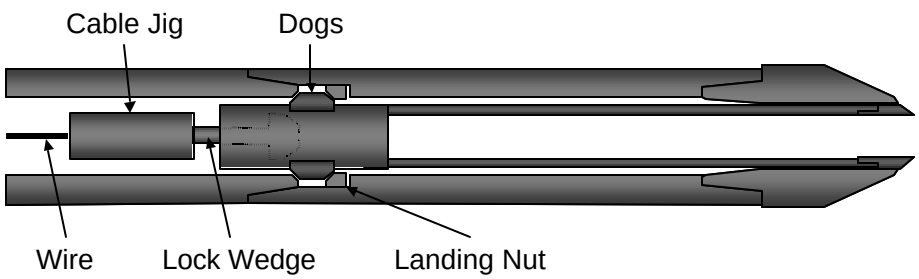

Figure 3. Wireline Locking and Retrieval Mechanism.

To illustrate the advantages of the Wireline system, consider a scenario where the piezocone tip, the soil sampler, and the grout module are all utilized. The CPT probe is advanced into the subsurface with the piezocone tip to gain information about soil stratigraphy. At a desired depth, the piezocone can be retrieved and replaced with the soil sampler. A sample or series of samples can be collected and retrieved. The piezocone tip can then be replaced to collect additional measurements or the grout module can be installed to seal the hole. In this example, the Wireline system allows multiple tools to be utilized to perform multiple tasks in a single penetration.

With conventional CPT, multiple tools can be deployed in a single penetration by stacking multiple tools in series on the same rod-string. This method is effective, but the number and type of tools that can be deployed together is limited. This method is not effective for collecting multiple soil samples. Some, but not all CPT tools have a grout-through capability, which allows the hole to be grouted upon retraction.

The Wireline soil sampler is especially effective when collecting multiple-depth soil samples. Using the Wireline system, core samples can be collected from multiple depths without retracting the rod-string. Using conventional CPT, the entire rod-string would have to be retracted to retrieve each soil sample and re-penetrated to collect another sample. Core samplers are available in the following sizes: 1 in. diameter by 12, 18 and 24 in. long. A photograph of the Wireline core sampler is provided in Figure 4.

Figure 4. Wireline Core Sampler.

SECTION 3
PERFORMANCE

Demonstration Plan

The Wireline CPT was demonstrated at the SRS and at the Hanford site. Demonstrations at SRS were conducted on two separate occasions; in May 1999, and in April 2000. The Hanford demonstration was conducted in July and August 2000. The demonstration plans for each site are described below and the results of the demonstration are provided in the following sub-section.

Savannah River Site

M-Basin Demonstration:

The initial demonstration at the M-Basin was designed to evaluate the following functional areas:

- performance of the tool locking mechanism;
- operational procedures;
- system survivability;
- refusal depth versus conventional CPT;
- piezocone performance versus ASTM standard piezocone; and
- production rate versus conventional CPT.

SRS Chemical Metals and Pesticides (CMP) Pits (Deployment)

A second field evaluation and demonstration of the Wireline CPT soil sampler was conducted at SRS from April 5-20, 2000 in conjunction with ongoing environmental restoration work. Three deployments were accomplished during the evaluation period, and a fourth was accomplished following the demonstration. Deployments during the evaluation period included successful use of the Wireline system for:

- piezocone characterization in combination with soil gas sampling;
- piezocone characterization in combination with ribbon DNAPL sampling; and
- continuous soil sampling, in addition to cutting through a geologic layer that initially caused refusal at the A14 outfall.

In addition, ARA was prepared to install permanent soil gas monitoring points through the Wireline system had the results of gas sampling indicated any zones of concern. In the fourth deployment, the Wireline CPT system was used for continuous soil sampling at the Chemical Metals and Pesticides (CMP) Pits site.

Hanford Site

The Wireline CPT was also demonstrated at the DOE's Hanford site, on two occasions. The Wireline soil sampler was demonstrated at the Sisson and Lu site of 200 East on July 21 and 24, 2000. Evaluation of the Wireline system, in conjunction with ARA's sonic CPT system, occurred on August 1-4, 2000 at the Ash Pit of 100 F. The objective of the tests conducted at the Sisson and Lu site was to compare the performance of the Wireline CPT soil sampler to the conventional CPT soil sampler. The objective of the demonstration at the 100F Ash Pit was to evaluate the use the Wireline soil sampler with the sonic vibratory head as a means of enhancing penetrability in difficult geologic conditions.

Results

Demonstration results from SRS and Hanford are presented below. In most cases results are presented in direct comparison to conventional CPT. For each performance category listed below, the test scenario is described followed by the results:

- Retrieval and Redeployment Reliability

- Performance of Wireline Piezocone Versus ASTM Standard Piezocone
- Refusal Depth
- Wireline CPT in Conjunction with Sonic CPT
- Production Rate

Retrieval and Redeployment Reliability (SRS Demonstration)

- ***Test:*** Penetrate to 15 meters below ground surface (bgs), stopping every meter to retrieve, inspect and re-deploy module.

- ***Result***: Wireline tools were successfully retrieved from the tip of the rod string and deployed multiple times at several depths and in several different geological materials. The Wireline piezocone tool withstood repeated deployments through an extremely difficult-to-penetrate layer at the SRS M-Basin. A single issue was observed during this set of tests, that is that long tools had a tendency to bind under the condition of a deflected rod string, preventing passage of the tool. Deflection of the rod string occurs in difficult geological settings. This occurrence can be minimized by designing tools as short as possible. The longest tool was an 18 in. core barrel sampler, but SRS representatives have noted that a 12 inch sampler is sufficient for most needs. In seven subsequent deployments, binding has not been a problem with a maximum length of 12 inches.

Performance of Wireline Piezocone Versus ASTM Standard Piezocone (SRS Demonstration)

- ***Test:*** Testing was performed to validate the results of the Wireline piezocone, which has smaller diameter (1.125 in.) than the standard ASTM piezocone (1.75 in.). To accomplish this, four penetrations were completed (two with each device) in close proximity. The penetrations were spaced approximately 1.0 to 1.5 meter apart along a line, alternating from the Wireline to the ASTM piezocone.

- ***Results:*** Statistical comparison of tip stress, sleeve stress, and pore pressure data from the four closely spaced penetrations revealed that variations due to soil heterogeneity (from adjacent sample locations one to two meters apart) are greater than any variation attributable to the differences in cone geometry. ARA concluded that there was no statistical difference between Wireline piezocone data and ASTM standard cone data. (Farrington et al 2000).

Refusal Depth (SRS Demonstration)

- ***Test:*** Refusal depth of the Wireline system was compared to that of conventional CPT under identical conditions during the field evaluation at the SRS, M-Basin. The Wireline system has a 2.0 in diameter and was fitted with 2.2 in. rod expanders. The conventional CPT has a 1.75 in. diameter and was fitted with 2.0 in. rod expanders. Rod expanders are utilized on some of the rods to widen the hole to decrease the friction along the side of the embedded rod; thus, increasing the penetration depth. Six rods with expanders were staggered among the 35, one-meter rod sections.

- ***Results:*** The results of the tests for refusal depth are presented in Table 1 below. In the May 99 test of the Wireline system, ARA ran out of rods prior to refusal, so the experiment was repeated in the same location in April 2000. The depth to refusal for the Wireline system is essentially the same as conventional CPT.

Table 1. Results of Refusal Depth Testing

Descriptions	System	Depth to Refusal
SRS Field Test (5/99)	Conventional	44.5 m (146 ft)
SRS Field Test (5/99)	Wireline	33.2 m (109) ran out of rods, not refusal.
SRS Field Test (4/00)	Wireline	46.0 m (151 ft)

During testing of the Wireline system at the CMP Pits at SRS, the soil sampler was utilized to “cut through” a difficult layer. Since direct push technology relies on the force of the rod to displace the soil as it is advanced, often-dense layers can not be penetrated because the soil is not easily displaced. ARA discovered that in some cases, these hard layers of soil could be penetrated by utilizing the soil sampler to

remove soil cores in that layer allowing the rod to be pushed through. This is beneficial if the layer that is difficult to penetrate is relatively thin, discrete, and the soil below can be penetrated by the normal push force.

Wireline CPT in Conjunction with Sonic CPT (Hanford Site):

- ***Test:*** The objective of the demonstration at the 100F Ash Pit was to evaluate the use the sonic vibratory head with the Wireline soil sampler as a means of enhancing penetrability in difficult geologic conditions. The native soil below the ash pit consists of low-porosity sand mixed with gravels and cobbles and is difficult to penetrate with CPT. The depth of the ash pit varied from 1m to 5m

- ***Result:*** Applying vibratory force through use of the sonic head aided penetration only marginally in the native soil below the ash pit. The gravels and cobbles of the native soil deformed the Wireline cutting mouth, nicked and scraped the dummy tip (which protruded 8 inches out of the cutting mouth), and deformed sample chambers when the soil sampler was used in attempts to remove difficult material. When trying to retrieve the tools, the dogs appeared to be retracting, but due to deformation of the equipment, the tools could not be pulled to the surface. Several times, upon attempting to retrieve the dummy tip, it became caught in the cutting mouth due to scratches and burrs. The sample chamber would deform with the cutting shoe and get wedged in or the threads on either end of the sample chamber would mushroom, wedging the sample chamber in the inside of the outer housing. A test of the Wireline with sonic assist in a dense, fine-grained soil, rather then a gravelly soil would have provided a better assessment of the ability of the Wireline system to enhance penetration in difficult layers.

Production Rate (SRS and Hanford Demonstrations)

- ***SRS Test :*** To determine the time savings offered by the Wireline CPT, a typical operation was performed with the Wireline system and with conventional CPT. The operation consisted of piezocone characterization to 51.8 meters and grouting the hole upon completion.

- ***Results:*** Data obtained from the field evaluation indicated that the Wireline system completed the operation in 1 hour and 10 minutes, while the conventional system took 1 hour and 32 minutes. Therefore, the Wireline system reduced the time to perform this most basic operation by 24 percent. The Wireline system also saves preparation time. In this case, as is typical, a second set of rods is pre-threaded with a grout tube to save time in the field. Without the second set of pre-threaded rods, the piezocone umbilical would have to be removed from the rod string and the grout tube re-threaded through the rod string.

- ***Hanford Test***: Timed testing was also conducted the Sisson and Lu site of 200 East in July 2000. The objective of these tests was to compare the speed of the Wireline system to conventional CPT for collection of continuous soil samples. Both samplers were used to retrieve continuous soil samples over an extended depth.

- ***Results***: Samples collected using the Wireline CPT soil sampler took an average of two minutes each to retrieve (about 10 seconds per inch of sample). Samples collected using a conventional CPT soil sampler took an average of 18 minutes to retrieve an 18-inch sample (about one minute per inch of sample). Therefore, use of the Wireline CPT soil sampler resulted in a time saving of approximately 83 percent over conventional CPT.

Performance Conclusions

- **Retrieval and Redeployment Reliability**: Over the course of several tests the Wireline CPT was retrieved and redeployed successfully and consistently. A single issue observed was that long tools had a tendency to bind under the condition of a deflected rod string.

- **Performance of Wireline Piezocone Versus ASTM Standard Piezocone:** The results from the 1.125 in. Wireline Piezocone were indistinguishable from ASTM cone for geotechnical characterization.

- **Refusal Depth:** The refusal depth for the two inch diameter Wireline probe was observed to be equivalent to a standard 1.75 inch CPT probe. The Wireline system demonstrated the capability to “cut through” hard layers, using Wireline sampler to remove dense soil.

- **Production Rate**: The Wireline system was found to reduce the time to perform the most basic operations by 24 percent. The time to collect continuous soil samples was reduced by 83 percent.

Overall the Wireline system performed exceptionally well, exhibiting increased speed and utility compared to conventional CPT without sacrificing data quality, or access depth.

SECTION 4
TECHNOLOGY APPLICABILITY AND ALTERNATIVES

Competing Technologies

The most widely used method for subsurface characterization is conventional drilling (e.g. hollow steam auger, and cable tool). Direct push technologies such as CPT and Geoprobe® have gained acceptance and become more commonly utilized for site characterization. The advantages and limitations of CPT compared to drilling have been well documented. For the purposes of this report, the baseline technology to which the Wireline CPT will be compared is conventional CPT.

Technology Applicability

The applicability of the Wireline CPT system is similar to that of conventional CPT. CPT is best suited to sites with compact sands and clays, and experiences increased difficulty at sites that have large cobbles, cemented strata. CPT can not penetrate competent bedrock. The Wireline system achieved penetration depths of 151 ft at SRS.

The applicability of the Wireline CPT system will expand, as additional tools are adapted to the system. To date, the piezocone, soil sampler, and grout module have been developed and tested. New tools such as water samplers, soil gas samplers, and chemical sensors will greatly increase the flexibility and applicability of the Wireline system.

Patents/Commercialization/Sponsor

Development of the Wireline CPT system was funded by the NETL's Industry Programs through a contract No. DE-AR26-95FT40366. ARA has applied for a patent on the Wireline technology and the system is commercially available through ARA's Vertek Division. SRS has purchased a Wireline system from ARA after successful demonstration and deployment at the site. Development of additional Wireline tools is likely to increase the commercial success of the technology.

SECTION 5
COST

Methodology

As discussed in the Performance section, the Wireline system is capable of performing certain tasks much faster than conventional CPT. This times savings and increased production directly translates to cost savings. The cost analysis here is based on the demonstrations at SRS and Hanford. Specific operations and tasks were performed with both the Wireline system and conventional CPT. The time to complete each task was carefully monitored and recorded.

A cost model was developed to predict the reduction in cost afforded by the Wireline CPT system for contiguous soil sampling. The cost model accounted for: (1) the time required to set up over each sampling location; (2) the rate at which a dummy tip can be advanced to the depth at which samples are desired; and (3) the rate of retrieving and recovering a sample from each apparatus. In addition, the model also considered fixed costs and consumables associated with each of the two sampling methods.

Times calculated for conducting contiguous sampling operations by each of the two methods were multiplied by a composite crew and equipment rate representing a two-person crew using a heavyweight (20-30 tons) CPT rig. The rate at which a sample is retrieved, also called "tripping", applies to the round trip rate for pulling the loaded sample apparatus to the surface and re-deploying it to the previous depth. For the Wireline system, the apparatus includes only the sampling tool. For conventional sampling, the apparatus includes the rod string. The fixed time per sample is the up-hole time required to remove the sample from the apparatus and re-assemble the apparatus to ready it for collection of the next sample. Table 2 below presents the inputs to the cost model.

Table 2. Inputs to the cost model for contiguous CPT soil sampling

Activity	Units	Wireline CPT	Conventional
Initial Penetration Rate	feet per minute	5	5
Fixed Time Per Sample	minutes	1	7
Sample Retrieval Rate ("Tripping")	feet of sample depth per minute (round trip)	30	2.5
Set-up time per hole	minutes	30	30
Crew & Equipment Rate	dollars per hour	312	312
Consumables	dollars per sample	15	15
Length of Sample	feet	1.5	1.75

Other assumptions applied to the cost model included the following:

- The consumables cost for both forms of sampling includes personnel protective equipment and plastic core sleeves;
- The conventional sampler recovered 21 inches of core at a time; the Wireline system recovered 18 inches of core at a time (12, 18, and 24-inch core barrels are available);
- Set-up time over each sampling location, including subsequent grout mixing and cleanup, required 30 minutes.

Cost Analysis

The cost savings realized with a Wireline CPT system for contiguous soil sampling versus conventional CPT is illustrated in Figure 5. The savings prediction considers the unit cost of collecting each sample under a variety of scenarios. The cost model was calibrated against actual cost data from field evaluations and operations at M-Basin of SRS and the Sisson and Lu site at Hanford 200 East. In the graph, the x-axis represents the length of the interval over which samples are collected. The y-axis represents the fraction of conventional CPT costs that the Wireline represents. A line is presented for each of several starting depths

for the interval. It should be noted that, although the graph includes scenarios involving samples from as deep as 200 feet, at the time of this writing, Wireline CPT soil sampling has been conducted no deeper than 151 feet.

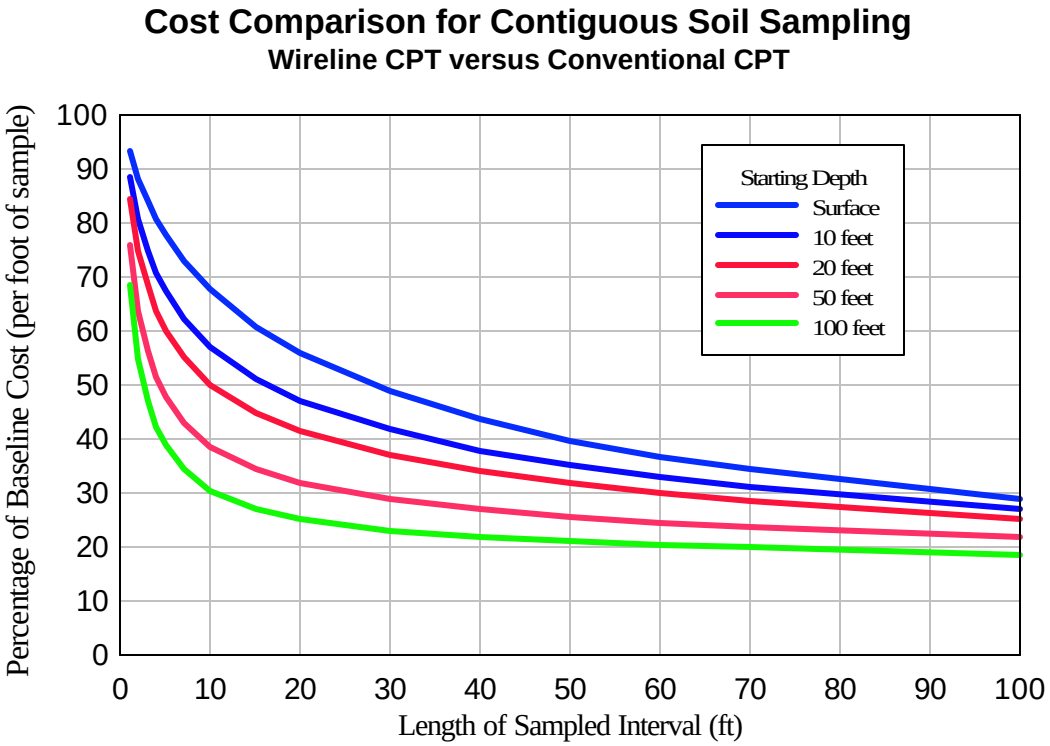

Figure 5. Cost Comparison: Percent of Baseline Cost vs. Length Sampled for Various Starting Depths.

Based on Figure 5, the cost of the Wireline system, expressed as "Percentage of Baseline" decreases with increased depth and length of sampled-interval. For example, in a scenario where continuous sampling is conducted with the Wireline system from a starting depth of 100 ft to a depth of 160 ft (60 ft sampled interval), the cost per foot is approximately 20 percent of the baseline cost. This cost reduction can be attributed to the drastic time savings in "tripping". The Wireline system is approximately ten times faster than conventional CPT with respect to the round trip rate for pulling the loaded sample apparatus to the surface and re-deploying it to the previous depth. Therefore; the cost savings is the greatest for deep samples, or long sampled-intervals that require several trips.

Cost Conclusions

For contiguous soil sampling, the Wireline CPT offers significant cost saving over the baseline technology. At very practical depths (50 to 150 feet), the cost of using the Wireline CPT system is 20 to 40 percent of the cost of conventional CPT. While the cost savings demonstrated for contiguous soil sampling are significant, the greatest cost savings from use of the Wireline CPT system will probably be realized in mixed applications, such as a combination of sensor characterization and sampling. In these cases, in addition to reducing re-penetration, the Wireline approach will eliminate the need to move the CPT rig to a new location each time a new process is initiated.

SECTION 6
REGULATORY AND POLICY ISSUES

Regulatory Considerations

- No special permits are required for the operation of a CPT. Regulatory approval is typically handled similarly to standard drilling where a drilling plan is submitted to the appropriate regulatory agency for their approval prior to initiation of field activities

- Conventional drilling/sampling activities create investigation derived wastes such as drilling fluids, cuttings, and equipment decontamination fluids that must be handled according to applicable local, state, and federal. CPT generates minimal waste (decontamination fluid only).

Safety, Risks, Benefits, and Community Reaction

Worker Safety

CPT is generally safer for workers than conventional drilling:

- CPT does not generate cuttings or drilling fluids minimizing worker exposure to hazardous materials
- CPT collects many measurements in situ, minimizing worker exposure
- CPT has few moving parts unlike rotary drilling methods that have many physical hazards to worker associated with moving parts on drill rig

Community Safety

Since the Wireline CPT is a monitoring technology (as opposed to an active treatment technology), there is little potential that community safety will be adversely impacted from its operation.

Environmental Impact

Environmental impacts of CPT are generally less than with conventional drilling.

- No drill cutting or drilling fluids are produced during operation;

- The Wireline CPT grout module ensures that the hole is sealed upon retraction. With conventional CPT, there is always a possibility that voids are created or a new hole is formed when re-penetrating to grout the hole;

- CPT is minimally intrusive; holes are smaller in diameter than most drill rods; and

- The entire system can be decontaminated at the surface with a minimal amount of fluid;

Socioeconomic Impacts and Community Perception

- Utilization of the Wireline CPT will have a minimal impact on the labor force and the economy of the region

- The general public has limited familiarity with CPT, but would be expected to support it as an improvement over conventional drilling

SECTION 7
LESSONS LEARNED

Technology Selection and Implementation Considerations

- Implementation considerations for the Wireline system are similar to those for conventional CPT.
- End users should consider their specific characterization needs and consult with ARA to determine the availability of specific tools to meet those needs.
- Although the number of Wireline tools is currently limited, development of a broad selection of Wireline tools is planned.

Technology Limitations and Needs for Future Development

The full potential of the Wireline CPT system will be achieved when a full complement of CPT tools is adapted to the Wireline system. This will allow the Wireline system to do what it does best, which is performing multiple tasks rapidly using multiple tools.

Development of Wireline chemical sensors, used in conjunction with soil and groundwater samplers will be a great asset. This would give CPT the capability to screen the subsurface for contaminated zones, then collect confirmation soil or groundwater samples rapidly by exchanging tools.

APPENDIX A
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APPENDIX B
ACRONYMS AND ABBREVIATIONS

ARA	Applied Research Associates, Inc.
ASTM	American Society for Testing and Materials
CMP	Chemical Metals and Pesticides
CPT	Cone Penetrometer Technology
DNAPL	Dense Non Aqueous Phase Liquid
DOE	Department of Energy
GPR	Ground Penetrating Radar
ITSR	Innovative Technology Summary Report
NETL	National Energy Technology Laboratory
ORP	Oxidation Reduction Potential
OST	Office of Science an Technology
SRS	Savannah River Site