UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Office of Research and Development
Washington, D.C. 20460

ENVIRONMENTAL TECHNOLOGY VERIFICATION PROGRAM
VERIFICATION STATEMENT

TECHNOLOGY TYPE:	**GROUND-WATER SAMPLING TECHNOLOGIES**	
APPLICATION:	**NARROW-BORE WELL WATER SAMPLING**	
TECHNOLOGY NAME:	**Model MB470 Mechanical Bladder Pump**	
COMPANY:	**Geoprobe Systems Inc.**	
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PROGRAM DESCRIPTION

The U.S. Environmental Protection Agency (EPA) has created the Environmental Technology Verification Program (ETV) to facilitate the deployment of innovative or improved environmental technologies through performance verification and dissemination of information. The goal of the ETV Program is to further environmental protection by accelerating the acceptance and use of improved and cost-effective technologies. ETV seeks to achieve this goal by providing high-quality, peer-reviewed data on technology performance to those involved in the design, distribution, financing, permitting, purchase, and use of environmental technologies.

ETV works in partnership with recognized standards and testing organizations and stakeholder groups consisting of regulators, buyers, and vendor organizations, with the full participation of individual technology developers. The program evaluates the performance of innovative technologies by developing test plans that are responsive to the needs of stakeholders, conducting field or laboratory tests (as appropriate), collecting and analyzing data, and preparing peer-reviewed reports. All evaluations are conducted in accordance with rigorous quality assurance protocols to ensure that data of known and adequate quality are generated and that the results are defensible.

Verification of contaminated site characterization and monitoring technologies is carried out within the Advanced Monitoring Systems (AMS) Center, one of seven ETV verification centers. Sandia National Laboratories, a Department of Energy laboratory, is one of the verification testing organizations within this ETV Center. Sandia collaborated with personnel from the US Geological Survey and Tyndall Air Force Base to conduct a verification study of ground-water sampling technologies for deployment in narrow-bore, direct-push wells at contaminated sites with potential ground-water contamination. This verification statement provides a summary of the results from a verification test of the Model MB470 Mechanical Bladder Pump manufactured by Geoprobe Systems Inc.

DEMONSTRATION DESCRIPTION
The performance of two ground-water sampling technologies was evaluated at the US Geological Survey Hydrological Instrumentation Facility at the NASA Stennis Space Center in southwestern Mississippi and at Tyndall Air Force Base near Panama City, Florida. Each technology was independently evaluated to assess its performance in the collection inorganic cations, commonly encountered in ground-water, as well as volatile organic compound- (VOC) contaminated ground-water.

The verification test, conducted over a one-week interval in February 2003, incorporated the use of a 5-inch diameter,100-foot standpipe at the USGS facility. The standpipe, serving as an "above-ground" well, was filled with tap water spiked with various concentration levels of five target inorganic cations (calcium, iron, magnesium, potassium and sodium) and six volatile organic compounds. Target VOC compounds (vinyl chloride, methyl-tertiary butyl ether, cis-1,2-dichloroethene, benzene, trichloroethene and ethyl benzene) were chosen to represent the range of VOC volatility likely to be encountered in normal sampler use. Target cation concentrations were in the range of 5 to 100 mg/L and VOC concentrations were in the range of 50 to 100 μg/L. Water sampling ports along the exterior of the standpipe were used to collect reference samples at the same time that ground-water sampling technologies collected samples from the interior of the pipe. Trials were carried out at two different inorganic cation concentrations, a single VOC concentration, and sampler depths ranging from 17 to 76 feet. An un-spiked, tap-water, blank sampling trial was also included in the test matrix. A total of 48 cation and 24 VOC samples were collected with the sample count equally split between vendor and reference sampling methods.

The standpipe trials were supplemented with additional trials at six,1-inch internal-diameter, direct-push-installed wells at Tyndall Air Force Base. Sampling at narrow-bore, direct-push wells provided an opportunity to observe the operation of the sampling system under typical field-use conditions. A simple reference sampler was deployed alongside the vendor technology such that co-located, simultaneous samples could be collected from each well. Principal contaminants at the Tyndall monitoring wells included trichloroethene and its degradation products as well as hydrocarbon contaminants such as benzene and ethyl benzene. Ground-water VOC concentrations ranged from low μg/L to low mg/L levels. A total of 96 ground-water samples were collected, with the sample count equally split between vendor and reference methods.

All technology and reference samples were analyzed by an offsite laboratory utilizing EPA SW-846 Standard Methods 3010A (Acid Digestion of Aqueous Samples and Extracts For Total Metals by FLAA or ICP Spectrometry) and 6010B (Inductively Coupled Plasma Atomic Emission Spectrometry) for inorganic cation analysis and EPA SW-846 Standard Method 8260B (Volatile Organic Compounds by Gas Chromatography/Mass Spectroscopy) for VOC analysis. The overall performance of the ground-water sampling technologies was assessed by evaluating sampler precision and comparability with reference samples. Other logistical aspects of field deployment and potential applications of the technology were also considered in the evaluation.

Details of the demonstration, including an evaluation of the sampler's performance, may be found in the report entitled *Environmental Technology Verification Report: Geoprobe Systems Inc., Mechanical Bladder Pump, Model MB470,* EPA/600/R-03/086.

TECHNOLOGY DESCRIPTION
The Model MB470 is a narrow-diameter (25.5-inch length x 0.47-inch outside diameter) bladder pump suitable for deployment in direct-push-installed ground-water wells. The pump consists of an internal, concentrically corrugated, flexible bladder that is positioned within a rigid stainless steel tube. The bladder's internal volume can be reduced by applying a vertical force to collapse the bladder along it longest dimension. The bladder is equipped with one-way inlet and outlet check valves and passively fills

with water when the pump is at depth in the well as a result of the hydrostatic pressure exerted by the surrounding water column. Following the bladder fill cycle, a length of rigid tubing running from the pump to the surface is pushed downward at the surface in order to collapse the bladder and push water to the surface. The pumping sequence consists of repeated fill-compress cycles, using either a hand-operated crank or an electric motor and actuator positioned on the top of the well head. The narrow-diameter sampling pump with an inert bladder design offers the advantage of minimizing sample turbulence, which can result in loss of VOCs in the sample, as well as eliminating contact of the water with an air vacuum and further potential VOC losses.

Pump accessories include a hand-crank mechanical actuator, an electric-motor actuator (currently under development) and various tubing configurations. The measured flow rate of the pump (equipped with the motor-driven actuator) at a depth of 35 feet below the surface with a 30-foot water column above the pump was approximately 100 mL/min. Higher flow rates were observed with the hand-crank actuator accessory.

Costs for the pump and accessories are as follows: pump, $430; mechanical actuator, $240; electrical actuator (undetermined). Concentric tubing sets are priced as follows: HDPE (outer) /FEP (inner), $100 per 50-foot roll; HDPE/LDPE, $54 per 50-foot roll.

VERIFICATION OF PERFORMANCE

The following performance characteristics of the Model MB470 mechanical bladder pump were observed:

Precision: The precision of the sampler was determined through the collection of a series of replicate samples from a number of standpipe trials that included known concentrations of inorganic cations and VOCs. Sampler depths ranged from 17 to 76 feet. Sampler precision, represented by the percent relative standard deviation, for all target cation compounds at all concentrations and sampling depths evaluated in this study ranged from 0.3 to 5.0 percent with a median value of 0.9 percent. Precision for VOCs at a single concentration and multiple sampler depths ranged from 0.2 to 3.4 percent with a median value of 1.2 percent. Pump precision measured in the Tyndall field trials was similar to that observed in the standpipe trials for the target cations. Tyndall monitoring-well field trials revealed considerably more variability in the replicate samples from the pump and co-located reference sampler for VOCs.

Comparability with a Reference: Mechanical bladder pump results from the standpipe trials were compared with results obtained from co-located external reference port samples that were collected simultaneously. Both bladder pump and external port samples were analyzed at an off-site laboratory using standard EPA methods for inorganic cations and VOCs. Sampler comparability is expressed as percent difference relative to the external port data. Sampler differences for all target cations compounds at all concentrations and sampler depths in this study ranged from -12.6 to 3.6 percent with a median percent difference of 0.0. Sampler differences for all VOC compounds at all sampling depths ranged from -5.0 to -0.3 percent with a median value of -2.5 percent.

Two statistical tests, the F-ratio test and the t-test for two sample means, were used to assess whether the observed differences at the standpipe between the mechanical bladder pump and external port sample precision and mean pump and external port target compound concentrations were statistically significant. The tests show that the observed differences between the bladder pump and port samples with regard to both precision and accuracy can be attributed to random variation. Thus, no statistically significant difference exists between the results from the bladder pump and the external port samples.

The comparability of the pump with the reference sampling method for target cations at Tyndall monitoring wells was similar to that observed during the standpipe trials. Comparability results for VOCs were considerably more variable with percent differences ranging from -29.6 to 34.6 percent with a median value of -8.3 percent for all compounds detected at Tyndall. The controlled aspects of the standpipe tests should be considered in combination with the Tyndall field test results for a comprehensive understanding of pump performance.

Versatility: Sampler versatility is the consistency with which it performed with various target compounds, concentration levels, and sampling depths. The mechanical bladder pump performance did not vary with changes in compounds or concentration levels. Deployment of the pump at depths in excess of 50 feet may result in flow rates that are deemed unacceptable for some sampling applications. In general, the Geoprobe mechanical bladder pump is regarded as a versatile technology and applicable for sampling the types of inorganic and VOC contaminants from narrow-diameter direct push wells.

Logistical Requirements: The sampler can be deployed and operated in the field by one person. Several hours of training are adequate to become proficient in the use of the system. The system requires a source of DC or AC power when used with the electric-motor actuator (currently under development). The bladder pump can be used as a dedicated sampler or as a movable sampler; however, decontamination procedures are required when moving the pump from well to well.

Overall Evaluation: The results of this verification test show that the Geoprobe mechanical bladder pump and associated mechanical actuator accessories can be used to collect inorganic cation- and VOC-contaminated water samples from monitoring wells such that results are statistically comparable to reference samples. The system is specifically designed for use in narrow-bore (0.5-inch minimum internal diameter) wells. Furthermore, the pump is compatible with sampling programs that incorporate low-volume purge methodologies.

As with any technology selection, the user must determine if this technology is appropriate for the application and the project data quality objectives. For more information on this and other verified technologies visit the ETV web site at http://www.epa.gov/etv.

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