THE ENVIRONMENTAL TECHNOLOGY VERIFICATION PROGRAM

ETV JOINT VERIFICATION STATEMENT

TECHNOLOGY TYPE:	**GROUND WATER SAMPLING TECHNOLOGIES**
APPLICATION:	**VOC-CONTAMINATED WATER SAMPLING**
TECHNOLOGY NAME:	**Micro-Flo -- Model 57400 Bladder Pump and Model 5001 Pump Cycle Controller**
COMPANY:	**GeoLog Inc.**

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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 substantially 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.

The Site Characterization and Monitoring Technologies Pilot, one of 12 technology areas under ETV, is administered by EPA's National Exposure Research Laboratory. Sandia National Laboratories, a Department of Energy laboratory, is one of the verification testing organizations within the ETV Site Characterization and Monitoring Technologies Pilot. Sandia collaborated with personnel from the US Geological Survey (USGS) to conduct a verification study of groundwater sampling technologies. This verification statement provides a summary of the results from a verification test of the Micro-Flo bladder pump and pneumatic controller manufactured by GeoLog Inc.

DEMONSTRATION DESCRIPTION

In August 1999, the performance of six ground water sampling technologies was evaluated at the US Geological Survey Hydrological Instrumentation Facility at the National Aeronautics and Space Administration (NASA) Stennis Space Center in southwestern Mississippi. Each technology was independently evaluated in order to assess its performance in the collection of volatile organic compound- (VOC) contaminated water.

The verification test design incorporated the use of a 5-inch-diameter,100-foot standpipe at the USGS facility. The standpipe, serving as an "aboveground" well, was filled with water spiked with various concentration levels of six target volatile organic compounds. The target compounds (1,2-dichloroethane, 1,1-dichloroethene, trichloroethene, benzene, 1,1,2-trichloroethane, and tetrachloroethene) were chosen to represent the range of VOC volatility likely to be encountered in normal sampler use. 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. A total of seven trials were carried out at the standpipe. The trials included the collection of low (~20 µg/L) and high (~200 µg/L) concentrations of the six target VOC compounds in water at sampler depths ranging from 17 to 91 feet. A blank sampling trial and an optional "clean-through-dirty" test were also included in the test matrix. The "clean-through-dirty" test was included to investigate the potential of contaminant carryover as a sampler is lowered through a "dirty" (high VOC concentration) layer of water in order to sample an underlying "clean" (low VOC concentration) layer. The test was optional for samplers such as the Micro-Flo bladder pump, which is designed for dedicated use in a monitoring well.

The standpipe trials were supplemented with additional trials at ground water monitoring wells in the vicinity of sites with VOC-contaminated ground water at the NASA Stennis facility. The technologies were deployed in a number of 2-inch and 4-inch wells, along with collocated submersible electric gear pumps as reference samplers. The principal contaminant at the onsite monitoring wells was trichloroethene. The onsite monitoring provided an opportunity to observe the operation of the sampling system under typical field-use conditions.

All technology and reference samples were analyzed by the same field-portable gas chromatograph-mass spectrometer (GC/MS) system that was located at the test site during the verification tests. The GC/MS analytical method used was a variation of EPA Method 8260 purge-and-trap GC/MS, with the use of a headspace sampler in lieu of a purge-and-trap unit. The overall performance of the ground water sampling technologies was assessed by comparison of technology and reference sample results with particular attention given to key performance parameters such as sampler precision and accuracy. Aspects of field deployment and potential applications of the technology were also considered.

Details of the demonstration, including an evaluation of the sampler's performance, may be found in the report entitled *Environmental Technology Verification Report: GeoLog Inc. Micro-Flo Bladder Pump,* EPA/600/R-00/075.

TECHNOLOGY DESCRIPTION

The Micro-Flo bladder pump consists of an internal flexible bladder that is positioned within a rigid stainless steel pump body. The inner bladder is equipped with one-way inlet and outlet 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 fill cycle, compressed air or nitrogen from a cylinder or compressor at the wellhead is driven down to the pump through tubing to compress the bladder, thus driving the water sample up to the surface through a second tubing line. The pumping sequence consists of repeated fill–compress cycles, using a pneumatic controller positioned at the wellhead. The controller is used to vary the duration and frequency of the fill–compress cycles in order to deliver the desired sample flow rate at the wellhead. The bladder design offers the advantage of minimizing sample turbulence, which can result in loss of VOC in the sample, as well as eliminating contact of the water sample with the compressed air or nitrogen used to lift the sample to the surface.

GeoLog offers bladder pumps constructed with stainless steel and Teflon or polyvinyl chloride and Teflon. The pump tested during this evaluation was the Model 57400, which is the stainless steel and Teflon version. The pump is 24 inches long with a 1.66-inch external diameter and a weight of 2.5 pounds. The volumetric capacity of the pump is 225 mL. The pump intake stainless steel screen mesh size was 0.25 mm (0.01 inch). The pump can operate at pressures up to 200 psi, which is equivalent to a lift capacity of about 460 feet.

A GeoLog Model 5001 pneumatic controller was used to control the flow of compressed nitrogen, obtained from a cylinder or compressor at the wellhead, to the bladder pump. The controller has dimensions of $14.5 \times 10 \times 9$ inches and weighs 15 pounds. Drive air for the bladder pump can be delivered from compressed gas cylinders or from a field-portable gasoline-powered compressor.

The bladder pump tested costs $425 and the controller is priced at $1,295. Teflon-lined polyethylene tubing is also a requirement for most VOC sampling applications and is priced at $2.25 to $2.75 per foot.

VERIFICATION OF PERFORMANCE

The following performance characteristics of the Micro-Flo bladder pump were observed:

Precision: The precision of the sampler was determined through the collection of a series of replicate samples from 4 standpipe trials using low (~20 µg/L) and high (~200 µg/L) VOC concentrations at 17-foot and 91-foot collection depths. Each trial included 6 target VOCs for a total of 24 cases. Micro-Flo pump precision, represented by the relative standard deviation, for all compounds at all concentrations and sampling depths evaluated in this study, ranged from 2.7 to 26.7%, with a median value of 8.5%. In 18 cases, the relative standard deviation of the Micro-Flo bladder pump was greater than the reference, with Micro-Flo pump precision less than or equal to reference sample precision in the other 6 cases. The F-ratio test was used to assess whether the precision differences were statistically significant. Test results showed that precision differences between Micro-Flo and reference samples were statistically insignificant at the 95% confidence level in all of the 24 test cases.

Comparability with a Reference: Micro-Flo bladder pump results from the standpipe trials were compared with results obtained from reference samples collected at the same time. Both Micro-Flo and reference samples were analyzed by the same analytical method using the same GC/MS system. Sampler comparability is expressed as percent difference relative to the reference data. Sampler differences for all target VOC compounds at all concentrations and sampler depths in this study ranged from –21 to 27%, with a median difference of –1%. The t-test for two sample means was used to assess whether the differences between Micro-Flo and reference sample results were statistically significant. These tests showed that in 17 of 24 trials, differences were statistically indistinguishable from 0% at the 95% confidence level. Statistically significant negative bias did not exceed – 21% (4 cases) and statistically significant positive bias did not exceed 27% (3 cases).

Versatility: Sampler versatility is the consistency with which the sampler performed with various target compounds, concentration levels, and sampling depths. Sampler performance did not significantly vary with changes in compound volatility, concentration, or sampler depth and the sampler is judged to be widely applicable to the variety of groundwater sampling situations likely to be encountered in field use.

Logistical Requirements: The sampler can be deployed and operated in the field by one person. One day of training is generally adequate to become proficient in the use of the system. The system requires a source of compressed air or nitrogen at the wellhead, such as a compressed gas cylinder or a gas-powered compressor. The bladder pumps are designed for dedicated use in a monitoring well; however, the system can also be moved from well to well.

Overall Evaluation: The results of this verification test show that the Micro-Flo bladder pump and associated pneumatic controller can be used to collect VOC-contaminated water samples that are statistically comparable to a reference method with regard to both precision and comparability with a reference sample. The results of a clean-through-dirty test revealed some sampler carryover of contaminants from an overlying dirty water column into an underlying clean water column. The system is designed for use in well-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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