THE ENVIRONMENTAL TECHNOLOGY VERIFICATION PROGRAM

ETV JOINT VERIFICATION STATEMENT

TECHNOLOGY TYPE:	**GROUNDWATER SAMPLING TECHNOLOGIES**
APPLICATION:	**VOC-CONTAMINATED WATER SAMPLING**
TECHNOLOGY NAME:	**GORE-SORBER Water Quality Monitoring**
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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 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 Pilot. Sandia collaborated with personnel from the U.S. Geological Survey to conduct a verification study of groundwater sampling technologies. This verification statement provides a summary of the results from a verification test of GORE-SORBER Water Quality Monitoring technology manufactured by W. L. Gore and Associates, Inc.

DEMONSTRATION DESCRIPTION

In August 1999, the performance of six groundwater sampling technologies was evaluated at the US Geological Survey (USGS) Hydrological Instrumentation Facility at the National Aeronautics and Space Administration 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 "above-ground" well, was filled with tap 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 over the same time interval that the passive membrane samplers were exposed to the water inside the standpipe. Two trials were carried out at the standpipe. The first trial was a relatively low (~20 µg/L) concentration level mixture of the six target VOCs. The second trial incorporated a slowly changing concentration in the standpipe at higher (~200 µg/L) concentrations. The modules were tested at five depths ranging from 17 to 53 feet.

The standpipe trials were supplemented with additional trials at groundwater monitoring wells in the vicinity of sites with VOC-contaminated groundwater at the NASA Stennis facility. The GORE-SORBER modules were deployed in five 2-inch and 4-inch wells, along with co-located 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 GORE-SORBER modules were analyzed using a gas chromatograph-mass spectrometer (GC-MS) at the W. L. Gore and Associates, Inc. (Gore) laboratory since the sampler is sold with analysis included. The Gore laboratory uses a modified method derived from EPA Methods SW-846 8260 and 8270. All reference samples were analyzed by two identical field-portable GC-MS systems that were located at the test site during the verification tests. The GC-MS analytical method used for the reference samples was a variation of EPA Method 8260 purge-and-trap GC-MS, incorporating a headspace sampling system in lieu of a purge and trap unit. The overall performance of the groundwater 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: W. L. Gore and Associates, GORE-SORBER Water Quality Monitoring,* EPA/600/R-00/091.

TECHNOLOGY DESCRIPTION

The GORE-SORBER module consists of a water impermeable membrane surrounding an adsorbent material that is used to collect volatile and semi-volatile compounds in water. When placed in the screened, saturated interval of a monitoring well or piezometer, the waterproof, vapor-permeable membrane collector housing allows for the selective movement of volatile and semi-volatile organic compounds across the membrane onto the adsorbent. The hydrophobic nature of the membrane restricts liquid water transfer across the membrane.

A GORE-SORBER module consists of four separate sorber packets combined into a single sampling unit. A typical sorber packet is about 25 mm in length, 3 mm in diameter, and contains 40 mg of a granular adsorbent material that is selected on the basis of the specific compounds to be detected. Proprietary polymeric and carbonaceous resins are used as the sorbent material because of their affinity

for a broad range of VOCs and semi-VOCs. The sorber packets are sheathed in the bottom of a length of vapor-permeable insertion and retrieval cord that includes a loop attachment. The four sorber units and associated membrane cord are collectively termed the GORE-SORBER module. Both the retrieval cord and sorbent container are constructed solely of inert, hydrophobic, microporous membrane. Every module has sufficient sorbers such that there are always a minimum of two samples available in each module for use as duplicates or backups as needed. A unique feature of the membrane is that it is hydrophobic, excluding the transfer of liquid water across the membrane, while facilitating vapor transfer. Thus, VOC and SVOC vapors can penetrate the sorbent module freely and collect on the adsorbent material. Depending on the membrane characteristics, liquid water transfer across the membrane will be limited up to a particular depth, and therefore, it is important to know the desired depth of installation. Different membranes can be used for different installation depths, and GORE technical support personnel can help in membrane selection. Standard (STND) and high water entry pressure (HWEP) membranes were evaluated in this verification test.

The sampling modules are compact and completely passive. They are fastened to a string and stainless steel weight, suspended in the well, normally at the mid-screen location, and left in place for 48 hours. Upon retrieval they are placed in airtight containers and overnight shipped to the Gore laboratory. Laboratory analysis options for the sorbent modules include methods for the determination of volatile organic compounds, semi-volatile organic compounds, and polycyclic aromatic hydrocarbons. In addition to these common suites of compounds, the samples can also be analyzed for specific groups of compounds; i.e., fuel hydrocarbons, chlorinated organics, and others. The analyses follow modified EPA SW846 Methods 8260 for VOCs, and 8270 for semi-VOCs. All analytical services on GORE-SORBER modules are performed at the W.L. Gore & Associates, Inc. laboratory in Elkton, MD.

VERIFICATION OF PERFORMANCE

The following performance characteristics of the GORE-SORBER Water Quality Monitoring system were observed:

Precision: The precision of the sampling modules, under stable concentration conditions, was determined by the collection of replicate samples in a standpipe trial in which the target concentration levels were about 20 µg/L at water column depths ranging from 17 to 46 feet. GORE-SORBER STND membrane module precision, represented by the relative standard deviation, for all target VOC compounds at 17- and 28-foot sampling depths ranged from 2 to 28% with a median value of 14%. GORE-SORBER HWEP module relative standard deviations at 17-, 28-, 35- and 46-foot depths ranged from 9 to 35% with a median of 21%. Reference method relative standard deviations, under similar sampling, conditions ranged from 3 to 17% with a median value of 12%.

Comparability with a Reference: GORE-SORBER module results are reported in terms of total mass of VOC collected in the module. In this format, the data are not directly comparable to the concentration data derived from conventional groundwater monitoring. The first deployment of a module is usually accompanied by the collection and analysis of a conventional groundwater sample, which enables comparison of the two data formats. The correlation between GORE-SORBER modules data and conventional groundwater sample data was carried out by deploying GORE-SORBER modules and reference pump in five different wells with known TCE contamination. Trichloroethene concentration in these 5 wells ranged from 5 to 2,000 µg/L. The observed correlation between GORE-SORBER module data and reference sample data was very good. The correlation coefficients for the STND and HWEP modules were 0.997 and 0.998 respectively.

Versatility: The versatility of the GORE-SORBER module in typical field screening and monitoring applications for VOC compounds in groundwater is as follows: The modules have limited versatility in terms of deployment depth since the maximum deployment for which they are rated is a water column depth of 50 feet. The modules have wide versatility in terms of the number of compounds detected

since they can sample both VOCs and semi-VOCs. The modules are judged to have limited versatility in terms of application to monitoring for regulatory compliance by virtue of their moderate (15-30% relative standard deviation) precision.

Logistical Requirements: The sampling modules can be easily deployed and retrieved in the field by one person. An hour of training is generally adequate to become proficient in the use of the samplers. The samplers require a 48-hour exposure interval, and thus two trips are required to the well for deployment and retrieval. The modules are completely passive and require no external power for operation. Following retrieval, the samplers are shipped to the Gore analytical laboratory by overnight mail. Refrigeration of the sample during shipment is not required. In order to estimate groundwater concentrations, the GORE-SORBER module must be periodically accompanied by co-located conventional groundwater sampling and analysis. Vendor recommendations are, at the onset of sampling, to deploy the modules and conventional methods in two parallel sampling events to establish the relationship between the two sampling methods. Thereafter, annual parallel sampling events are suggested.

Overall Evaluation: The results of this verification test show that the GORE-SORBER Water Quality Monitoring system can be used to monitor long-term concentration trends of VOCs in monitoring wells. The GORE-SORBER modules are designed and are optimally suited for relatively low-cost VOC concentration trend monitoring and screening. They are well suited for plume edge monitoring to detect general concentration trends. The technology does require the periodic collection and analysis of co-located reference samples in order to interpret the data from GORE-SORBER module in terms of water concentration.

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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