Sampling and Remedial System Design Optimization Through Passive Soil Gas Screening

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A passive soil gas (PSG) survey that employs innovative Gore-Sorber (W.L. Gore and Associates) technology is used to determine the extent of groundwater and soils contamination and remedial investigation solutions for a naval facility with dissolved contaminants and nonaqueous-phase liquids (NAPL) in groundwater and soils. Chemical-specific PSG modules, placed in grids, are used to determine potential contaminant sources and geometries of the contaminant plume(s). Results of the PSG screening are used to reduce and optimize the number of soil and groundwater sampling locations required to help develop risk-based remedial alternatives. Each module consists of chemical-specific organic compound-sensitive resins encapsulated in a Gore-Tex sleeve, which is inserted 3 feet into the ground in a predrilled hole. Because the modules adsorb soil gasses over a 2-week period under atmospheric pressures and temperatures, the data are not biased by soil texture, moisture, or changing ambient surface and subsurface conditions. After 2 weeks, the modules are removed and analyzed by gas chromatography/mass spectroscopy (GC/MS). The length of time from module installation through report delivery is 6 weeks. This Environmental Protection Agency accepted PSG screening technology provides a low-cost expedient method of reducing characterization costs and optimizing sampling and remedial system design and monitoring requirements.

The investigation site has been used for fire fighting training. During training and test exercises, fires set on a concrete deck were fanned by propeller wash from a turboprop aircraft. Trainees used aqueous film forming foam at 1 percent dilution with water to extinguish the fires. Fuels used to generate the fires included JP-4 and JP-5. From 1979 to 1987, a mixture of water, unburned fuel, and aqueous film forming foam was discharged to an unlined evaporation pond during the course of these activities. The investigation site is bounded by bedrock outcrops to the north, east, and south. A playa (dry lake) is located to the west of the site.

Floating fuel product and dissolved-phase volatile and semivolatile organic compounds (VOC and SVOC) have been detected in soil and groundwater beneath the evaporation pond. Other potential hydrocarbon contamination source areas include the former locations of two aboveground fuel storage tanks, in-place fuel pipelines, and NAPL that may be trapped under the concrete pad. The results of previous investigations have indicated that a dissolved-phase hydrocarbon contaminant plume emanates from the unlined evaporation pond and extends approximately 400 feet to the northwest. A subsurface bedrock channel appears to provide a preferential pathway for contaminant movement into the playa. To complete the characterization of the site and to develop the appropriate remedial alternatives, the source areas and nature and extent of soil and groundwater contamination must be established. The PSG survey is being conducted to establish contaminant source areas, delineate the extent of soil and groundwater contamination, and determine the optimal placement of sampling locations for risk assessment.

A total of 72 PSG modules are installed in a series of grids at a depth of 3 feet (1) in and around

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the northeast extent of the NAPL and dissolved-phase plume near and northwest of the site, (2) in and around the former location of the aboveground storage tanks, (3) along the buried fuel pipeline, and (4) within and near the southern edge of the concrete pad (Figure 1). A PSG module consists of a 1-foot long Gore-Tex sleeve containing resins sensitive to organic compounds; the sleeve is attached to a 3/4-inch diameter cork by string. A 5/8-inch diameter solid steel rod (tile probe) is driven into the ground to a depth of 3 feet using a slide hammer or portable electric hammer drill. The PSG module is placed in the hole using a 1/8-inch diameter by 4-foot long, steel rod. After insertion, the installation rod is removed, and the cork is pushed firmly into the top of the hole at the ground surface to seal the hole. The PSG modules remain in place for approximately 2 weeks to allow time for the soil vapors to be adsorbed by the organic resins. As a result, the PSG screening technology provides good results for sites with either dry or saturated and low to high permeability soils and minimizes fluctuations in soil gas availability due to changing ambient and subsurface conditions.

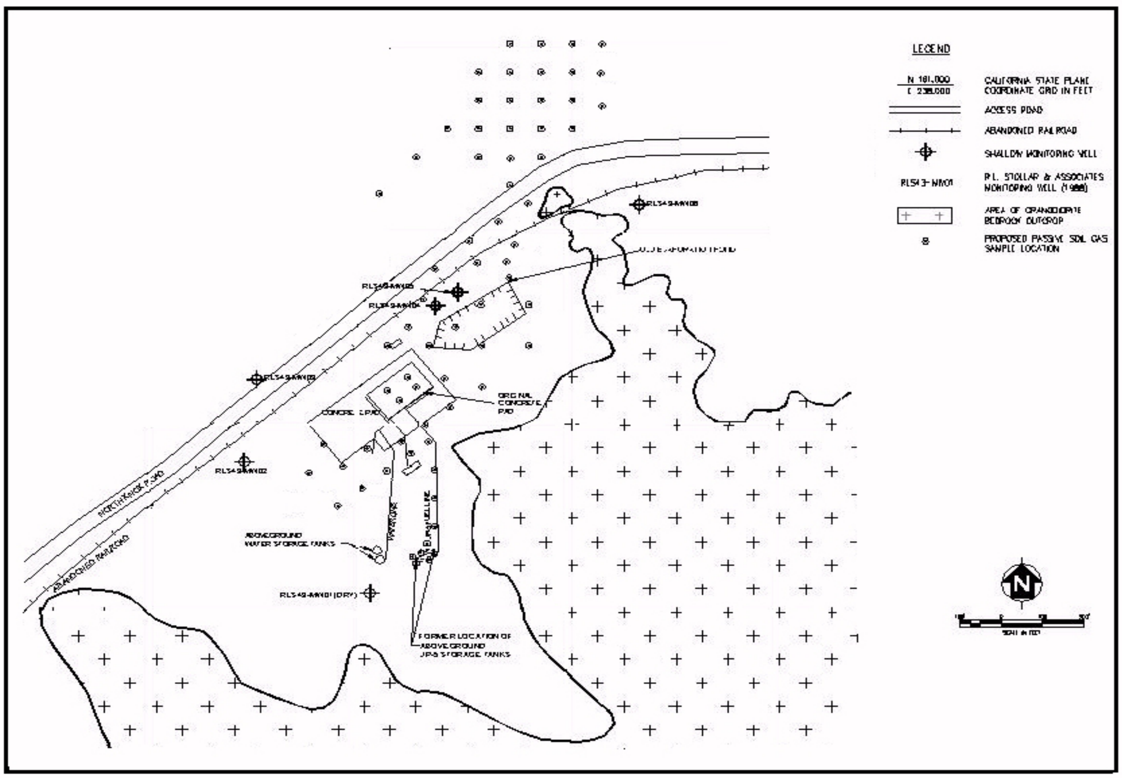

Figure 1. General site plan and PSG module installation grid.

After the required 2-week sampling period, the modules are retrieved from the field and shipped to the PSG module manufacturer's analytical laboratory for chemical analysis for selected polynuclear aromatic hydrocarbons, VOCs, and SVOCs by thermal desorption or solvent extraction coupled with GC/MS. The analytical laboratory then prepares a report that includes the results of all analyses in tabular format and isoconcentration contour maps for selected compounds.

The results of the PSG survey will be used to identify areas of impacted soil and groundwater in order to select and target the soil boring drilling and sampling locations for a human health and ecological risk assessment. The decision rule for additional sampling is based on the value of the mass concentration for a given chemical of potential concern (COPC). If a PSG sample has a COPC value that is equal to or greater than 20 percent over the minimum detection limit, then the area where the sample was collected will be considered for additional investigation as a source area. Alternatively, if the mass concentration is less than 20 percent of the minimum detection limit, then the area where the sample was collected will not be considered as a contaminant source area and will be removed from further consideration as an area of investigation.

PSG surveys offer the following technical and cost advantages over conventional active soil gas (ASG) surveys. First, the PSG survey can be used to determine the presence of specific VOCs and SVOCs in the subsurface, whereas conventional ASG surveys are limited to mainly VOC screening. Secondly, the PSG sorbant module is contained within an inert, hydrophobic, microporous membrane that is left in place for a soil-vapor contact time of 2 weeks (in situ sampling), whereas the ASG screening technology uses a low-flow vacuum pump to extract soil vapors (grab sampling) in a single event. As a result, the vapor samples collected using PSG screening are more representative of ambient conditions than those collected using ASG screening. The ability of the Gore-Tex membrane to enable vapors to collect while keeping moisture out over a longer contact time allows the PSG screening technology to be applied under a wide variety of soil permeability and moisture conditions.

PSG screening technology is an effective decision-making tool because it enables samples to be collected and analyzed in a fraction of the time that it would take to install soil borings, collect soil and groundwater samples, and receive validated analytical results. PSG screening results lead to cost savings in future sampling endeavors since they can be used to establish the optimal placement of soil borings or monitoring wells, thereby minimizing drilling and sampling by conventional methods and thus reducing exposures to hazardous substances and the volume of investigation-derived waste. Analytical costs can be minimized since fewer samples need to be collected and can be analyzed for known COPCs, establishing a baseline that can be used to determine the feasibility of remedial alternatives and to monitor the effectiveness of the selected remedial alternative once it is implemented.

Biography

Katherine Monks is a senior hydrogeologist with Tetra Tech EM Inc. She has over 15 years of experience in hydrogeology, groundwater modeling, and hydrogeochemistry and holds a M.S. in Geology/Hydrogeology from Wright State University.

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