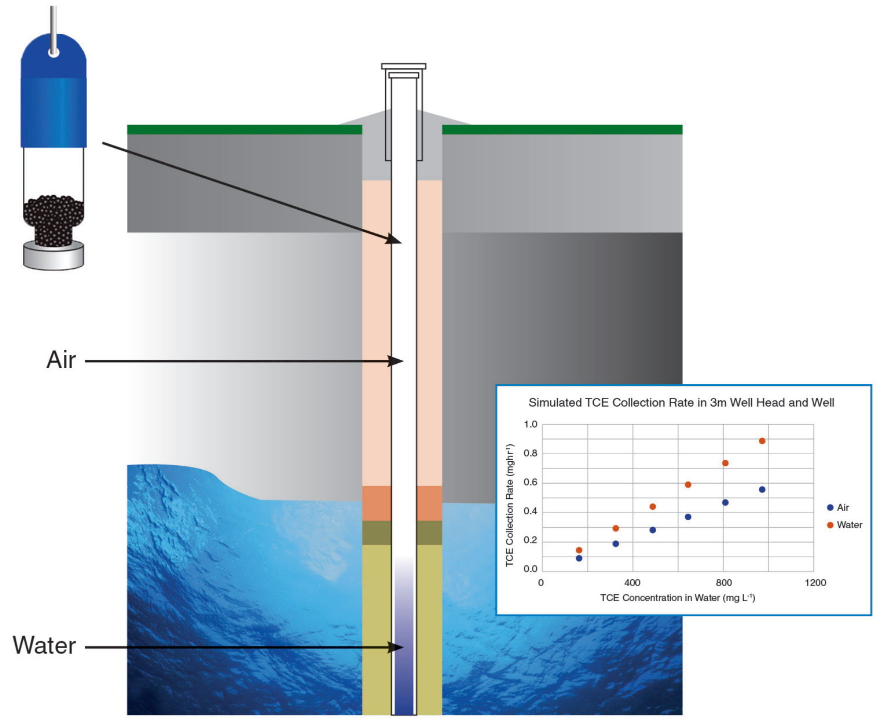
In-Well Headspace Samplers for Long-Term Groundwater Chlorinated Hydrocarbon Monitoring



By suspending samplers in well headspace (and by adding additional transitions) deployments can be lengthened to integrate in situ concentrations over long collection periods.

OBJECTIVE:

This project will validate the use of commercially available passive samplers for long-term monitoring of groundwater chlorinated hydrocarbon concentrations.

PROBLEM STATEMENT:

The Navy and Marine Corps Environmental Restoration (ER) sites may contain fuels, chlorinated solvents, explosives and/or heavy metals. Over 3,500 sites are identified within the Navy's area of responsibility. Remedies often require long-term (over 30 years) operation and maintenance due to persistence of these substances, site complexity or a combination of both. Because site managers must balance risk, costs and outcomes that satisfy regulators and stakeholders, there is a persistent need for methodological improvements to provide long-term fate and transport data for the substances in question.

Discrete (grab) sampling to obtain concentrations of these substances is expensive and may yield inconsistent results. For instance, quarterly or yearly sampling provides only punctuated information on transport, dynamics and fate of the targeted compounds. Passive samplers installed in groundwater wells offer an attractive alternative because they can be deployed for longer timeframes than discrete sampling can provide. They reduce costs by decreasing purge water disposal, equipment use or rental and time spent on-site by personnel.

Passive sampler disadvantages or limitations are that they must have sufficient sorptive capacity for the analytes in question, may be subject to diffusive filtration, may experience trapped biodegradation of the targeted compounds during longer deployments and may not be able to be deployed in wells with free product (e.g. floating analyte layers which might overwhelm the sampler during deployment or removal). Time-averaged sampling is widely needed at clean-up sites, but may be difficult given current sampler limitations.

DESCRIPTION:

This project team will tackle the limitations of passive in-water samplers by deploying modified passive sampling systems within screened groundwater wells. By deploying traps within a well headspace, atmospheric interferences can be eliminated. Disadvantages of passive in-water samplers such as biofouling, analyte biodegradation, diffusive effects and deployment time limitations may also be minimized by this placement.

> *The technology innovation will allow a potentially broader time and space domain for sampling and understanding chlorinated solvent (and other compounds) distributions on-site.*

In-well diffusive samplers can be deployed to collect volatile organic compounds (chlorinated solvents in this demonstration) over long durations. Duration can be "tuned" by taking advantage of differential contaminant permeation rates through phase transitions between water, air, and permeation barriers. Collected samples can be thus time-averaged, and modeled. Zone of Influence (ZOI) models, similar to those developed for the Strategic Environmental Research and Development Program (SERDP)—under SERDP project no. ER-2338 (CO_2 Radiocarbon Analysis to Quantify Organic Contaminant Degradation, MNA and Engineered Remediation Approaches) can be used to calculate the sampling volume given hydrogeologic parameters and the physical properties of the targeted compounds. The technology innovation will allow a potentially broader time and space domain for sampling and understanding of chlorinated solvent (and other compounds) distributions on-site.

This design innovation merges passive in-water and air sampling technologies in an effort to maximize the methodological strengths, minimize weaknesses and increase the time domain for long-term sampling. Existing technologies will be used in a novel fashion, requiring minimal design efforts, focusing on how best to deploy the samplers within the monitoring well headspace.

Commercially-available diffusion samplers will be suspended in well headspaces above the screen intervals. These samplers are designed to work in high humidity environments and they accumulate analytes slowly, making them ideal for long-term deployments. The advantage for this type of deployment is that the targeted compound must first diffuse from the water phase to the gas phase (in the well headspace). This phase transition increases the time for diffusion into the sampler by a modellable margin. This rate reduction will increase the time a sampler can be deployed before being saturated with analyte. A very rough calculation puts the deployment time approximately 92 percent longer than currently used passive samplers (by simply suspending in the well headspace). Additionally, the sampler can be deployed within tubing containing permeation barriers with additional phase transitions (water lenses for instance). Tubes could also be deployed as a depth array in the well casing to determine vertical distribution of the targeted compund.

With no direct groundwater contact, biofouling and compound biodegradation could virtually be eliminated. Samplers will be deployed in conjunction with in-water passive samplers to determine the comparability. The team plans to use two commercially available samplers that have undergone adequate field testing to be used as passive sampler controls.

The project will begin with laboratory testing, followed by quarterly field deployment at two sites. (NASNI, San Diego, CA is the first site. The other site has yet to be established.) In-water samplers, low-flow traditional sampling and new headspace traps will be installed. ZOI modeling will be performed at each test site, followed by sample analysis, performance evaluation and cost analysis.

TRANSITION DESCRIPTION:

Results, models and data will be transitioned to end-users such as the Navy's Remedial Project Managers (RPM), contractors and regulators. A seminar will be developed and incorporated into the Open Environmental Restoration Resources Webinar Series, the Technical Insight and Problem Solving forum and/or the in-person Remediation Innovative Technology Seminar. Presentations will be made at major conferences and published in the proceedings. A guidance document will be generated for sampler design, use, recovery and analysis.

Interfacing with regulators will be done in conjunction with site RPMs and through developing work plans and sampling and analysis plans. Given the Principal Investigator's deployment history at several sites proposed here, access to regulators and strong working relationships have already been forged. As the team has already obtained interest from several RPMs, follow-on studies will be proposed at sites unable to be demonstrated during this project.

CONTACT:

For more specific information about this project, contact the Principal Investigator at 202-404-6424. Contact the NESDI Program Manager at 805-982-4893 for more general information about the program.

ABOUT THE NESDI PROGRAM

The Navy Environmental Sustainability Development to Integration (NESDI) program is the Navy's environmental research and development demonstration and validation program, sponsored by the Chief of Naval Operations Energy and Environmental Readiness Division and managed by the Naval Facilities Engineering Systems Command from the Engineering and Expeditionary Warfare Center in Port Hueneme, CA. The mission of the program is to provide solutions by demonstrating, validating and integrating innovative technologies, processes and materials and by filling knowledge gaps to minimize operational environmental risks, constraints and costs while ensuring Navy readiness and lethality.

Visit the program's public website at https://www.navfac.navy.mil/NESDI for more information.