

# Technology Innovation News Survey

## Entries for April 1-15, 2023

### Market/Commercialization Information

**EPA REGION 1 RAF RES TO REMEDIAL ACTION SCOVILL**  
U.S. Environmental Protection Agency, Region 1 Contracting Office, Boston, MA  
Contract Opportunities on SAM.gov, Solicitation 68H0123R0002, 2023

This is a total small business set-aside under NAICS code 68H0123R0002. EPA Region 1 is seeking contractors that are qualified to provide the following services at the 25-acre Scovill Industrial Landfill Superfund Site, which is located in New Haven County, Connecticut: construction of a protective cap with nearby wetland restoration, limited targeted removal of contaminated soils throughout various areas to be placed under the cap, and the removal of select soil areas to be disposed offsite. The contract will be a multiple-award IDIQ contract with a period of performance of up to 30 months. Offers are due by 4:00 PM EDT on May 25, 2023. <https://sam.gov/opp/2afbb55c16f64a5c6d4c8b44501c724633/view>

**RAYMARK SUPERFUND SITE, STRATFORD CT OUA LANDFILL CAP**  
U.S. Army Corps of Engineers, North Atlantic Division, New England District, Concord, MA  
Contract Opportunities on SAM.gov, Solicitation W912WJ23X0005, 2023

This is a sources sought notice for marketing research purposes only under NAICS code 562910. The U.S. Army Corps of Engineers, New England District, is issuing this sources sought announcement to determine the interest, availability, and capability of (a) HubZone, Women-Owned, Service-Disabled Veteran-Owned, and Small Businesses. If the project proceeds, the solicitation is expected in October 2023, and the work is expected to begin in January 2024. A six- to nine-month duration is expected for the work. The proposed work is to construct a Resource Conservation and Recovery Act (RCRA) hazardous waste landfill cap and supporting infrastructure for the Raymark Superfund OUA Consolidation Area in Stratford, Connecticut. This project has the following major components: RCRA cap constructed per design and specifications; all Raymark waste material currently being excavated from various properties to be assumed on site and already consolidated at the landfill before the cap construction is to begin; the consolidated waste material will generally be to final subgrade elevations - however, some shaping, grading, and compaction of material will likely be required; an on-site, armored, and lined stormwater detention basin; 200' x 30' gravel building pad incorporated into the cap; supporting infrastructure, including but not limited to, swales, gas vent system, utility corridors, access roads and building pad; and robust air monitoring and dust prevention practices. Interested firms should demonstrate their project experience by providing two projects completed within the last 10 years. Capability packages are due by 1:00 PM EDT on June 8, 2023. <https://sam.gov/opp/20f7bb87378d4a42ab43d70944f8af72/view>

**CERCLA TCRA AT BURN SITES IN ROCKY MTN NP, CO**  
U.S. Department of the Interior, National Park Service (NPS), Washington Contracting Office, Lakewood, CO  
Contract Opportunities on SAM.gov, Solicitation 140P2123R0008, 2023

This is a total small business set-aside under NAICS code 562910. The NPS seeks a contractor to perform a response action under CERCLA at twenty-two burn sites within Rocky Mountain National Park that burned in the East Trough wildfire in October 2022. Limited to small businesses, the contractor shall perform confirmation sampling and analysis under a previously-prepared Sampling and Analysis Plan. In addition to the base items, cleanup of additional burned sites at two locations; risk assessments; and additional sampling and analyses are included as optional tasks. A payment bond (100%), performance bond (100%), and liability insurance will be required prior to contract performance. Rocky Mountain National Park is located in north-central Colorado ~55 miles northwest of Denver. The park is situated between the gateway communities of Estes Park to the east and Grand Lake to the west. There will be no site visit because the burn sites are inaccessible due to snow or seasonal road closures. Photos and maps are included in the RFP and prospective offerors are encouraged to research the park and sites using publicly-available information. The award will be a single firm-fixed-price construction contract. Offers are due by 11:00 PDT on May 24, 2023. <https://sam.gov/opp/12a0f9a1f6bc2708858d467d95e1d472/view>

**R – MCLELLAN CERCLA REMEDIAL INVESTIGATION AND RESPONSE ACTIONS**  
U.S. Department of the Air Force (USAF), Air Force Materiel Command, Air Force Installation and Mission Support Center, JBSA Lackland, TX  
Contract Opportunities on SAM.gov, Solicitation FA8903-23-R-0073, 2023

When the solicitation is released, it will be competed as a full and open competition under NAICS code 562910. The USAF requires A-E services in support of the Air Force Civil Engineer's environmental program area at the Former McClellan AFB in Sacramento, California. The goals of this anticipated task order (TO) are to accomplish a CERCLA Remedial Investigation (RI) and Response Actions that characterize the environmental conditions, define the nature and extent of per- and polyfluoroalkyl substances (PFAS) at the site, identify preliminary remedial alternatives, and identify and implement response actions (i.e., removal or interim remedial actions). The contractor is to produce all necessary documents to meet the goals of the task order. As the technical expert in emerging contaminants including knowledge of PFAS, the intent is that new or changing analytical methodologies, regulatory or DoD guidance and requirements, toxicity criteria and ecological benchmarks, and technologies to assess and remediate PFAS will be utilized throughout the Task Order. There is no solicitation at this time. <https://sam.gov/opp/4c3572c0e64f0b361673ab50e3a67e30e/view>

### Cleanup News

#### INNOVATIVE TECHNOLOGY SUPPORTS REMEDIATION SUCCESS AT LAKE CITY ARMY AMMUNITION PLANT

Milligan T. U.S. Army Environmental Command website, April 20, 2023

The environmental impacts of production at the Lake City Army Ammunition Plant (LCAAP) generated large quantities of potentially hazardous wastes, including oils/greases, solvents, explosives, and metals, some of which were released into the environment. LCAAP instituted an environmental restoration program in 1980 and the site was added to EPA's NPL in 1987. The cleanup is divided into 36 discrete areas of concern and four operable units to allow for the comprehensive planning, remediation, and measurement needed for a project of this scope and scale. A mature site with continuing remediation needs, work involves continually improving and upgrading the use of cutting-edge technology to produce high-resolution site assessment, aggressive monitoring, and treatment of NAPL while maintaining a strong community involvement program. Remediation includes clean up of waste pits that contain ~2 million lbs of petroleum hydrocarbons and chlorinated solvents and have extensive NAPL contamination. Limited zero-valent iron, established barriers, and hydraulic fracturing techniques prevented movement of the contaminants. Still, the restoration timeline estimated for the site remained at hundreds of years using these methods. An in situ thermal remediation system is now being used and has treated 28,000 bank yds of NAPL-contaminated waste pits. The process uses thermal gas conduction, high-resolution site assessment, and dye-induced fluorescence (DyeLIF). The DyeLIF system provided real-time NAPL results, allowing for a dynamic and adaptive strategy. This high-resolution site assessment has generated >100,000 readings to create a precise 3D model of the NAPL contaminants within the waste pits. Another example of innovative technology is the use of the in situ thermal remediation system to heat soil, groundwater, and NAPL contaminants within the waste pits to the boiling point of water for effective extraction and treatment, which dramatically improved restoration timelines. These efforts have gained LCAAP's team Secretary of the Army recognition for innovative planning and implementation of remediation efforts. See 2023 Secretary of Army Environmental Awaris document for more information: <https://www.dauw.ecd.mil/warwick/demos/files/sites/12/2023/04/23-Nominations-Summary-1-4-AS-5088-2.pdf>

#### PFAS FATE AND REMEDIATION: TREATMENT METHODS AND RESIDUAL WASTE STREAMS

Potter, P. I. Association of Clean Water Administrators 2023 Mid-Year Meeting, 15-16 March, Alexandria, VA, 40 slides, 2023

Currently, most assessments of thermal treatment methods use targeted PFAS quantification of a limited number of compounds. This targeted approach to assessing thermal treatment methods can overlook products of incomplete combustion (PICs). There is a critical need to assess the efficacy of existing and emerging thermal treatment methods to completely destroy PFAS. Non-targeted analysis of PFAS is required to properly evaluate the efficacy of these thermal treatment methods and to determine the fate of these compounds in thermal treatment systems. The ongoing work involves multiple bench, pilot-, and full-scale thermal systems treating a variety of materials. [https://rtpub.epa.gov/sls/public\\_report\\_report.cfm?URLEntryId=35736381&ab=CFSE&simplesearch=0&showCriteria=2&sortBy=pubDate&timeType=8&dateBeginPublisbedPresented=06/15/2018&searchAll=remediation](https://rtpub.epa.gov/sls/public_report_report.cfm?URLEntryId=35736381&ab=CFSE&simplesearch=0&showCriteria=2&sortBy=pubDate&timeType=8&dateBeginPublisbedPresented=06/15/2018&searchAll=remediation)

#### DISTINGUISHING NOISE FROM SIGNAL IN THE MEASUREMENT OF NATURAL SOURCE ZONE DEPLETION (NSZD) RATES AT PETROLEUM CONTAMINATED SITES

Zimbron, J.A. I REMTECH 2022: The Remediation Technologies Symposium, Banff, AB, Canada, 11-14 October. Environmental Services Association of Alberta, Edmonton, AB (Canada), 29 slides, 2022

This presentation addresses the different error sources on applying multiple methods to measure natural source zone depletion (NSZD) rates. Best practices that help achieve a degree of measurement uncertainty commensurate with different measurement objectives are discussed. Three examples are provided with site data to illustrate sources of error due to temporal and spatial variations in the processes being measured: a) the use of background correction vs. a radiocarbon-based location-specific correction for a mass balance method based on CO<sub>2</sub> efflux measurements; b) the error sources from short-term vs. long-term measurements based on CO<sub>2</sub> efflux measurements; and c) the use of a background correction vs. a single stick method for a heat balance method. Among the different methods available, each method can control one or more sources of error (awareness of the specific traits of each method will allow practitioners to select methods compatible with the monitoring goals for each site and remedial stage combination. <https://esa.ca/wp-content/uploads/2022/11/18222Zimbron.pdf>

**Longer Abstract:** <https://esa.ca/wp-content/uploads/2022/11/18222Zimbron-Abstracts-51.pdf>

#### COMPARISON OF PFAS SOIL REMEDIATION ALTERNATIVES AT A CIVILIAN AIRPORT USING COST-BENEFIT ANALYSIS

Drenning, P., Y. Volchko, L. Ahrens, L. Rosen, T. Soderqvist, and J. Normann.  
Science of The Total Environment 882:163664(2023)

A probabilistic cost-benefit analysis for evaluating PFAS remediation alternatives, which includes monetization of direct costs and benefits as well as externalities, is presented. A case study using the method compared five remediation alternatives to manage PFAS-contaminated soil at Stockholm Arlanda Airport in Sweden. The net present value (NPV) of each remediation alternative was calculated and compared to two reference alternatives ('total excavation of the site or 'do nothing'). Sensitivity analyses and model scenarios were tested to account for uncertainties, including small or large PFAS spreading and simulating different values for the magnitude of the annual avoided cost of inaction from PFAS remediation. Four of the five remediation alternatives resulted in a positive mean NPV compared to total excavation. Excavation and stabilization/solidification of the onsite hotspot combined with stabilization using activated carbon for the remainder of the site had the highest NPV for both spreading scenarios (Alt 2) and was the most socially profitable alternative. Simulations of the annual avoided cost of inaction enabled estimation of the breakeven point at which a remediation alternative becomes socially profitable (NPV > 0) compared to 'do nothing'. Alt 2 had the lowest breakeven point: 7.5 and 5.75 millions SEK/year for large and small spreading, respectively.

### Demonstrations / Feasibility Studies

#### FIELD-SCALE INVESTIGATION OF PER- AND POLYFLUOROALKYL SUBSTANCES (PFAS) LEACHING FROM SHALLOW SOILS TO GROUNDWATER AT TWO SITES IN NEW HAMPSHIRE, 2021-2022

Santangelo, L.M., S.M. Welch, A.K. Tokranov, A.F. Drouin, K.E.A. Schlosser, J.M. Marts, T.A. Lincoln, N.A. Deyette, and K. Perkins. U.S. Geological Survey data release, 2023

PFAS and related chemical and physical data are presented from shallow soil and groundwater sampling conducted at the Brentwood Fire Training Area and White Farm sites in New Hampshire, both known to contain PFAS. Soil samples were collected in a gridded pattern across each site. Soil horizons within the sampling intervals were described using the National Soil Survey Center Natural Resources Conservation Service U.S. Department of Agriculture Field Book for Describing and Sampling Soils (<https://www.nrcs.usda.gov/resources/guides-and-instructions/field-book-for-describing-and-sampling-soils>). Analyses included 36 PFAS compounds, 36 PFAS compounds post-total oxidizable precursor assay (TOPA), total organic carbon (TOC), moisture content, pH, autoclaved extractable protein, grain size, major ions, and other physical and physico-chemical parameters. Groundwater samples were collected over five years to meet PFAS regulations. Temporary treatment systems were accepted as full-scale pilot systems, leading to the optimum design and construction of three separate full-scale permanent PFAS treatment systems. The MacPherson and Shabokin wells were treated using granular activated carbon, and the Patton Well was treated using ion exchange. With the temporary systems being used as pilot studies, operations were not always representative of what a permanent treatment system would entail. The team had to adapt to new challenges that arose throughout the study to ensure the system could supply water with non-detect PFAS concentrations. [https://www.journals.usgs.gov/digital-companion/1123\\_march\\_2023/20230401/field-scale-investigation-2021-2022/](https://www.journals.usgs.gov/digital-companion/1123_march_2023/20230401/field-scale-investigation-2021-2022/)

#### FULL-SCALE PILOT DEPLOYMENT AND ACCELERATED TREATMENT DESIGN PROVIDES RAPID RESPONSE TO PFAS THREATS

Francis, S. and B. Martin. I. Journal of the New England Water Works Association, Boston Vol. 137(1):19-30(2023)

Groundwater resources were impacted by various compounds, including PFAS, due to decades of military training and waste disposal activities at Fort Devins, a former military base. Through December 2017, all Devens Public Water Supply samples for PFOA and PFOS were below EPA's Health Advisory of 70 ppt. One of Devens three drinking water wells, the MacPherson Well, was taken offline when PFAS impacts indicated the well was at risk of being out of compliance, as sampling results indicated PFOS and PFOA concentrations as high as 69 ppt. The Shabokin and Patton wells were also at risk of being out of compliance. With all three source water wells impacted by PFAS, full-scale emergency efforts to implement temporary and permanent treatment systems were conducted over five years to meet PFAS regulations. Temporary treatment systems were accepted as full-scale pilot systems, leading to the optimum design and construction of three separate full-scale permanent PFAS treatment systems. The MacPherson and Shabokin wells were treated using granular activated carbon, and the Patton Well was treated using ion exchange. With the temporary systems being used as pilot studies, operations were not always representative of what a permanent treatment system would entail. The team had to adapt to new challenges that arose throughout the study to ensure the system could supply water with non-detect PFAS concentrations. [https://www.journals.usgs.gov/digital-companion/1123\\_march\\_2023/20230401/field-scale-investigation-2021-2022/](https://www.journals.usgs.gov/digital-companion/1123_march_2023/20230401/field-scale-investigation-2021-2022/)

#### PHYTOSCREENING FOR PER- AND POLYFLUOROALKYL SUBSTANCES AT A CONTAMINATED SITE IN GERMANY

Wurth, A., M. Mechler, K. Menberg, M.A. Kippar, R. Martus, R.S. Sohlmann, R.S. Boedinghaus, and P. Blum. I. Environmental Science & Technology 57(10):4122-4132(2023)

The applicability of phytoscreening was investigated to detect PFAS at a contaminated site in Germany. Foliage of white willow (*Salix alba* L.), black poplar (*Populus nigra* L.) and black alder (*Alnus glutinosa* L.) were sampled to evaluate seasonal and annual variations in PFAS concentrations. Phytoscreening results indicated species and specific differences, with the highest PFAS sum concentrations of 223 observed in October by white willow (0-1800 µg/kg), followed by black poplar (6.7-32 µg/kg) and black alder (0-13 µg/kg). The bulk substances in leaves were highly mobile short-chain PFACs. In contrast, the PFAS composition in soil was dominated by long-chain PFACs, PFOA and PFDA, as a result of the low mobility with 223PFAS ranging between 0.18 and 26 µg/L (eluate) and between 66 and 420 µg/kg (solid). However, PFAS composition in groundwater was comparable to the spectrum observed in leaves. Spatial interchanges of PFAS in groundwater and foliage correspond well and demonstrate the successful application of phytoscreening to detect and delineate the impact of PFAS in groundwater.

#### A FIELD STUDY TO ASSESS THE ROLE OF AIR-WATER INTERFACIAL SORPTION ON PFAS LEACHING IN AN AFFF SOURCE AREA

Schaefer, C.E., G.M. Lavorgna, D.R. Lippincott, D. Nguyen, E. Christie, S. Shea, S. O'Hare, M.C.S. Lemes, C.P. Higgins, and J. Field.  
Journal of Contaminant Hydrology 248:104001(2022)

Field-deployed lysimeters were used to measure PFAS concentrations in soil porewater at a site historically impacted with AFFF. Samples collected over 49 days showed that PFOS and PFHxS were the highest concentrations of PFAS in porewater, at ~10,000 and 25,000 ng/L, respectively. The corresponding average mass flux under lysimetry for PFOS and PFHxS was 28,000 ± 11,000 and 92,000 ± 32,000 ng/m<sup>2</sup>/d, respectively. Employing batch desorption isotherms (soil/water slurries) to determine desorption K<sub>d</sub> values resulted in overestimating PFAS porewater concentrations by a factor of 1.4 to 4. However, using the desorption K<sub>d</sub> values from the batch desorption isotherms combined with a PFAS mass balance that incorporated PFAS sorption at the air-water interface resulted in improved predictions of the PFAS porewater concentrations. This improvement was most notable for PFOS, where the inclusion of air-water interfacial sorption resulted in a 58% reduction in the predicted PFOS porewater concentration and predicted PFOS porewater concentrations that were identical (within the 95% confidence interval) to the lysimeter-measured PFOS porewater concentration.

### Research

#### SUPERFUND RESEARCH BRIEF NUMBER 340 - MIMICKING MOLECULES MADE BY BACTERIA TO REMOVE METALS FROM WATER

National Institute of Environmental Health Sciences, Superfund Research Program, April 2023

A new study funded by the NIEHS Superfund Research Program developed a method to extract metals from water using synthetic molecules inspired by those produced by bacteria. Researchers studied seven different synthetic rhhamnolipids, which can be customized for specific uses, to evaluate their ability to remove three metals from solutions by forming a solid complex. The biodegradable molecules could one day be used to remove toxic metals or extract rare and valuable elements from aqueous mining and industrial waste. [https://nrihs.niehs.nih.gov/srp/1/ResearchBriefs/nrihs/SRP\\_ResearchBrief\\_340\\_508.pdf](https://nrihs.niehs.nih.gov/srp/1/ResearchBriefs/nrihs/SRP_ResearchBrief_340_508.pdf)

#### NON-TARGETED IDENTIFICATION AND SEMI-QUANTIFICATION OF EMERGING PER- AND POLYFLUOROALKYL SUBSTANCES (PFAS) IN US RAINWATER

Kim, Y., K.A. Pike, R. Gray, J.W. Sprankle, J.A. Faust, and P.L. Edmiston. Environmental Science: Processes & Impacts(2023)

High-resolution mass spectrometry was used to screen for emerging PFAS in precipitation samples collected at seven sites in the U.S. Nine of the targeted analytes are included on EPA's Regional Screening Level list. PFAS compounds were identified by liquid chromatography quadrupole time-of-flight mass spectrometry. Several emerging PFAS were detected across all samples, with the most prevalent compounds being C8 hydrogen-substituted perfluorocarboxylic acids (H-PFCAs) and fluorotelomer carboxylic acids (FTCAs). Concentrations of emerging PFAS were in the 10-1,000 ng/L range (~1-2 orders of magnitude greater than EPA-monitored PFAS) at all sites except Wooster, OH, where concentrations were even higher, with a maximum estimated  $\Sigma$ PFAS of 16,400 ng/L. The elevated levels of emerging PFAS in the Wooster samples were predominantly even and odd chain-length H-PFCAs and FTCAs comprised of complex mixtures of branched isomers. This unique composition did not match any known manufactured PFAS formulation reported to date, but it could represent thermally transformed by-products emitted by a local point source. Results indicate that PFAS outside of the standard analyte lists make up a significant and previously unappreciated fraction of contaminants in rainwater collected within the central U.S.

#### LONG-TERM BIOREMEDIATION OF CADMIUM CONTAMINATED SEDIMENT USING SULFATE REDUCING BACTERIA: PERSPECTIVE ON DIFFERENT DEPTHS OF THE SEDIMENT PROFILE

Zhao, Q., X. Li, Y. Wang, Y. Cheng, and W. Fan. Chemical Engineering Journal 451(Part 2):138697(2022)

Column reactors with sediment profile sampling devices were used to investigate the variations in Cd speciation, labile  $S_2^-$ , and the microbial community at different sediment profile depths during Cd bioremediation by sulfate-reducing bacteria (SRB) over 270 days. To evaluate the remediation effect, in vitro extraction of sediment was performed with *Sipunculus nudus* intestinal juice to determine Cd bioavailability. Results showed that bioremediation caused acid-soluble Cd to decrease in the surface sediment (0-5 cm), while reducible and residual fractions of Cd increased. Cd bioavailability in the surface sediment was reduced by 25.1%, though no significant changes were observed in other sediment layers. Results indicate that the surface sediment was the main remediation range when SRB was initially added at the water-sediment interface. Labile Cd and  $S_2^-$  in the surface sediment of the bioremediation column reactor exhibited a negative correlation ( $P < 0.1$ ), though were positively correlated in the sediment profile below 12 cm ( $P < 0.1$ ) and throughout the whole control column reactor ( $P < 0.1$ ). Results demonstrate that the correlation between labile Cd and  $S_2^-$  could potentially be used as an indicator to reflect remediation performance. Principal component analysis results revealed that the remediation effect was related to the different Cd fractions, labile  $S_2^-$  and microbial community in the sediment, among which Cd speciation was the most influential factor.

#### PFAS CONCENTRATIONS IN SOIL VERSUS SOIL POREWATER: MASS DISTRIBUTIONS AND THE IMPACT OF ADSORPTION AT AIR-WATER INTERFACES

Busseue, M.L. and B. Guo. IChemosphere 302:134938(2022)

Research was conducted to delineate the relationship between soil porewater concentrations and soil concentrations based on a comprehensive model of PFAS mass distribution within a soil sample volume. Measured parameters representing solid-phase sorption and air-water interfacial adsorption were used to illustrate the impact of soil and PFAS properties on the distribution of representative PFAS between soil and soil porewater. Literature data reported for soil and soil porewater concentrations of several PFAS obtained from outdoor lysimeter experiments were used to test the distribution model. Soil-to-porewater concentration ratios predicted with the model compared very well to the measured concentration ratios. The nondimensional distribution coefficient that describes the distribution of PFAS mass amongst all domains within a soil sample was observed to be a function of PFAS molecular size. Numerical simulations conducted for a model fire-training source area were used to illustrate the ranges in magnitude of soil versus porewater concentrations for representative field conditions. Results of the measured and simulated data sets demonstrated the importance of air-water interfacial adsorption for the distribution of the longer-chain PFAS within soil samples. PFAS soil porewater concentrations are anticipated to range from ng/L to mg/L, depending upon soil concentrations, which in turn depend upon the nature of the site.

#### DEVELOPING NOVEL PERSULFATE PELLETS TO REMEDIATE BTEXs-CONTAMINATED GROUNDWATER

Wang, B., W. Zhang, C. Gao, X. Du, and Q. Journal of Water Process Engineering 52:103505(2023)

Novel slow-release persulfate (PS) pellets were prepared and tested for their release capabilities and effectiveness to remediate organic contaminants in groundwater. Each pellet's release efficiency and average release rate within 14 days were 87.36% and 46.80 mg-persulfate/d, respectively, when the mass ratio of sodium PS to paraffin was 3/1. Dissolution and diffusion via pores were the main mechanisms of the PS delivery from slow-release pellets in water. Solution pH, ionic species and addition of quartz sand into release pellets played dissimilar effects on the release kinetics. Column experiment results indicated that the pellets could expand the PS influence range in the barrier and continuously remediate BTEX-contaminated groundwater (initial concentration of each compound = 50 mg/L) and reach 64.2-85.1% removal efficiency. Electron spin resonance spectroscopy results show that both  $S_2^{2-}$  and  $\bullet OH$  contributed to BTEX removal.

#### RAMAN SPECTROSCOPIC AND MICROSCOPIC MONITORING OF ON-SITE AND IN-SITU REMEDIATION DYNAMICS IN PETROLEUM CONTAMINATED SOIL AND GROUNDWATER

Gao, S., G. Zhan, H. Zhang, T. Gao, and L. Zhang. Water Research 233:119777(2023)

Using dual-excitation Raman spectroscopy and microscopy, a strategy was developed to detect petroleum compositions onsite and monitor petroleum contents in soil and groundwater in situ. The detection time was 0.5 h using the Extraction-Raman spectroscopy method and one minute using the Fiber-Raman spectroscopy method. The detection limit was 94 ppm for the soil samples and 0.46 ppm for the groundwater samples. Petroleum changes at the soil-groundwater interface were successfully observed by Raman microscopy during in situ chemical oxidation. Results revealed that hydrogen peroxide oxidation released petroleum from the interior to the surface of soil particles and then to groundwater during the remediation process, while persulfate oxidation degraded only petroleum on the soil surface and in groundwater.

#### ENHANCED DELIVERY OF REMEDIAL REAGENTS IN LOW-PERMEABILITY AQUIFERS THROUGH COUPLING WITH GROUNDWATER CIRCULATION WELL

Wang, P., J. Li, P. An, Z. Yan, Y. Xu, and S. Fu. Journal of Hydrology 618:129260(2023)

A combination of two-dimensional sandbox experiments and numerical simulations was used to explore the migration process of remedial reagents driven by a groundwater circulating well (GCW). The study investigated the influences of the circulating flow rate, concentration of the remedial reagent ( $H_2O_2$  as a model), and cycle operation mode on the migration of GCW-enhanced remedial reagents. The flow rate of the pumped water can enhance the concentration gradient at the interface of different permeation zones. Reagent redistribution by increased Fick diffusion significantly increased the dispersion range. Parametric sensitivity analysis results showed the aggregation effect of remedial reagents in the low permeability area (~10-7 m/s) and related to the injection site. Considering remedial reagents attenuation, a reactive transport model can better simulate the concentration changes in low-permeability regions ( $R^2 = 0.980$ ). Numerical simulation results showed that the principal component of the hydrodynamic field was tangential to the main axis of the target area. The diffusion coefficient of the low-permeability region was one order of magnitude lower than that of the high-permeability region (~10-3 m/s). Thus, the low-permeability region was less affected by the hydraulic action of the GCW and had a longer retention time for remedial reagents. Specific aquifer parameters and operating modes are key engineering design factors of a GCW that should be considered in conjunction with other in situ chemical technologies. This study provides some new insights for in situ remediation of contaminated aquifers with a GCW. It suggests that (i) the hydraulic circulation driven by GCW can promote the accumulation of injected remedial agents in low permeability areas, especially injection point is located near the wellbore; and (ii) the residence time of reagents in contaminated areas should be comprehensively considered when chemical remediation technology is coupled with GCW.

#### General News

#### LAB-SCALE BIODEGRADATION ASSAY USING PASSIVE SAMPLERS TO DETERMINE MICROORGANISMS' ABILITY TO REDUCE POLYCHLORINATED BIPHENYL (PCB) VOLATILIZATION FROM CONTAMINATED SEDIMENT

Bako, C.M., A. Martinez, R.F. Marek, K.C. Hornbuckle, J.L. Schnoor, and T.E. Mattes. MethodsX 10:102039(2023)

A lab-scale PCB biodegradation assay is described to screen potential bioaugmentation strains or consortia for their ability to decrease PCB mass flux from contaminated sediment to air through biodegradation of freely dissolved PCBs that have desorbed from sediment particles. The assay uses two types of passive samplers to simultaneously measure PCB mass that is freely dissolved in an aqueous solution and PCB mass that has volatilized to the headspace of the bioreactor. Using this approach, relative comparisons of PCB mass accumulated in passive samplers between bioaugmented treatments and controls allow for assessment of a microbial strain's ability to reduce both freely dissolved and vapor phase PCB concentrations. The method is designed to be conducted using aliquots of homogenized, well-characterized, PCB-contaminated sediment gathered from a field site. This work details the experimental design methodology, required materials, bioreactor setup, passive sampling, PCB extraction, sample cleanup, and quantification protocols such that the biodegradation assay can be conducted or replicated. A step-by-step protocol is also included and annotated by experienced analysts.

#### TRANSLOCATION, BIOACCUMULATION, AND DISTRIBUTION OF PERFLUOROALKYL AND POLYFLUOROALKYL SUBSTANCES (PFAS) IN PLANTS

Xu, B., W. Qiu, J. Du, Z. Wan, J.L. Zhou, H. Chen, R. Liu, J.T. Magnuson, and C. Zheng. iScience 25:104061(2022)

This review discusses several factors, such as soil properties and the species of PFAS and plants, and concludes that PFAS are predominantly absorbed by roots from sources in the soil. In addition, following uptake by root, long-chain PFAS ( $C \geq 7$  for PFCAs and  $C \geq 6$  for PFSA) were preferentially retained within the root, whereas the short-chain PFAS were distributed across tissues above the ground. The bioaccumulation potential of PFAS within various plant structures was expressed by calculating the bioaccumulation factor (BAF) across various plant species. Results showed that PFAS have a wide range of BAF values within root tissue, followed by straw and grain. Due to its high-water solubility, PFOA is the predominant compound accumulated in soil and within plant tissues. Among different plant groups, the potential BAF values rank from highest to lowest as follows: leaf vegetables > root vegetables > flower vegetables > shoot vegetables. Several PFAS groups, such as PFOA, PFBA, and PFOS, may have an increased public health risk based on the daily intake rate. Future research on possible PFAS degradation occurring in plant tissues to explain metabolite changes that occur under PFAS stress at the genetic level is suggested.

#### GREEN REMEDIATION BEST MANAGEMENT PRACTICES: CLEANER FUELS AND AIR EMISSIONS FOR SITE CLEANUP

EPA Office of Land and Emergency Management. EPA 542-F-23-001, 5 pp, 2023

This EPA fact sheet describes and illustrates best management practices (BMPs) intended to minimize fuel consumption and air emissions due to operating equipment such as power generators and on-road or off-road vehicles such as light- or heavy-duty trucks, tractor-trailers and excavators. Environmental investigation and remediation at hazardous waste sites can involve significant consumption of fossil fuels by vehicles and mobile or stationary equipment powered by internal combustion engines. Burning of fossil fuels results in significant carbon dioxide emission, a greenhouse gas that disturbs the Earth's natural carbon cycle and significantly contributes to climate change. It also increases the production of ground-level ozone which can trigger human health problems, impacts that disproportionately affect communities with environmental justice concerns. Key strategies focus on deploying engines and vehicles equipped with advanced emission control technologies, conserving the fuel required to operate engines and vehicles, and integrating BMPs in project-level transportation plans for activities such as offsite waste disposal. Such strategies are critical as the U.S. continues to transition to an electric economy. [https://www.clu-in.org/greenremediation/docs/GBR\\_BMP\\_fact\\_sheet\\_cleaner\\_fuels\\_emissions.pdf](https://www.clu-in.org/greenremediation/docs/GBR_BMP_fact_sheet_cleaner_fuels_emissions.pdf)

#### A REVIEW ON THE USE OF PERMEABLE REACTIVE BARRIERS AS AN EFFECTIVE TECHNIQUE FOR GROUNDWATER REMEDIATION A REVIEW ON THE USE OF PERMEABLE REACTIVE BARRIERS AS AN EFFECTIVE TECHNIQUE FOR GROUNDWATER REMEDIATION

Sakr, M., H. El Agamawi, H. Klammier, and M. Mohamed. Groundwater for Sustainable Development 21:100914(2023)

A comprehensive review was conducted on permeable reactive barrier (PRB) techniques to remediate groundwater for a wide range of contaminants. The fundamentals of installation, including site selection and design; different PRB designs, including the funnel and gate, continuous trench, and sequential configurations; and different methods to optimize PRBs to achieve maximum removal rates of contaminants are discussed. Reactive mechanisms, which play a crucial role in the removal process, are reviewed in detail for various types of reactive media. The effect of combining multiple materials for enhancing the performance of single and multiple PRB systems was also reviewed. Optimization factors that contribute to the longevity of the various PRB designs to enhance groundwater remediation were determined. Previous studies reported that PRBs could successfully treat groundwater contaminated with organics, heavy metals, and radioactive substances, including BTEX, Ar, Pb,  $^{137}Cs$ , and U. Several reactive materials, including zero-valent iron, activated carbon, and zeolites, satisfy the characteristics required for groundwater remediation. The potential of new reactive materials, including sand, apatite, straw-based materials, gravel, and mixed mixture, to remove different contaminants through using PRB systems is also analyzed. With the correct design and appropriate selection of reactive materials, a PRB system can be highly effective in remediating groundwater contaminant plumes.

The Technology Innovation News Survey welcomes your comments and suggestions, as well as information about errors for correction. Please contact Michael Adam of the U.S. EPA Office of Superfund Remediation and Technology Innovation at [adam.michael@epa.gov](mailto:adam.michael@epa.gov) or (703) 603-9915 with any comments, suggestions, or corrections.

Mention of non-EPA documents, presentations, or papers does not constitute a U.S. EPA endorsement of their contents, only an acknowledgment that they exist and may be relevant to the Technology Innovation News Survey audience.