

Technology Innovation News Survey

Entries for July 16-31, 2016

Market/Commercialization Information

2016 SMALL BUSINESS INNOVATION RESEARCH (SBIR) PHASE I SOLICITATION U.S. EPA, Funding Opportunity SOL-NC-16-00038, 2016

EPA contemplates awarding approximately 18 firm-fixed-price contracts of \$100,000 each under its Phase I SBIR Program during Fiscal Year 2017. Phase I topics of interest include (1) Air and Climate [low-cost sensors for formaldehyde and methane]; (2) Manufacturing; (3) Toxic Chemicals; (4) Water [lead test for tap water in homes]; (5) Water and Homeland Security; and (6) Greener Buildings. The period of performance for each Phase I contract will be six months. The solicitation and all pertinent documents are available at <https://www.fedconnect.net/FedConnect/?doc=SOL-NC-16-00038&agency=EPA> [Note: It might be necessary to copy and paste the URL into your browser for direct access.]. Proposals must be received via FedConnect by 12:00 noon ET on October 20, 2016. Phase I awards are expected by May 10, 2017.

ENVIRONMENTAL REMEDIATION SERVICES TO SUPPORT THE MILITARY MUNITIONS RESPONSE PROGRAM (MMRP)

U.S. Army Corps of Engineers, USACE District, Jacksonville.
Federal Business Opportunities, FBO-5383, Solicitation W912EP-16-Z-0020, 2016

This notice is a Sources Sought announcement to determine the availability and technical capability of small businesses to provide environmental remediation services to support the MMRP at the National Training Center, Fort Irwin, California. The USACE Jacksonville District is considering the award of an IDIQ SATOC for work to be conducted primarily under CERCLA and RCRA requirements as follows: (1) characterize potential environmental contamination, (2) develop approaches to the remediation of water and soils, (3) conduct environmental sampling and monitoring, (4) perform military munitions response activities, (5) prepare reports, and (6) successfully negotiate with and obtain approval from applicable stakeholders. This is a new requirement; there are no incumbent contractors. The anticipated NAICS code is 562910, with a size standard of 750 employees. Firms are also encouraged to provide information regarding their plans for joint venturing or partnering to meet any of the requirements. Capabilities statements are due via email by 3:00 PM ET on September 16, 2016. <https://www.fbo.gov/spg/USA/COE/DACA17/W912EP-16-Z-0020/listing.html>

MESA SUBSTATION SITE REMEDIATION PROJECT

Department of Energy, Western Area Power Administration.
Federal Business Opportunities, FBO-5391, Solicitation DE-SOL-00010045, 2016

This project consists of furnishing all necessary labor, supervision, materials, licenses, permits, insurance, transportation, and equipment necessary to perform site remediation at the Western Area Power Administration's Mesa Substation located in Phoenix, Arizona. Release of the solicitation on FedBizOpps is anticipated on or about September 9, 2016. This requirement will be solicited as a competitive 100% small business set-aside RFQ subject to NAICS code 562910, with a size standard of \$20.5M. A firm-fixed-price contract is contemplated. <https://www.fbo.gov/notices/0967a17c6b81969bd57c75a4b57881a>

Cleanup News

REMEDY OPERATION STATUS SUBMITTAL, 901 EAST STREET, DEDHAM, MA

Massachusetts Department of Environmental Protection, Site RTN 3-27223, 38 pp, 2015

To remediate a fuel release that occurred at the gasoline service station at 901 East Street, the remedy selected was in situ injection of Oxygen BioChem (OBC®), a formulation consisting of a mixture of sodium persulfate and calcium peroxide that is employed using the patent-pending Klorur[®] activation chemistry. The initial OBC injection occurred in 2011, and supplemental targeted injections took place in 2012 and 2014. Reduction of contaminant concentrations below Massachusetts' Method 1 Standards has been observed in all areas across the site except for a small area in the northwest corner. Based on the collected data, it is assumed that the last injection from 2014 will sufficiently attenuate residual contamination in this area to the extent that a Permanent Solution can be obtained. Monitoring will continue for evaluation of the progress of the implemented remedial measures. See [this submittal and follow-on status reports at](http://public.dep.state.ma.us/SearchableSites2/Site_Info.aspx?textfield=RTN=3-0027223&searchType=ALL&CurrentPage=1) http://public.dep.state.ma.us/SearchableSites2/Site_Info.aspx?textfield=RTN=3-0027223&searchType=ALL&CurrentPage=1.

ACCELERATED GROUNDWATER RISK MANAGEMENT FOR PROTECTION OF AN ECOLOGICALLY SENSITIVE AREA BY IN-SITU PERMEABLE TREATMENT TRENCH PROCESS

Waddell, J. and B.J. Min.
Canadian Land Reclamation Association, Alberta Chapter, 2016 Annual General Meeting and Conference, 24-26 February 2016, Red Deer, AB, Canada. Abstract, 2016

A groundwater risk management plan was developed for an oil and gas site to manage environmental risks associated with a petroleum hydrocarbon plume migrating toward a sensitive marsh. Due to very low soil hydraulic conductivities and groundwater flow velocities, an engineered risk mitigation measure consisting of permeable reactive treatment trenches was designed and installed to support ongoing risk management. The approach provides enhanced contaminant transport into the trenches and a primary medium that allows rapid and repeatable oxidant treatment performance. Water passing through the trench is treated in place, thus reducing plume distribution with no need to extract or divert water. Treatments conducted to date have consistently produced >90% reductions following each treatment and are exhibiting concentration reductions in nearby downgradient monitoring wells. The treatment process also allows measurement of contaminant mass reduced, with ~1.7 kg of contaminant mass oxidized over the course of 6 treatments so far. Significant concentration reduction and downgradient effects were observed in the adjacent low conductivity aquifer very quickly after system startup.

OVERBURDEN AND BEDROCK REMEDIATION USING ACTIVATED CARBON BASED INJECTATES

Mazzarese, M. SMART Remediation, January 28, 2016, Toronto. 14 slides, 2016

Activated carbon (AC)-based injectants were used to remediate petroleum hydrocarbon and chlorinated solvent contamination at two subject sites. Each site underwent a thorough data gap analysis and subsequent remedial design characterization (RDC), with sampling of vertically dense soil and groundwater at one site and bedrock fracture characterization using custom inflatable straddle packers at the other. Following incorporation of the RDC data into the final designs, the reagents were surgically applied to the identified affected areas and vertical zones, taking into account the project objectives, total mass present (aqueous and sorbed), lithology, hydraulics, and reagent distribution. At Site 1, a large former manufacturing facility, vapor degreasing practices in the '70s and '80s released chlorinated VOCs in limited soil and widespread groundwater areas. In the primary source areas (groundwater TCE concentrations >50 mg/L), the contractor applied BOS 100® (AC impregnated with reactive iron) over two injection rounds to achieve average contaminant concentration reductions of 90% (VC) to 98% (TCE). At Site 2, a former retail gas station, hydrocarbon-impacted groundwater lay within shallow fractured bedrock and overburden soil. After performing an RDC in both the unconsolidated and consolidated strata, the contractor injected BOS 200® (AC blended with terminal electron acceptors, nutrients, and a bacterial blend) over two field events to successfully achieve the site cleanup goals.

http://www.smartremediation.com/wp-content/uploads/2015/11/SMART_Toronto-2016_Mike-Mazzarese_AST-Environmental.pdf

CASE STUDY: IN-SITU FORMALDEHYDE SPILL RESPONSE

Tunncliffe, B. SMART Remediation, 4 Feb 2016, Ottawa, ON. 25 slides, 2016

In 2012 a transport truck containing 35,000 L of heated waste formaldehyde crashed, releasing its contents and diesel fuel to a steep embankment. The steaming waste cascaded along a secondary roadway before being released through a culvert to a lake that supplies drinking water to more than 75,000 people in North Bay, Ontario. Formaldehyde and petroleum hydrocarbon compounds (PHCs) affected surface soils and water over a wide area as well as the sand and bedrock aquifers. The local community, elected officials, and Ministry of the Environment were all actively involved. Easily accessible soils were excavated and removed as swiftly as possible. Formaldehyde concentrations in the sand and bedrock aquifers were detected at >3,000,000 µg/L and 600,000 µg/L, respectively. Due to the unknown behavior of high levels of dissolved and adsorbed formaldehyde and petroleum hydrocarbon concentrations in the subsurface, a bench-scale study was completed to assess oxidation treatment effectiveness. Pilot-scale testing was also undertaken to verify the injection rate, and tracers were used to assess oxidant delivery and distribution. Two applications of percarbonate (RegenOx) were completed to address the petroleum hydrocarbons, and full-scale in situ chemical oxidation using hydrogen peroxide was completed to achieve successful remediation of the formaldehyde spill and downgradient locations. http://www.smartremediation.com/wp-content/uploads/2015/11/SMART_Ottawa-2016_Bruce-Tunncliffe_Vertex.pdf

Demonstrations / Feasibility Studies

CREOSOTE REMEDIATION WITH SURFACTANT ENHANCED PRODUCT RECOVERY AND SURFACTANT-ENHANCED IN-SITU CHEMICAL OXIDATION TECHNOLOGIES

Holcomb, J., D. Socci, and G. Dahal.
2016 RPIC Federal Contaminated Sites (FCS) National Workshop, 25-27 April 2016. Poster

A pilot test was implemented using surfactant-enhanced product recovery (SEPR) and surfactant-enhanced in situ chemical oxidation (S-ISCO) at a former wood treatment facility in Delaware, where creosote waste and condensate water had been released into an unlined lagoon. Site investigations revealed extensive

highly viscous creosote oil impacts throughout the soil matrix, with little product accumulation in monitoring wells. For the pilot test, the SEPR chemical formulation was customized to enhance its effectiveness at emulsifying and thereby breaking apart the creosote oil into easily extractable globules. The pilot also allowed an examination of the relationship of SEPR to the subsequent S-ISCO polishing phase to determine the most effective treatment sequence. A customized mixture of plant-based surfactants and cosolvents was injected simultaneously with low concentrations of peroxide during SEPR implementation to desorb and emulsify DNAPL free product for subsequent extraction. The case study of this pilot test includes an overview of the treatment chemicals and the innovative design of the injection and extraction system. *See 18 slides from an earlier presentation:*
http://www.smartremediation.com/wp-content/uploads/2015/11/SMART_Toronto-2016_Dan-Socci_EthicalChem.pdf

CASE STUDY: REMEDIATION OF CRUDE OIL IN FRACTURED SHALE USING MULTI-PHASE EXTRACTION (MPE) ENHANCED BY SURFACTANT

Sharif, S. SMART Remediation, January 28, 2016, Toronto. 12 slides, 2016

A pilot test was conducted from May to June 2015 in a small area in southwestern Ontario where crude oil impacts in shallow fractured Queenston shale bedrock had persisted for decades. The pilot test was performed to determine the feasibility and design parameters for full-scale remediation of the petroleum hydrocarbon (PHC) impacts using multi-phase extraction (MPE) enhanced by injections of a non-ionic surfactant. The four-week surfactant-enhanced MPE operation was conducted in varying configurations to compare configuration efficacy. Upon injection of surfactant solutions, both free-phase and dissolved-phase PHC recovery increased substantially, with very little vapor-phase PHC.
http://www.smartremediation.com/wp-content/uploads/2015/11/SMART_Toronto-2016_Salah-Sharif-Parsons.pdf

Research

REMEDICATION OF NITRO BENZENE CONTAMINATED SOIL BY COMBINING SURFACTANT ENHANCED SOIL WASHING AND EFFLUENT OXIDATION WITH PERSULFATE

Yan, J., W. Gao, L. Qian, L. Han, Y. Chen, and M. Chen.
PLoS ONE 10(8):e0132878(2015)

The combination of surfactant-enhanced soil washing and degradation of nitrobenzene (NB) in effluent with persulfate was investigated to remediate NB-contaminated soil. Aqueous solution of sodium dodecylbenzenesulfonate (SDBS, 24.0 mmol/L) was used at a mass ratio of solution to soil (20:1) to extract NB from contaminated soil (47.3 mg/kg), resulting in NB desorption removal efficiency of 76.8%. The washing effluent was treated in Fe^{2+} /persulfate and $\text{Fe}^{2+}/\text{H}_2\text{O}_2$ systems successively. NB degradation removal was 97.9%, much higher than that of SDBS (51.6%) with addition of 40.0 mmol/L Fe^{2+} and 40.0 mmol/L persulfate after 15 min reaction. The SDBS could be reused for washing the contaminated soil. The combination of surfactant-enhanced washing and the preferential degradation of NB with Fe^{2+} /persulfate provide a useful option to remediate NB-contaminated soil. *This paper is Open Access at*
<http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0132878>.

DESIGN AND OPTIMIZATION OF SURFACTANT BASED ENHANCED REMEDIATION OF BUNKER C FUEL OIL CONTAMINATED SOIL

Zubair, Abdulrazaq, Ph.D. thesis, Memorial University of Newfoundland, Canada, 197 pp, 2015

This research presents an assessment of the performance of soil washing technology for the remediation of Bunker C fuel oil from weathered contaminated soil using patented surfactant formulations. Specific research objectives included (1) determining the micellar properties (surface tension and CMC) of the patented surfactants; (2) development of a reliable analytical method for the analysis of heavy petroleum hydrocarbons in soil; (3) evaluation of the parameters that govern soil washing implementation and assessment of their effects on the washing of weathered Bunker C oil from contaminated soil at surfactant concentrations below the CMC (mobilization mechanism) using the multivariate experimental and statistical approach; and (4) determination of the optimum conditions for removal of Bunker C oil with the tested surfactants. <https://core.ac.uk/download/pdf/33560277.pdf>

THREE-DIMENSIONAL PRINTING: TRANSFORMATIVE TECHNOLOGY FOR EXPERIMENTAL GROUNDWATER RESEARCH

Hasiuk, F.J., L.J. Florea, and M.C. Sukop.
Groundwater 24(2):157-158(2016)

Advances in 3D printing have set the stage for transformative aquifer characterization and lab experimentation. Flow studies through 3D reproductions of Biscayne Aquifer karst from southeast Florida is a rare example in a largely uncharted field. Soil pore networks have also been reproduced. In 2007, the 20-cm long by 10 cm diameter "core" of Biscayne Aquifer karst cost \$2600; today that model would cost less than \$100, and entire 3D printers can be purchased for \$2600. Available technologies are evolving rapidly and selection of appropriate techniques depends on end-product requirements. For example, reproducing Biscayne Aquifer porosity necessitated dual wax-epoxy methods, with subsequent wax removal, to handle interconnected cm-scale pores. In contrast, more uniform sandstone porosity can be replicated using fused-deposition modeling or stereolithography, technologies common in even hobbyist printers. Aquifer prototyping could be used to investigate reactive transport. The CT scans or simulations of vuggy limestone pore spaces could be printed in soluble wax and subsequently encased in carbonate mineral precipitated from solution. Dissolving the wax would yield a reproducible starting point for diagnosis research, including studies of cementation and dissolution. As 3D printing technology improves, so will the accuracy and intricacy of produced models. *See additional information by F.J. Hasiuk on 3D printing on pages 28-29 at* <http://rock.geosociety.org/pub/GSAToday/gt1408.pdf>.

ANALYZING TREE CORES TO DETECT PETROLEUM HYDROCARBON-CONTAMINATED GROUNDWATER AT A FORMER LANDFILL SITE IN THE COMMUNITY OF HAPPY VALLEY-GOOSE BAY, EASTERN CANADIAN SUBARCTIC

Fonkwe, M.L. and S. Trapp.
Environmental Science and Pollution Research 23(16):16137-16151(2016)

The feasibility of analyzing tree cores to detect BTEX compounds and MTBE in groundwater in eastern Canada subarctic environments was investigated at a former landfill site in the remote community of Happy Valley-Goose Bay, Labrador. Tree cores were taken from trembling aspen, black spruce, and white birch and analyzed by headspace-gas chromatography-mass spectrometry. BTEX compounds were detected in tree cores, corroborating known groundwater contamination. A zone of anomalously high concentrations of total BTEX constituents was identified and recommended for monitoring by groundwater wells. Tree cores collected outside the landfill site at a local control area suggest the migration of contaminants off-site. Tree species exhibit different concentrations of BTEX constituents, indicating selective uptake and accumulation. Toluene in wood exhibited the highest concentrations, which may also be due to endogenous production. MTBE, however, was not found in the tree cores and is considered to be absent in the groundwater. The results demonstrate that tree-core analysis can aid in the proper management of contamination during landfill operations and after site closures. *See additional information in a report at*
https://www.mun.ca/harriscentre/reports/Fonkwe_14-15_Waste.pdf.

AN INTEGRATED GEOPHYSICAL AND GEOCHEMICAL APPROACH TO CHARACTERIZING ACID MINE DRAINAGE IN A HEADWATER MOUNTAIN STREAM IN COLORADO, USA

Johnston, Allison, Master's thesis, Colorado School of Mines, 81 pp, 2016

Geochemical sampling, fluid electrical conductivity logging, electromagnetic induction, and electrical resistivity imaging (ERI) were used to investigate the impact of acid mine drainage (AMD) from the Minnesota Mine, an inactive gold and silver mine on Lion Creek, a headwater mountain stream near Empire, Colo. The project characterized seasonal AMD contamination levels and identified control points and diffuse sources of AMD entering Lion Creek. The pH and electrical conductivity of the water in Lion Creek correlate inversely, indicating that the low pH characteristic of AMD-impacted water correlates to high electrical conductivity values that can serve as a target for the geophysical methods. ERI surveys were run along the east bank of Lion Creek along a reach where acidic water seeps out of the steep stream bank and into the creek. The ERI surveys identified two areas where diffuse contamination is likely entering the stream. Total dissolved solids (TDS) were calculated using an empirical relationship between fluid electrical conductivity and TDS, and TDS load (TDS concentration times stream discharge) was calculated. TDS load is greatest in the early summer and displays a large diel signal. Results will help to inform remediation planning; identification of diffuse AMD sources enables remediation option targeting, and knowledge of seasonal variation supports prediction of the costs and outcome of different remediation scenarios. <https://dspace.library.colostate.edu/handle/11124/170261>

ENDOPHYTIC PHYTOAUGMENTATION: TREATING WASTEWATER AND RUNOFF THROUGH AUGMENTED PHYTOREMEDIATION

Redfern, L.K. and C.K. Gunsch.
Industrial Biotechnology 12(2):83-90(2016)

Phytoremediation, which relies on plants to take up or transform the contaminant of interest, is not widely used, largely due to its low treatment efficiency. Endophytic phytoaugmentation is a variation on phytoremediation that relies on augmenting selected plants with exogenous strains to stimulate associated plant-microbe interactions that facilitate and improve remediation efficiency. Few case studies of this technique have been published to date. This review summarizes current knowledge and developments in endophytic phytoaugmentation and presents potential future applications for the technology.

EFFECT OF BENZOIC ACID ON THE REMOVAL OF 1,2-DICHLOROETHANE BY A SIDERITE-CATALYZED HYDROGEN PEROXIDE AND PERSULFATE SYSTEM

Li, S., M. Li, X. Luo, G. Huang, F. Liu, and H. Chen.
Environmental Science and Pollution Research 23(1):402-407(2016)

Benzoic acid can affect iron-oxide mineral dissolution and react with hydroxyl radical. This study investigated the effect of the process on 1,2-DCA removal by siderite-catalyzed hydrogen peroxide and persulfate. The variation of benzoic acid concentrations can affect pH value and soluble iron concentrations; when benzoic acid varied from 0 to 0.5 mmol/L, pH increased while Fe^{2+} and Fe^{3+} concentrations decreased, resulting in a 1,2-DCA removal efficiency decrease from

91.2% to 5.0%. When benzoic acid varied from 0.5 to 10 mmol/L, however, pH decreased while Fe²⁺ and Fe³⁺ concentrations increased, resulting in a 1,2-DCA removal efficiency increase from 5.0% to 83.4%.

ESTIMATING THE DEGRADATION RATE FOR LARGE-SCALE BIOVENTING

Mosco, M. and R.G. Zytner.
2016 RPIC Federal Contaminated Sites (FCS) National Workshop, 25-27 April 2016. Poster

Field application of bioventing technology for the cleanup of petroleum hydrocarbon spills in the unsaturated soil zone still has uncertainties associated with remediation time frame (i.e., biodegradation rates) and scale-up issues. An experimental 80-kg soil bioventing reactor system was developed, consisting of a custom-made reactor, climate chamber, low-flow venting system, and an off-gas capture device. Both a sandy and a clayey soil were tested with known concentrations of spiked synthetic gasoline. Environmental conditions monitored included moisture levels, pH, microbial levels, and nutrient and oxygen levels to ensure an accurate representation of natural soil environmental conditions. Preliminary results show a 2-stage degradation process, consistent with results obtained from a previous mesoscale (4 kg) study, and suggest that the biodegradation scale-up factor is larger than that observed in the mesoscale study. The final analysis will produce a scale-up factor that can be used to determine the effectiveness of transferring bioventing experimental results from lab to field. See more in M.J. Mosco's 2016 thesis at <http://atrium.lib.uoguelph.ca/xmlui/handle/10214/9889>.

BIOAVAILABILITY-BASED IN SITU REMEDIATION TO MEET FUTURE LEAD (Pb) STANDARDS IN URBAN SOILS AND GARDENS

Henry, H., M.F. Naujokas, C. Attanayake, N.T. Basta, Z. Cheng, G.M. Hettiarachchi, et al.
Environmental Science & Technology 49(15):8948-8958(2015)

The Centers for Disease Control and Prevention lowered the blood Pb reference value to 5 µg/dL in 2012. As a result, regulatory decision makers may lower residential soil screening levels (SSLs) used in setting Pb cleanup levels to levels that might be difficult to achieve, especially in urban areas. Although in situ remediation with phosphate amendments is a viable option, conditions in urban settings may necessitate basing SSLs on bioavailable rather than total Pb concentrations; however, variability in soil composition can influence bioavailability testing and soil amendment effectiveness. This study discusses challenges in remediation and bioavailability assessments of Pb in urban soils in the context of lower SSLs and identifies research needs to better address those challenges. <http://www.osti.gov/scitech/servlets/purl/1265580>

SURFACE TENSION TECHNIQUE AS A STRATEGY TO EVALUATE THE ADSORPTION OF BIOSURFACTANTS USED IN SOIL REMEDIATION

Gusiatin, Z.M.
Environmental Biotechnology 11(2):27-33(2015)

A surface tension technique enabled determination of the adsorption of biosurfactants in soil at their critical micelle concentration. Adsorption of non-ionic saponin and anionic Reco-10 was higher in soils with more clay and organic matter. On each soil, less saponin was adsorbed than Reco-10 at the higher soil/biosurfactant solution ratio (1/10, m/V), whereas more saponin was adsorbed than Reco-10 at the lower ratio (1/40, m/V). Taking into account the sorption of saponin and Reco-10, their application in soil remediation would be more efficient for sandy clay loam than for clay. [http://www.environmentalbiotechnology.pl/eb_dzialy/eb_online/2015/vol11_2/eb2015.11\(2\)_ms267.pdf](http://www.environmentalbiotechnology.pl/eb_dzialy/eb_online/2015/vol11_2/eb2015.11(2)_ms267.pdf)

AN OVERVIEW ON MICROWAVE HEATING APPLICATION FOR HYDROCARBON-CONTAMINATED SOIL AND GROUNDWATER REMEDIATION

Falciglia, P.P., A. Bonifacio, and F.G.A. Vagliasindi.
Oil and Gas Research 2(1):1-6(2016)

The authors discuss the theoretical background of microwave heating and the related techno-economic features. Only limited data for full-scale MW treatments are currently available in the literature, which serves to limit the applicability of the technology despite its several advantages. <http://www.omicsonline.org/open-access/an-overview-on-microwave-heating-application-for-hydrocarboncontaminatedsoil-and-groundwater-remediation-.pdf>

MICROWAVE-ASSISTED THERMAL REMEDIATION OF DIESEL CONTAMINATED SOIL

Chang, K.-S., W.-H. Lo, W.-M. Lin, J.-X. Wen, S.-C. Yang, C.-J. Huang, and H.-Y. Hsieh.
Engineering Journal 20(4):93-100(2016)

Leakage of petroleum products—gasoline and diesel—at gas stations in Taiwan is a major source of soil contamination, ascertained as affecting 154 gas stations since implementation of the Soil and Groundwater Remediation Act in 2002. One of the contaminated sites, affected mainly by diesel, was studied to evaluate the feasibility of microwave-assisted thermal remediation. The average of total petroleum hydrocarbons (TPH) in a site hotspot was 2,845 mg/kg, which exceeds the 1,000 mg/kg regulatory limit. Soil samples were treated in the lab by microwave radiation with and without water to approximate treatment effects on the saturated and vadose zones, respectively. Results show that 12 min of microwave energy heated soil with water to 235°C and degraded its TPH to 934 mg/kg, and 5 min of microwave energy heated soil without water to 220°C and degraded its TPH to 520 mg/kg. <http://engi.org/index.php/ej/article/download/1098/469>

RADIO FREQUENCY HEATING FOR OIL RECOVERY AND SOIL REMEDIATION

Bientinesi, M., C. Scali, and L. Petarca.
9th International Symposium on Advanced Control of Chemical Processes, 7-10 June 2015, Whistler, BC, Canada. The International Federation of Automatic Control, 1199-1204, 2015

This paper presents basic principles of radio-frequency (RF) heating and describes its possible applications for oil extraction and soil remediation, based on experiences at Consorzio Polo Tecnologico Magona. RF heating can present a valid alternative to more consolidated techniques for application from oil extraction to contaminated soil remediation in terms of performance and operational flexibility. RF can be used in several scenarios where the use of alternative methods (such as steam injection) is infeasible or strongly limited by geological or logistic constraints. <http://www.nt.ntnu.no/users/skoge/prost/proceedings/adchem2015/media/papers/0134.pdf>

TEMPERATURE EFFECT ON PHOTOLYSIS DECOMPOSING OF PERFLUOROCTANOIC ACID

Zhang, T., G. Pan, and Q. Zhou.
Journal of Environmental Sciences 42:126-133(2016)

In an investigation of the effect of temperature on the photolytic decomposition of PFOA, the defluorination ratio increased from 8% at 25°C to 50% at 85°C in 60 min. Production of perfluorinated carboxylic acids (PFCAs, C7-C5), PFCAs (C4-C3), and TFA (trifluoroacetic acid, C2) accelerated and attained a maximum within 30 to 90 min at 85°C, although these reactions did not occur at 25°C despite extending irradiation to 180 min. PFOA was decomposed in a step-wise process by surrendering one CF2 unit. In each cyclical process, increased temperature enhanced the quantum yields of irradiation and reactions between water molecules and intermediates radicals. The energy consumption for removing each µmol of PFOA was reduced from 82.5 kJ at 25°C to 10.9 kJ at 85°C using photolysis. Photolysis coupled with heat achieved high rates of PFOA degradation and defluorination. Manuscript: http://irep.ntu.ac.uk/27974/1/5501_Pan.pdf

PERFLUOROALKYL ACIDS INHIBIT REDUCTIVE DECHLORINATION OF TRICHLOROETHENE BY REPRESSING DEHALOCOCCOIDES

Weathers, T.S., K. Harding-Marjanovic, C.P. Higgins, L. Alvarez-Cohen, and J.O. Sharp.
Environmental Science & Technology 50(1):240-248(2016)

This paper reports on a study in which reductive dechlorination by a methanogenic mixed culture was significantly inhibited when exposed to concentrations representative of perfluoroalkyl acid (PFAA) source zones (>66 mg/L total of 11 PFAA analytes, 6 mg/L each). TCE dechlorination, DCE and VC production and dechlorination, and ethene generation were all inhibited at these PFAA concentrations. Significant repression of *Dehalococcoides* (8-fold decrease in abundance) coupled with a corresponding enhancement of methane-generating *Archaea* (a 9-fold increase) was observed. Growth and dechlorination by axenic cultures of *Dehalococcoides mccartyi* strain 195 were similarly repressed under these conditions, confirming an inhibitory response of this pivotal genus to PFAA presence. See additional information on this study in T.S. Weathers' 2015 dissertation at <https://dspace.library.colostate.edu/handle/11124/166686>.

DETECTION OF POLY- AND PERFLUOROALKYL SUBSTANCES (PFAS) IN U.S. DRINKING WATER LINKED TO INDUSTRIAL SITES, MILITARY FIRE TRAINING AREAS, AND WASTEWATER TREATMENT PLANTS

Hu, X.C., D.Q. Andrews, A.B. Lindstrom, T.A. Bruton, L.A. Schaider, P. Grandjean, et al.
Environmental Science & Technology Letters, 2016

A spatial analysis of 2013-2015 national drinking water PFAS concentrations is presented from U.S. EPA's third Unregulated Contaminant Monitoring Rule (UCMR3) program. The number of industrial sites that manufacture or use these compounds, the number of military fire training areas, and the number of wastewater treatment plants are all significant predictors of PFAS detection frequencies and concentrations in public water supplies. Among samples with detectable PFAS levels, each additional military site within a watershed's 8-digit hydrologic unit is associated with a 20% increase in PFHxS, a 10% increase in both PFHpA and PFOA, and a 35% increase in PFOS. The number of civilian airports with personnel trained in the use of aqueous film-forming foams is significantly associated with the detection of PFASs above the minimal reporting level. Drinking water supplies for 6 million U.S. residents exceed EPA's lifetime health advisory (70 ng/L) for PFOS and PFOA. Lower analytical reporting limits and additional sampling of smaller utilities serving This paper is **Open Access** at <http://pubs.acs.org/doi/abs/10.1021/acs.estlett.6b00260>.

POLY- AND PERFLUOROALKYL SUBSTANCES IN WASTEWATER: SIGNIFICANCE OF UNKNOWN PRECURSORS, MANUFACTURING SHIFTS, AND LIKELY AFFF IMPACTS

Houtz, E.F., R. Sutton, J.-S. Park, and M. Sedlak.
Water Research 95:142-149(2016)

In late 2014, wastewater effluent samples were collected from eight treatment plants that discharge to San Francisco (SF) Bay in order to assess PFASs currently released from municipal and industrial sources. In addition to direct measurement of 20 specific PFAS analytes, the total concentration of perfluoroalkyl acid (PFAA) precursors was also indirectly measured by adapting a previously developed oxidation assay. Compared to SF Bay municipal wastewater samples collected in 2009, short-chain PFBA and PFHxA rose significantly in concentration. The elevated levels observed in effluent samples from two of the plants are likely related to aqueous film forming foam (AFFF) sources impacting their influent; PFASs attributable to both current use and discontinued AFFF formulations were observed. Indirectly measured PFAA precursor compounds accounted for 33-63% of the total molar concentration of PFASs across all effluent samples, and the PFAA precursors indicated by the oxidation assay were predominately short-chained. PFAS levels in SF Bay effluent samples reflect the manufacturing shifts toward shorter chained PFASs while also demonstrating significant impacts from localized usage of AFFF.
<https://assets.documentcloud.org/documents/2838580/TRACK-16.pdf>

General News

ESTIMATING THE ECONOMIC IMPACTS OF ECOSYSTEM RESTORATION: METHODS AND CASE STUDIES

Thomas, C.C., C. Huber, K. Skrabis, and J. Sidon.

U.S. Geological Survey, Open-File Report 2016-1016, 104 pp, 2016

This analysis estimates the economic impacts of a wide variety of ecosystem restoration projects associated with U.S. Department of the Interior (DOI) lands and programs. Reviewers estimated economic impacts for 21 DOI projects, including projects that are part of the Bureau of Land Management and the Natural Resource Damage Assessment and Restoration program. The study indicates that ecosystem restoration projects provide meaningful economic contributions to local economies and to broader regional and national economies, and based on the case study analyses, between 13 and 32 job-years and between \$2.2 and \$3.4 million in total economic output are contributed to the U.S. economy for every \$1 million invested in ecosystem restoration.

<https://pubs.er.usgs.gov/publication/ofr20161016>

The individual case studies are provided in appendix 1 of this report and are also available in an online database at

<https://www.fort.usgs.gov/economic-impacts-restoration>.

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 or (703) 603-9915 with any comments, suggestions, or corrections.

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