Technology Innovation News Survey

Entries for December 1-15, 2020

**Market/Commercialization Information**

**REMEDIAL INVESTIGATIONS FOR PER- AND POLYFLUOROALKYL SUBSTANCES (PFAS) IMPACTED AREAS AT ARMY INSTALLATIONS IN THE NORTHEAST REGION**
U.S. Army Corps of Engineers, Baltimore District, Baltimore, MD.
Contract Opportunities at Beta.SAM, Solicitation W912DR21R0020, 2021

This notice is for market research purposes only. The Government is seeking to identify qualified business sources both large and small under NAICS code 562211 (Environmental Services), small business size standard 750 employees. The USACE Baltimore District is interested in sources with current relevant qualifications, experience, personnel, and capabilities to support USACE and its customers in conducting remedial investigations, with the option to conduct field investigations across approximately 12 installations. The Goal of the investigations is to identify PFAS substances that have been discharged to the environment and which may require additional investigation or remediation.

**LEGACY (PCB-CONTAMINATED) ELECTROLYTIC DISOLOVER TRANSFORMER DISPOSAL**
Savannah River Nuclear Solutions LLC (DOE Contractor), Aiken, SC.
Contract Opportunities at Beta.SAM, SRNS2021114TRANSFORMERDISPOSAL2021, 2021

The intent of this request for information is to identify potential market research purposes only. Savannah River Nuclear Solutions LLC (SRNS), which manages and operates portions of the Savannah River Site under a DOE prime contract, solicits expressions of interest from companies capable of legacy (PCB-contaminated) electrolytic disolver transformer disposal. The subcontractor shall be an EPA-approved TSCA contractor, responsible for dismantling, removing and transporting a PCB-transformed transformer from the Savannah River Site to an EPA-approved TSCA-compliant facility for scrap metal recovery and/or land disposal; with scrap metal recovery being the preferred method of disposal. The transformer is 12.54 ft high by 7.9 ft wide by 16.13 ft long and weighs about 27,050 lbs. It has been drained of all free-flowing liquids. Sampling results of drained oil yielded PCB concentrations of 500 ppm. The subcontractor will complete all transformer disposal actions necessary, including including up-front planning, document reviews, inspections, characterization (sampling and analysis), spill prevention, transportation, and treatment in compliance with TSCA, CERCLA, DOT, and the recycling or disposal facility’s licensing requirements. Supplier response to this RFI does not guarantee selection to participate in the RFP.

**ENVIRONMENTAL SERVICES FOR VARIOUS WASTE SERVICES**
Contract Opportunities at Beta.SAM, Solicitations N6247321S51229, 2021

The Naval Facilities Engineering Systems Command Southwest (NAVFAC SW) is issuing this sources sought as market research to determine whether there are potentially qualified small businesses; 8(a): HUBZone; service-disabled veteran-owned; small disadvantaged; woman-owned; and/or veteran-owned small business concerns under NAICS code 562211 (Hazardous Waste Treatment and Disposal) that have the current qualifications, experience, personnel, and capabilities to provide, under contract, all labor, equipment, material, and supervision necessary to perform-specific environmental services. The Government is considering a solicitation for the following services: (1) operation of Government-owned hazardous waste treatment, disposal, (2) containerized solid waste services, (3) oil and hazardous substance spill response, and (4) RIDG professional services for site assessment, remediation, and/or compliance projects. The majority of services would be performed for Navy and Marine Corps installations throughout the Southern California regions, although the NAVFAC SW region also includes Arizona, Nevada, Colorado, and New Mexico. A DRAFT performance-based work statement is provided for reference at betasam. The Government will use responses to this sources sought to make acquisition plans.

**SUPERFUND HAZARDOUS SUBSTANCE RESEARCH AND TRAINING PROGRAM**
DHHS, National Institutes of Health, Funding Opportunity RFA-E5-20-014, 2020

The National Institute of Environmental Health Sciences (NIEHS) supports problem-based, solution-oriented research centers for the Superfund Hazardous Substance Research and Training Program. See details at http://grants.nih.gov/grants/guide/rfa-files/RFA-E5-20-014.html. The scope of the Superfund Hazardous Substance Research and Training Program includes: (1) advanced techniques for the detection, assessment, and evaluation of the effects of hazardous substances on human health; (2) methods to assess the risks to human health presented by hazardous substances; (3) methods and technologies to detect hazardous substances in the environment; and (4) basic biological, chemical, and physical methods to reduce the amount and toxicity of hazardous substances.

**OAK RIDGE RESERVATION CLEANUP CONTRACT (ORRCC) - FINAL RFP**
U.S. DOE, Environmental Management Consolidated Business Center, Cincinnati, OH.
Contract Opportunities at Beta.SAM, Solicitations 562331989EM000047, 2020

The ORRCC Final RFP reflects an IDIQ contract under which cost-reimbursement and/or fixed-price task orders may be issued. The contract ordering period will be 10 years, including a 90-day transition period. The contract is estimated to be worth up to approximately $8.3B over the 10-year ordering period. The NAICS code for this RFP is 562210. See additional information at the EMBCR ORRCC portal website https://www.embcrr.orcrcc.com. Offers are due by 4:00 PM ET on February 16, 2021. https://beta.sam.gov/opps/3f2e194bd2ad43c0bacc677fe3e227a/view

**CleanUp News**

**REVIEW OF REMEDIAL OPTIONS FOR THE BOAT HARBOUR REMEDIATION PROJECT IN NOVA SCOTIA, CANADA**

The Boat Harbour Effluent Treatment Facility (BHETF) received industrial effluent wastewater from a nearby kraft pulp mill and chlor-alkali plant until 2020. The discharge resulted in widespread contamination of sediments and surface water with metals, dioxins and furans, and PAHs. The province of Nova Scotia has committed to remediating the BHETF with a goal of returning Boat Harbour to its natural state as a lidal estuary to restore the land’s historical, traditional, and recreational uses. A list of approaches was developed along with subsequent alternatives for each design component. They were screened to eliminate options that were not feasible or did not align with remediation goals. The remaining design with remediation options included detailed review and evaluation to select qualified remedial options to be shared with stakeholders for input. For more information on the project, see https://novascotia.ca/boatharbour/

**A FULL-SCALE APPLICATION OF PHYTOREMEDICATION TO ADDRESS A 1,4-DIOXANE PLUME**
Ovbye, T. and A. Brenzikofer, Parsons Technical Webinar (58 minutes), 15 October 2020

A formal industrial site on the coast of South Carolina was a source of 1,4-dioxane and VOC contamination in groundwater. In 2007, the PRP installed a phytoremediation system to accelerate contamination attenuation in shallow groundwater. Investigations of the system found that trees were removing VOCs from the top of the surficial aquifer, but roots were not reaching VOCs located in the bottom portion of the surficial aquifer. In addition, VOC concentrations were not diminishing in the groundwater, indicating an onsite contamination source. A soil removal action was completed that uncovered a former sump and possible discharge resulted in widespread contamination of sediments and surface water with metals, dioxins and furans, and PAHs. The province of Nova Scotia has committed to remediating the BHETF with a goal of returning Boat Harbour to its natural state as a lidal estuary to restore the land’s historical, traditional, and recreational uses. A list of approaches was developed along with subsequent alternatives for each design component. They were screened to eliminate options that were not feasible or did not align with remediation goals. The remaining design with remediation options included detailed review and evaluation to select qualified remedial options to be shared with stakeholders for input. For more information on the project, see https://novascotia.ca/boatharbour/

**FINAL REMEDIATION DESIGN REPORT SOIL VAPOR EXACTION AND TREATMENT SYSTEM AND IN SITU BIOREMEDIATION BANDERA ROAD GROUND WATER PLUME SUPERFUND SITE BEAXER COUNTY, TEXAS**
EPA Region 6, SB62146, 2020

This report presents remedial design criteria to construct SVE and in situ bioremediation (ISB) systems for treating chlorinated VOCs at the Bandera Road Ground Water Plume Superfund site. SVE will be used to treat the shallow vadose zone with Vertebrae™ wells and the deeper vadose zone using horizontal wells. ISB will be used to remediate groundwater. The design criteria are based on remedial action objectives that include preventing exposure to contamination in groundwater and indoor air concentrations greater than cleanup levels; preventing or minimizing further migration of contamination in surface soils; reducing VOCs and volatile zone bedrock, and groundwater concentrations greater than cleanup levels; and returning groundwater to their expedited beneficial use wherever practical. The cost for remediation, including construction, operation, and post-remedy monitoring, is estimated to be $6,245,000.

DHHS, National Institutes of Health, Funding Opportunity RFA-E5-20-014, 2020

2019 ANNUAL SUMMARY REPORT DARTMOUTH COLLEGE, RENNIE FARM SITE
G2A GeoEnvironmental, Inc. on behalf of Dartmouth College, 911 pp, 2020

In 2011, Dartmouth remediated a portion of Rennie Farm where the school disposed of animal carcasses from medical research in the 1960s and 70s. Particulate matter was monitored to determine a 1:1 ratio of released particulate matter sourced from the disposed oil products. Dartmouth installed groundwater extraction and treatment systems to remediate contamination and prevent further migration. The systems utilize liquid-phase granular activated carbon (LGAC) and Ambersorb® filters in sequence to remove 1,4-dioxane. The Ambersorb is periodically steam-regenerated. The contaminated condensate is treated through two LGAC canisters in series before being combined with treatment system influent. Performance data indicates that the systems are meeting remedial objectives. Based on results and estimates, the period of active remediation of the source area system will likely be less than 6 years. Dartmouth plans to expand the systems to treat groundwater in areas beyond the current capture zone.

DARTMOUTH COLLEGE, RENNIE FARM SITE

Demonstrations / Feasibility Studies

HARMFUL ALGAL BLOOM INTERCEPTION, TREATMENT, AND TRANSFORMATION SYSTEM, “HABITATS”

The objective of ERDC’s HABITATS project is to develop a rapidly deployable system for mitigating large harmful algal blooms (HABs) at various design scales. Progress in the project’s first year includes: 1) development and deployment of an interception technology that efficiently collects algae at the water surface, 2) validation of high throughput treatment using dissolved air flotation (DAF) technology to clarify algae-laden water, 3) oxidation of the DAF effluent using ozone for removing microcystin and other potential cyanotoxins, and 4) successful permitting with the Florida Department of Environmental Protection to discharge the treated water back to a surface water body at the demonstration site, 5) demonstration of rapid concentration of algae from a natural water source, transformation of concentrated algae from the study site into biofuel at bench scale, and 6) development of a scalability analysis model to establish baseline estimates for full-scale performance and cost. https://apps.dtic.mil/otis/pdf/AD1089650.pdf

CLEANING OF OIL-POLLUTED BOTTOM SEDIMENTS OF THE BOREAL LAKE, SAMOTLOR OIL FIELD, NORTH RUSSIA: CASE REPORT

A two-wire resistivity circuit was built to be attached as arrays to a central stalk and installed by direct-push techniques. An installed network of multilevel sandboxes was conducted to test and refine the DRP design before field testing. Results from field studies demonstrated the utility of the DRPs to generate information efficiently and cost-effectively regarding the arrival and persistence of reagents. While additional field testing is warranted, results suggest that the system can improve understanding of the detailed migration of injected reagents in treatment zones.

SIMPLE RESISTIVITY PROBE SYSTEM FOR REAL-TIME MONITORING OF INJECTED REAGENTS

In 2011, Dartmouth remediated a portion of Rennie Farm where the school disposed of animal carcasses from medical research in the 1960s and 70s. Particulate matter was monitored to determine a 1:1 ratio of released particulate matter sourced from the disposed oil products. Dartmouth installed groundwater extraction and treatment systems to remediate contamination and prevent further migration. The systems utilize liquid-phase granular activated carbon (LGAC) and Ambersorb® filters in sequence to remove 1,4-dioxane. The Ambersorb is periodically steam-regenerated. The contaminated condensate is treated through two LGAC canisters in series before being combined with treatment system influent. Performance data indicates that the systems are meeting remedial objectives. Based on results and estimates, the period of active remediation of the source area system will likely be less than 6 years. Dartmouth plans to expand the systems to treat groundwater in areas beyond the current capture zone.

PER- AND POLYFLUOROALKYL SUBSTANCES IN THE AIR PARTICLES OF ASIA: LEVELS, SEASONALITY, AND SIZE-DEPENDENT DISTRIBUTION

The East Central Phoenix 24th Street and Grand Canal site is in an urban area with relatively deep depth to groundwater, making implementing an efficient remedial approach for PCE in groundwater challenging and expensive. A proprietary specialized five-well ozone sparge pilot system was designed and installed in April 2020 as an aggressive and cost-effective alternative to establish the remedial system process. The probe is equipped with a cryogenic pulse process pressure pulse process incorporating micro-wire sparge and enhanced injection wells. The process resulted in an increase in dissolved-oxygen compared to traditional sparging and a significantly larger radius of influence than was expected. Groundwater monitoring indicated a significant decrease in PCE concentration in the groundwater influenced by the system. The presentation covers the nuances of this remedial approach, challenges that were overcome, the system’s effectiveness, and the anticipated path forward for this site and others.

PER- AND POLYFLUOROALKYL SUBSTANCES IN THE AIR PARTICLES OF ASIA: LEVELS, SEASONALITY, AND SIZE-DEPENDENT DISTRIBUTION

To see more information on the site, including documents, that are available, see https://azdeq.gov/ecp-24th-gc.

GROUNDWATER MONITORING & REMEDIATION

KINETIC PASSIVE SAMPLING: IN SITU CALIBRATION USING THE CONTAMINANT MASS MEASURED IN PARALLEL SAMPLERS WITH DIFFERENT THICKNESSES

A complementary calibration approach was developed to determine dissolved contaminant concentrations by measuring the contaminant mass ratio (CMR) from two parallel passive samplers with different thicknesses. The CMR calibration was tested in a lab experiment with defined and constant concentrations and in the field at a groundwater extraction and treatment site. Silicone passive samplers with different thicknesses were used to sample a range of dissolved PAHs. In the lab study, concentrations derived from the CMR calibration were compared with those from water extraction and passive dosing. The comparison resulted in differences below a factor of 2. In the field, CMR-derived concentrations were compared with performance reference compound calibrations. Differences ranged from a factor of 1 to 3. Findings indicate that the CMR calibration can be applied as a stand-alone or complementary calibration method for kinetic passive sampling.

RESEARCH

DESTRUCTION OF PERFLUOROALKYL ACIDS ACCUMULATED IN TYPHA LATIFOLIA THROUGH HYDROTHERMAL LIQUEFACTION

Researchers investigated whether hydrothermal liquefaction (HTL) could degrade PFAs accumulated in plant biomass. Researchers first evaluated the degradation of individual and mixed PFAs in pure aqueous solutions using HTL. All five PFAs were completely removed after 2 hours at 300°C. Three PFAs had greater removal efficiencies, while the other two remained unchanged. Treatment with KOH, HTL at 300°C, or treatment with both KOH and HTL at 300°C decreased the concentration of all PFAs in common cattails (Typha latifolia), including nearly 100% of PFAs. Removal of PFOS was 98.4% in roots and 98.4% and 9.6% in shoots. Results indicate the need for further investigation to optimize HTL to handle plant biomass used for phytoremediation of PFAs.

EVALUATION OF PILOT SCALE IN-VITRO AND EX-SITU HYDROCARBON BIOREMEDIATION POTENTIAL OF TWO NOVEL INDIGENOUS STRAINS OF BACILLUS VALLISMORTIS

Indigenous Bacillus vallismortis viz. strains DU12 and DU14 were isolated from oil-impacted soil samples collected from automobile garages located in Assam, India. After 28 days under in vitro conditions, the isolates were detected 26.34% and 53.85% of used engine oil. Pilot-scale ex-situ bioremediation assays on diesel-contaminated soil samples by both isolates resulted in biodegradation and Cicer arietinum seeds after 20 days of treatment. Both seedlings showed significant growth after bioremediation as compared to the respective controls.

PER- AND POLYFLUOROALKYL SUBSTANCES IN THE AIR PARTICLES OF ASIA: LEVELS, SEASONALITY, AND SIZE-DEPENDENT DISTRIBUTION

To see all site data, including site maps, photographs, and documents such as the design plans for the system expansion, see https://www.dartmouth.edu/ehs/rennie_links.html. #Information.
In this study, 248 size-specific particulate matter (PM) samples collected from nine Asian cities were analyzed for 34 PFAS. Of the 34 investigated PFAS, PFOA and PFOS were the major compounds. Hexafluoropropylene oxide dimer acid, an emerging PFAS, was quantified in PM for the first time, with concentrations ranging from less than 0.086 to 21.5 pg/mL. Spatially PFOA and PFOS were the predominant compounds in China, while precursors, emerging PFAS, and short-chain PFAS were predominant in India. FAPAS showed that most PFAS were predominantly affiliated in fine particles, while PFOS and its alternatives tended to attach to coarser particles. PFOS distributed on specific sizes exhibited seasonal and regional dependency, while no such patterns were observed for PFOA.

PFAS and dissolved organic carbon (DOC) were analyzed in nine pairs of foam and underlying bulk water samples collected from a PFAS-impacted freshwater lake. The DOC concentrations of 16 PFAS ranged from 97,000 ng/L (PFOS) and longer-chain, more hydrophobic PFAS. Only five PFAS, including PFOS and shorter chain length, were quantified in underlying bulk waters. Enrichment factors ranged from 10 (PFHxS) to 2,830 (PFOS). AFFF foams contained the highest concentrations and numbers of PFAS classes with PFOS concentrations exceeding the 200 ng/L EPA health advisory level. PFAS concentrations were significantly below published critical micelle concentrations. Concentrations represented less than 0.1% of overall DOC concentrations in foam, indicating that PFAS are a minor fraction of DOC and that DOC likely plays a central role in foam formation. Estimates indicated that foam ingestion is a potentially important route of exposure for children and adults when they are in surface waters where foam is present.

**LEAD TOLERANT ENDOPHYTE** **TRAMETES HIRU S** **IMPROVED THE GROWTH AND LEAD ACCUMULATION IN THE VEGETATIVE PARTS OF TRITICUM AESTIVUM**


Trametes hirsuta, an endophytic fungus, was isolated from the *Chenopodium album* L. plant growing in Pb-contaminated soil of an industrial area. When tested in vitro, the fungus was tolerant to 1,500 mg/L Pb. Wheat seedlings (*Triticum aestivum* L.) infected by *T. hirsuta* showed Pb tolerance. With fungal inoculation, cumulative plant growth and total chlorophyll content increased by 24% and 18%, respectively, compared to their respective non-inoculated controls at 1000 mg/kg Pb. Similarly, 50% more Pb accumulation was measured in the shoots of fungal inoculated plants at 1500 mg/kg Pb as compared to control. Results suggest that fungal inoculation can improve plant growth and assist with phytoextraction of heavy metals from polluted sites by increasing uptake by host plants.

**PER- AND POLYFLUOROALKYL SUBSTANCES IN DUST COLLECTED FROM RESIDENTIAL HOMES AND FIRE STATIONS IN NORTH AMERICA**


Researchers collected dust samples from 184 homes in North Carolina and 49 fire stations across the U.S. and Canada to analyze for PFAS. FTOHs and diPAP were significantly higher in PFAS both in fire stations and homes compared to residential dust. PFAS concentrations in dust ranged from 100 ng/dry gram to 6400 ng/dry gram. Zwitterionic and PFAA levels in residential dust appeared to increase over time, particularly PFOS and PFOSA. Results highlight a need to better understand what factors contribute to PFAS levels in dust and how much dust contributes to overall human PFAS exposure.

**PUMP-AND-TREAT CONFIGURATIONS WITH VERTICAL AND HORIZONTAL WELLS TO REMEDIATE AN AQUIFER CONTAMINATED BY HEXAVALENT CHROMIUM**


Soil and groundwater from an AFFF-impacted site were sampled at high resolution (n = 105 for soil, n = 58 for groundwater) and analyzed for an extensive list of aromatic, zwitterionic, and cationic PFAS at an AFFF-impacted site. Spatial trends for PFASs and many precursors enable a better understanding of PFAS composition, transport, and transformation. Summed PFAS and individual PFAS concentrations were often higher at depth than near the surface in soil and groundwater. Zwitterionic and cationic PFAS concentrations ranged from 97% in AFFF plume to 2% in underlying bulk waters. Enrichment factors ranged from 10 (PFHxA) up to 2,830 (PFOS). AFFF foams contained the highest concentrations and numbers of PFAS classes with PFOS concentrations exceeding the 200 ng/L EPA health advisory level. PFAS concentrations were significantly below published critical micelle concentrations. Concentrations represented less than 0.1% of overall DOC concentrations in foam, indicating that PFAS are a minor fraction of DOC and that DOC likely plays a central role in foam formation. Estimates indicated that foam ingestion is a potentially important route of exposure for children and adults when they are in surface waters where foam is present.

**SPATIAL TRENDS OF ANIONIC, ZWITTERIONIC, AND CATIONIC PFAS AT AN AFFF-IMPACTED SITE**


Soil and groundwater from an AFFF-impacted site were sampled at high resolution (n = 105 for soil, n = 58 for groundwater) and analyzed for an extensive list of aromatic, zwitterionic, and cationic PFAS. Spatial trends for PFASs and many precursors enable a better understanding of PFAS composition, transport, and transformation. Summed PFAS and individual PFAS concentrations were often higher at depth than near the surface in soil and groundwater. Zwitterionic and cationic PFAS concentrations ranged from 97% in AFFF plume to 2% in underlying bulk waters. Enrichment factors ranged from 10 (PFHxA) up to 2,830 (PFOS). AFFF foams contained the highest concentrations and numbers of PFAS classes with PFOS concentrations exceeding the 200 ng/L EPA health advisory level. PFAS concentrations were significantly below published critical micelle concentrations. Concentrations represented less than 0.1% of overall DOC concentrations in foam, indicating that PFAS are a minor fraction of DOC and that DOC likely plays a central role in foam formation. Estimates indicated that foam ingestion is a potentially important route of exposure for children and adults when they are in surface waters where foam is present.

**TREATMENT WELL (HRX WELL)® FOR MANAGING CONTAMINANTS IN COMPLEX GEOLLOGICAL ENVIRONMENTS**

Divine, C. ESTCP ER-201631, software, 2021

The HRX Well design tool was developed to provide preliminary site design estimates to practitioners considering implementing the HRX Well. Many HRX Well configurations are possible, but the applicability of any design is subject to site-specific factors. The tool allows the user to optimize the design based on user-defined criteria. This tool is optimized for use in simple conceptual models with minimal background information. The tool can be used as inputs to support high-level estimations. The tool predicts well length, capture width, and the number of wells required to meet target treatment goals. In addition, it provides information on potential disturbances and how they affect the design. The tool is a useful tool for planning and it is intended to be used as a first step in the design process. For many sites, a more detailed numerical flow and transport model may be needed for final design and predict and assess HRX Well performance.
A better understanding of the mechanisms underlying heavy metal accumulation and tolerance in plants is necessary to improve phytoremediation efficiency. This review describes the mechanisms of how heavy metals are taken up, translocated, and detoxified in plants with a focus on the strategies applied to improve the efficiency of phytostabilization and phytoextraction, including the application of genetic engineering, microbe-assisted, and chelate-assisted approaches. This article is Open Access at https://www.frontiersin.org/articles/10.3389/fpls.2020.00359/full.

Contaminant back diffusion from secondary sources may hamper site remediation if it is not properly addressed in the remedial design. This paper reviews reported technologies and strategies that have been or could be applied to address plume persistence due to back diffusion as published in the peer-reviewed literature. The technologies and strategies are classified into four major categories: 1) passive low permeable zones (LPZ) management approaches; 2) strategies that promote contaminant destruction through the forward diffusion of amendments into the LPZ; 3) strategies that alter physical characteristics of the secondary source, including viscosity modification, fracturing, and soil mixing; and 4) thermal and electrokinetic remediation.

This paper provides an overview of research and development efforts to date by SERDP and ESTCP related to analytical advancements, fate and transport, ecological risks, and remedial strategies to assist in managing aqueous film-forming foam (AFFF)-impacted sites. The projects aim to measure PFAS in the environment, characterize AFFF-associated sources of PFAS, understand PFAS fate and behavior in the environment, assess the risk to ecological receptors, develop in situ and ex situ treatment technologies for groundwater, treat soils and investigation-derived wastes, and examine the ecotoxicity of PFAS-free fire suppression formulations. https://setac.onlinelibrary.wiley.com/doi/epdf/10.1002/etc.4894

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.

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.