

Suggested Research and Activities for the Superfund Hazardous Substance Research and Training Program Center Grants (P42)

This document contains suggested research and activities for the NIEHS Superfund Hazardous Substance Research and Training Program (P42) RFA-ES-15-019 (<http://grants.nih.gov/grants/guide/rfa-files/RFA-ES-15-019.html>) referred to as the Superfund Research Program (SRP) Center grant. SRP Center grants support problem-based, solution-oriented research Centers that consist of multiple, integrated projects representing both the biomedical and environmental science and engineering disciplines; as well as cores tasked with administrative, research translation, community engagement, training, and research support functions. The research and activities from each Center are expected to address the SRP mandates:

- 1) Advanced techniques for the detection, assessment, and evaluation of the effect 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.
- 4) Basic biological, chemical, and physical methods to reduce the amount and toxicity of hazardous substances.

How this document was developed: SRP seeks input from key stakeholders at sister Superfund programs within the U.S. Environmental Protection Agency (EPA) and the Agency for Toxic Substances and Disease Registry (ATSDR) in order to identify the research gaps needed for stakeholders within EPA, ATSDR, and other related Federal, State, local, and Tribal entities responsible for the assessment and management of sites impacted by hazardous substances. In addition, recent NIH Strategic Plans (SRP: <http://www.niehs.nih.gov/research/supported/centers/srp/about/register/index.cfm> and NIEHS: <http://www.niehs.nih.gov/about/strategicplan/>) serve as a basis for prioritizing research topics and activities.

- **Section A:** divides research topics by SRP's mandate areas in order to demonstrate how basic and applied research can be directed to solve problems relevant to SRP's mandates. For any given topic, applicants are encouraged to integrate knowledge and results from multiple projects and cores to achieve a holistic (e.g. involving biomedical, environmental, and research translation/community engagement approaches) resolution to these complex environmental problems. Likewise, topics within one mandate area are likely to be synergistic with topics in other mandate areas. Applicants, therefore, should take into consideration the relationships between mandate area topics in order to develop an integrated, problem-solving SRP Center.
- **Sections B – C:** lists Hazardous Substances and Exposure Scenarios of interest to EPA, ATSDR, and NIEHS stakeholders.
- **Sections D – G:** lists recommended Research Translation (including Investigator-Initiated Research Translation), Community Engagement, and Training activities.
- **Section H:** lists resources, websites, and points of contact.

Section A) Suggested Research Needs

The following list consists of topics meant to direct applicants to areas in need of research that would be responsive to SRP mandates and could be accomplished through interdisciplinary research. These examples are not intended to be exhaustive, and applicants may utilize these and many other topics in order to meet the objectives of [RFA ES-15-019](#).

1) Advanced techniques for the detection, assessment, and evaluation of the effect of hazardous substances on human health.

- Dissection of molecular, genetic, and biochemical events that describe the normal physiological processes that contribute to good health and the roles that hazardous substances play in their disruption
- Use and interpretation of high throughput cell-based assays (e.g., “omics techniques”) to create mechanistically based toxicity profiles for hazardous substances to develop toxicological and epidemiological studies; develop cell-based assays utilizing novel cell types (e.g., induced pluripotent stem cells) and techniques
- Application of advanced techniques to determine the contribution of genetic and environmental variables (i.e. GxE interaction) in the development of disease (e.g., genetic polymorphisms, epigenetic factors, gender, and age) and host factors (e.g., susceptibility, nutrition, co-morbid disease/conditions, lifestyle habits, psychological stressors; and timing of exposure)
- Employment of integrative or systems biology approaches to study the effects of environmentally relevant exposure routes/levels of hazardous substances on the dynamic nature of biological systems and to identify biologically relevant events that lead to disease and dysfunction
- Utilization, combination, and integration of diverse epidemiological data sets from environmental studies to conduct environmental wide-association (EWAS) studies to determine relationship between environmental exposures and phenotypic response(s)
- Development of new and appropriate biostatistical approaches and mathematical algorithms to understand gene-environment, gene-gene, or multi-gene-environment interactions; apply comparative genomics and toxicokinetic approaches to study functional consequences of genetic polymorphisms
- Development, validation, and interpretation of mathematical and computational approaches/models for analysis of high density data and to predict and develop physiologically-based mechanistic models to predict toxicity (e.g., data used in *in silico* studies)
- Development of integrated technologies that can be used to enhance the assessment of the Absorption, Distribution, Metabolism and Elimination (ADME) of environmental toxicants, for singular, binary, and mixtures of compounds
- Identification and validation of sensitive and novel diagnostic or prognostic biomarkers of exposure, biological response anchored to a phenotypic characteristic, disease, and therapeutic efficacy (human or animal studies); development and validation of biomarkers of disease that can be easily detected in blood, urine, saliva, etc. of humans/animal models (e.g., development of high throughput screening methods for identification and validation of biomarkers)
- Investigation of the exposome, which will require the development, validation, and implementation of characterization of exposure and biological response; exposure assessment for multiple analytes; utilization of computational tools and resources for analyzing; conducting non-targeted analysis and suspect screening analysis; and providing centralized access to information on the associations between exposure and disease
- Investigation of disease/dysfunction related to environmentally-relevant (low dose) exposures, using observed human biomonitoring data and/or other large databases to develop testable hypotheses (e.g. National Health and Nutrition Examination Survey (NHANES), ToxCast, disease registries, etc.)
- Incorporation of bioengineering and synthetic biology to study the regulation, control, and response to environmental chemicals (e.g., toxicity sensors that rapidly detect and quantify low concentrations of chemicals in cells or tissues)
- Integration of high throughput screening (HTS) and classic animal model toxicology testing as a means to understanding human disease processes, as well as developing screening methods for rapid testing

2) Methods to assess the risks to human health presented by hazardous substances.

- Development of multi-dimensional risk models that incorporate exposure data, fate and transport, bioavailability, and biological responses
- Interpretation of virtual tissue / systems biology data and determination of how this data should be used in risk assessment
- Development of sophisticated and appropriate statistical and computational methodologies and improved mathematical algorithms for predictive and computational toxicology to better characterize the low dose-response effects that are biologically relevant
- Provide strategies to address uncertainty in risk assessment associated with:
 - differences in species, individual susceptibility and predisposition, gender, extrapolation of high to low dose, acute to chronic exposure, and *in vitro* to *in vivo* data:
 - methods/models that incorporate combined exposures or cumulative risk (e.g., component and whole mixture approaches, extrapolation from single chemical(s) to multiple exposures or mixtures; inclusion of non-chemical stressors)
 - methods/models using non-monotonic dose response relationships in risk assessment
 - methods/models to incorporate high throughput screening tests relevant to human toxicity, pathways, and endpoints (e.g., Adverse Outcome Pathways)
 - determining mode(s) of action of hazardous substances and application to risk assessment
 - predisposition based on current or past disease states (e.g., immune related- diseases, cardiovascular disease, cancer, endocrine disruption, etc.)
- Determination of how studies of the exposome (i.e., capacity for untargeted analysis of biomarkers of exposure and response including metabolomics, proteomics, transcriptomics and epigenomics) can be utilized in risk assessment
- Utilization of binding properties (kinetics) and macromolecular information to better understand mechanisms including structure/function relationships (e.g., QSAR) in response to exposure(s) to hazardous substances to reduce uncertainty in risk assessment
- Development, characterization, and validation of biomarkers of diseases or response pathways (e.g., signatures of oxidative damage or inflammation specific to an environmental toxicant or class of toxicants) that can be applied to improve risk assessment and to gain additional mechanistic insight into disease pathogenesis (validation should consist of assessing human relevance of effects to that observed in experimental models)
- Development of new, highly efficient monitoring technologies, platforms, and methods for biomonitoring of exposure within biological samples, while maximizing the number of analytes measured while minimizing laboratory and participant burden. The following website provides recently developed laboratory methods for both preparative and analytic chemical methods used on NHANES samples (<http://www.cdc.gov/exposurereport/>)
- Development of biomonitoring/analytical techniques to differentiate between sources of a hazardous substance exposure in biological samples (e.g., lead blood level attributed to mining sites versus other exposures to lead)
- Development of methods to determine exposure rates and different routes of exposure (e.g. tracer methods to identify the amount of soil ingested by children)

3) Methods and technologies to detect hazardous substances in the environment.

- Development of fast, accurate, robust, and advanced technologies that allow for portable real-time, on-site characterization, monitoring, and assessment of contaminant toxicity
- Integration of environmental data within a contextual framework of how contaminants affect nearby populations (human or wildlife) through modeling approaches
 - Utilization of ecological indicators as measures of disturbance due to hazardous substances in the environment as well as recovery of ecosystems and ecosystem services following remediation (e.g. natural succession, changes in food web uptake, species diversity, etc.)
 - Development of innovative generalizable methods to assess impacts of hazardous substances based on sentinel species

- Utilization of GIS-based environmental databases (e.g. EnviroAtlas <http://enviroatlas.epa.gov/enviroatlas/HowtoUse/index.html>) for understanding impacts of hazardous substances on ecosystem functioning (e.g., ecosystem services and natural succession)
- Development of mobile techniques, devices, or tools with field data exchange capabilities for real time remote monitoring of conditions, or technologies that automatically geo-reference collected data (e.g., solar powered sensors embedded with wireless transmitters; data collection via smart phones)
- Improvement of methods to assess physical characteristics of the environmental matrix (e.g. hydraulic conductivity, bedrock fractures, etc.) within the context of hazardous substance detection, characterization, and remediation management
- Utilization of visualization and molecular tools to characterize the physical, hydrogeochemical, or biogeochemical properties of complex sites (e.g. sites containing dense non-aqueous phase liquid (DNAPLs) and sites that are typically characterized by extensive, heterogeneous, and persistent source zones of entrapped and pooled organic liquids)
- Development of tools to support rapid assessment of bioavailable fractions of hazardous substances in the environment including relevant exposure times and locations in complex environments (e.g., tidal wedge estuaries, groundwater/surface water interaction zones, etc.)
- Development of methods to support characterization and understanding of contaminant degradation processes within rock matrices and diffusion mechanisms out of those matrices
- Development and standardization of passive sampling methods with commercial potential to broaden acceptance of passive sampling methods, particularly for assessing bioavailability of metals in sediments and water; application of passive sampling to validate remediation performance; conducting post-remedial monitoring; and comparison with conventional biomonitoring organisms
- Molecular and genetic endpoints in invertebrates, fish, birds and wildlife that can serve as early predictors of toxicity and reproduction/fecundity, that may impact normal wildlife population levels and/or ecological restoration/succession

4) Basic biological, chemical, and physical methods to reduce the amount and toxicity of hazardous substances.

- Optimization of sequential, compatible remediation strategies for different phases of a clean-up process (i.e., “combined remedies” or “treatment train”) to maximize the degradation/removal of hazardous substances at complex sites
- Development of innovative approaches to remediate complex contaminated sites (e.g. chemical mixtures; dense non-aqueous phase liquid (DNAPL) in complex matrices, particularly in fractured rock)
- Utilization of molecular, biochemical, cellular, and/or engineering tools to understand the basic structural and functional properties of microorganisms or plants involved in the bioremediation of hazardous substances
- Development of new technologies for *in situ* remediation of contaminated sediments, soils, and groundwater particularly with regard to delivering agents to the source
- Determination of the long-term efficacy and sustainability of a remediation technology for reducing toxicity of hazardous substances (e.g. the efficacy of using phosphates for long-term stabilization of lead in soil)
- Optimization and validation of food web bioaccumulation models for predicting long-term changes in tissue contaminant concentrations, particularly as a gauge of remediation success in sediment clean-up activities
- Development of sustainable, innovative “green technologies” for remediation that offer improved energy/resource-efficiency and reduce waste generation relative to other remediation technologies (e.g., sustainable remediation technologies for large mining-sites in arid regions); modifications to established technologies to improve their sustainability. Applicants are encouraged to quantify the environmental footprint of remediation activities (http://clu.in.org/greenremediation/subtab_b3.cfm)
- Application of basic engineering design principles to develop sustainable remediation solutions that are efficient, economically feasible, technologically sound, and acceptable to communities
- Development of nutrition or other prevention/intervention strategies to reduce toxicity of hazardous substances

- Impact of hazardous substance exposure on ecosystem services (for more information see: <http://www2.epa.gov/eco-research/ecosystems-services>)
- Optimizing remediation strategies to enhance natural succession and overcome ecosystem impacts due to hazardous substances
- Development of robust remediation strategies resilient to climate change impacts (for more information see: <http://www2.epa.gov/superfund/superfund-climate-change-adaptation>)

Section B. Hazardous Substances of Interest

SRP Centers present a unique opportunity to address research needs of existing Superfund sites; hence, research on chemical contaminants (e.g., halogenated organics or pesticides) and minerals (e.g., metals, elongated mineral particles, or mine tailings) that are the drivers of risk at hazardous waste sites are highly relevant to SRP. With regard to specific hazardous substances, please refer to the following areas of interest:

- **Mixtures:** Commonly-occurring mixtures of contaminants relevant to human exposure are of high interest to SRP and its stakeholders. Examples include but are not limited to: mercury and PCBs (potential co-exposures due to fish/shellfish consumption); apparent co-exposures identified in NHANES and other national databases; polycyclic aromatic compounds and metals; co-occurrences of endocrine disrupting chemicals (e.g., phthalates); metal mixtures associated with mining operations, etc. Applicants are encouraged to visit the following website for interaction profiles that have been developed by the ATSDR: <http://www.atsdr.cdc.gov/interactionprofiles/index.asp>.
- **Emerging Contaminants (ECs):** There are a number of contaminants that are of emerging concern to Superfund for reasons such as the increasing prevalence of the compound on Superfund sites or in human biomonitoring studies together with a lack of data about the hazards of the compound. *Applicants considering a focus on contaminants of emerging concern are strongly encouraged to contact SRP staff early in the application process in order to discuss the programmatic relevancy of the proposed hazardous substance.* As a general framework, the following characteristics would make ECs candidates for consideration within the SRP Centers: high production volume agents with demonstrated potential for human health and environmental impact (e.g., "high priority" for risk-based priority decisions: <http://www.echemportal.org/echemportal/participant/participantinfo.action?participantID=9>); chemicals presumed to be toxic based on structural similarity to the CERCLA Priority List of hazardous substances and likely to cause exposures from a point source; and environmental contaminants of emerging interest due to rapidly increasing production volume combined with suspected toxicological and bioaccumulative characteristics or a change in toxicity risk or regulatory status. Other ECs identified by SRP stakeholders include:
 - **Rare Earth Elements (REEs):** a recent, rapid increase in the domestic extraction of REEs (i.e. elements that fall into the class of Lanthanides as well as scandium and yttrium) has opened new mining reserves and developed numerous recycling processes. The environmental implications of these operations are not well understood. The following report has recent summary information on locations in US with elevated rare earth element contents targeted for extraction <http://nepis.epa.gov/Adobe/PDF/P100EUBC.pdf>.
 - **Chemicals of Unknown Hazard Found at Superfund Sites:** A Provisional Peer-Reviewed Toxicity Value (PPRTV) is a toxicity value derived for use in the Superfund Program when such a value is not available in EPA's Integrated Risk Information System (IRIS, the first tier in the Superfund hierarchy of human health toxicity values). PPRTVs can be found at: <http://hhpprtv.ornl.gov/>. In addition, there are several IRIS compounds relevant to Superfund for which particular hazard endpoints are unknown or for which there is insufficient data to derive reference values. The list of IRIS chemicals with Toxicological Reviews can be found at: <http://cfpub.epa.gov/ncea/iris/index.cfm?fuseaction=iris.showToxDocs>
 - **ATSDR emerging contaminants (ECs):** Includes extremely data poor contaminants that ATSDR or National Center for Environmental Health (NCEH) evaluates at hazardous waste sites or in other exposure scenarios. ATSDR ECs would also include extensively used new chemicals with a high potential to appear at hazardous waste sites or some environmental contaminants measured in NHANES (<http://www.cdc.gov/nchs/nhanes.htm>) human samples

(National Exposure Report produced by DLS/NCEH) with insufficient data to evaluate health effects (<http://www.cdc.gov/exposurereport/>).

- **Federal Facilities Restoration and Reuse Office (FFRRO) Emerging Contaminants**
FFRRO is a resource for many ECs. FFRRO ECs of particular relevance to SRP stakeholders include the following: 1,4-Dioxane, perchlorate, perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA), polybrominated diphenyl ethers (PBDEs), polybrominated biphenyls (PBBs). For a full list of FFRRO emerging contaminants and for additional EC resources, please see the following:
 - http://www2.epa.gov/sites/production/files/2014-04/documents/factsheet_contaminant_pfos_pfoa_march2014.pdf
 - <http://www2.epa.gov/fedfac/emerging-contaminants-and-federal-facility-contaminants-concern>.
- Applicants are highly encouraged to consult with SRP staff for specific questions about the relevancy of a hazardous substance for this program as the presence of a compound on one of the lists mentioned above does not automatically make it relevant to the SRP. Per SARA Mandates, hazardous substances do not include petroleum nor natural gas, natural gas liquids, liquefied natural gas, or synthetic gas usable for fuel.

Section C. Exposure Scenarios of Interest. SRP Centers also have the ability to investigate complex exposure scenarios. The following examples have been identified as scenarios that require further research efforts.

- **Susceptible Populations and Predisposition:** research on susceptible populations (e.g., pregnant women, children, elderly, ethnicity, disease states), and environmental health disparities (e.g. environmental justice communities), in order to develop strategies to reduce their burden of environmentally-influenced diseases; investigation of windows of susceptibility including pre-pregnancy, development, infancy, early childhood, puberty, and aging; determination of specific windows of susceptibility are most sensitive to environmental exposures and may lead to disease; identification of *in vitro* and *in vivo* models to accurately predict disease from exposure during critical life stages in human populations; development of biomarkers of exposure and disease to predict disease later in life; determination of the role of genetics and the mechanism(s) responsible for the latency of effect; determination of how exposure to environmental contaminants during windows of susceptibility can be used to support risk assessment and predict risk of disease; identification of other potentially susceptible populations.
- **Vapor Intrusion:** development of sustainable remediation strategies to mitigate exposure; development of more rapid and cost-effective source treatment methods; development of alternative method(s) for assessing effectiveness of vapor intrusion mitigation systems; studies that elucidate the relative risks from indoor vs vapor intrusion sources; effectiveness of vapor intrusion remedies for reducing total risk; development of cost-effective, real-time, and validated methods to detect vapor intrusion and/or assessment of indoor and outdoor exposures; the study of mechanisms and health consequences of chronic, low level (sub-maximum contaminant level) exposure of chemicals associated with vapor intrusion; the development and application of methods to enhance assessment and management of vapor intrusion and resultant potential health effects.
- **Combined Exposures and Cumulative Risk Assessment:** the investigation of effects of combined exposures which include any combination of chemical and/or nonchemical stressors that act jointly to elicit a measurable adverse effect; examples include mixtures containing multiple environmental toxicants, combinations of environmental toxicants and nonchemical stressors (e.g. physiological stressors or psychosocial stress), or the interactions between diet, or infectious agents, with environmental toxicants; development of computational toxicology approaches to understand the interactions among combined exposures, which may include mathematical and statistical models/approaches, to predict human health effects associated with combined exposures and to support cumulative risk assessments (for more information about cumulative risk assessment, see <http://www2.epa.gov/risk/framework-cumulative-risk-assessment>); investigation of combined exposures in tribal or environmental justice communities or other vulnerable or susceptible populations; development of innovative detection and/or remediation technologies for

combined exposures in the environment. In addition, applicants may wish to visit the EPA's [Community-Focused Exposure and Risk Screening Tool \(C-FERST\) webpage](#) for ongoing efforts to integrate information about community exposure to multiple stressors. Combined exposures selected for study should have relevance to Superfund and environmental exposures, with an emphasis on investigating environmentally relevant contaminant dose levels and proportions.

- **Emerging Exposure Pathways:** SRP and its stakeholders recognize the importance of investigating emerging exposure pathways. Examples include: risks from inhalation of PCBs emitted from light fixtures in schools; the emerging concern posed by arsenic inhalation from mining operations; and identifying the human and environmental health effects associated with e-waste and reclamation activities.
- **Exposome:** investigation of the exposome, which describes the totality of human exposures in an integrated temporal, spatial, and biological framework; exposome research will require the development, validation, and implementation of characterization of exposure and biological response (see Wild, 2012, International Journal of Epidemiology, Volume 41, Issue 1, p. 24-32; <http://ije.oxfordjournals.org/content/41/1/24.long>). Other exposome research topics include: comprehensive assessment of external exposure, internal dose, and biological response; assessment of multiple analytes in biological samples; computational tools and resources for analyzing and providing centralized access to information on the associations between exposure and disease; development of objective measures of historical exposures to inform investigations of latent effects of exposures or diseases arising from exposures during windows of susceptibility; assessment of exposure before, during, and after remediation; development and validation of exposure assessment tools to determine the incorporation of bioavailability of contaminants in the environment; measurements of exposure metrics such as fish and/or soil ingestion; contribution of soil to indoor dust due to human activities (e.g., tracking soil indoors and areal radius of the "outdoor" source available for transport); use and refinement of environmental monitoring and geographic information system (GIS) for spatial exposure assessment.

Section D. Suggestions for Research Translation Core (RTC) Activities

The SRP requires a Research Translation Core (RTC) within each SRP Center. Each RTC has a critical role in assisting project/core leaders in translating research emanating from the Center to appropriate audiences, thereby encouraging the accurate and timely use of these research products. RTCs serve as a conduit to assist in moving project outcomes to end-users and are not meant to be a pilot project/activity program. The following examples demonstrate some of the various tools and activities that can be used for effective research translation:

- **Communicating within SRP:** Per RFA, this includes Project-specific translation; SRP communication (i.e., communication with SRP at NIEHS headquarters); and Cross-Center communication. Examples include:
 - Coordinating with Project leaders to develop plain language description(s) of research project(s) for dissemination to broad audiences (e.g., elevator pitch, lightning talk, website summaries). Note: the RTC may plan to utilize these descriptions as the basis for multi-media outlets (e.g., YouTube videos, webinars, Twitter)
 - Coordinating with Project Investigators in identifying potential stakeholders for project research to assist in developing Investigator-Initiated Research Translation Plans (see **Section E**)
 - Communicating to SRP the results of research translation activities through utilization NIEHS SRP research translation activity data collection tool to provide information about various activities (e.g., investigator awards, meetings, workshops) – visit SRP Data Collection Form (<https://tools.niehs.nih.gov/srp/rtc/>).
 - Participating in SRP Research Translation teleconferences, webinars, and working groups as appropriate to the Center
 - Proactively disseminating timely information to SRP and other Centers (e.g., high impact publications, press releases)

- Developing workshops and meetings among the various SRP Centers to advance scientific themes of the Center
- Participating in networking groups between SRP Center investigators and stakeholders to advance translation of new scientific research
- Partnerships with Government Agencies
 - Identifying appropriate Center expertise for serving on External Advisory Panels (e.g., EPA or ATSDR panels) or providing comment for EPA's Integrated Risk Information System (IRIS <http://www.epa.gov/iris/publicmeeting/index.htm>), ATSDR (public comment requests <http://www.atsdr.cdc.gov/hac/pha/publiccomments.asp> and/or ToxProfiles, <http://www.atsdr.cdc.gov/toxprofiles/index.asp>), or other state (e.g. CalEPA) products
 - Establishing connections with Regional and Central EPA offices and ATSDR offices (e.g., plan to make contact with the [EPA Superfund and Technical Liaisons \(STLs\)](#) and [ATSDR Regional staff](#)) and Headquarter Offices.
 - Establishing a plan for participation in EPA's Partners in Technical Assistance Program (PTAP): <http://www2.epa.gov/superfund/partners-technical-assistance-program-ptap-pilot>)
 - Communicating scientific findings to local/state/Tribal health and environmental departments
 - Establishing working relationships with local/state/Tribal health and environmental departments (e.g., development of seminar series)
- Technology Transfer
 - Assisting in Investigator-Initiated Research Translation opportunities such as identifying appropriate sites for piloting remediation technologies and sharing/testing of environmental/biological samples (see Section E.)
 - Coordinating with formal technology transfer mechanisms (patents, licenses, Small Business Innovation Research/Small Business Technology Transfer Research grants)
 - Using research findings to improve current risk assessments
 - Advancing biomarker, remediation, detection, etc. research into application with consultation from technology transfer offices and/or stakeholders such as EPA and ATSDR.
 - Creating open source data sharing repositories
 - Refining technologies/demonstration research to make more applicable.
- Information Dissemination to other End-users
 - Developing website(s), informational videos, brochures, utilizing media (e.g., newspapers, magazines, social media, video) and/or factsheets about the SRP Center that is more readily available to a broader audience
 - Coordinate writing of editorials, commentaries, and review papers, and opinion papers
 - Developing audience appropriate educational courses/curricula/learning materials/meeting symposia/workshops based on the focus of the Center
 - Participating in local community or health events (e.g., health fairs, school based programs, etc.)
 - Hosting webinars, symposia, and science cafes

Section E. Suggestions for Investigator-Initiated Research Translation

The SRP Strategic Plan encourages interaction between project investigators and stakeholder end-users throughout the proposal development, the project duration, and conclusion of research activities as a means to increase Program relevancy. To address this, project investigators are expected to provide a plan for investigator-initiated research translation (IIRT) as part of the Data Sharing Plan. IIRT plans should, therefore, outline a strategy for the translation of their research beyond typical methods to disseminate research findings (i.e. the publication of research findings in scientific journals, presentations at scientific meetings, etc.).

The following activities have been identified by SRP and its stakeholders as potential ways to use research findings in the manner most appropriate for their application and the advancement of the research objectives. This list is not meant to be exhaustive. Investigators should be in communication with their Research Translation Core to identify IIRT opportunities most appropriate for a given research project. When work is proposed for Superfund Sites, the site Remedial Project Manager as well as appropriate EPA and ATSDR regional staff, should be contacted and incorporated into the IIRTs. As appropriate, the CEC's impacted community may be an appropriate end-user for project discoveries and could, therefore, be considered as part of IIRT plans.

IIRT plans may include the following:

- Project leaders should coordinate with the RTC to develop plain language description(s) of research project(s) for dissemination to broad audiences (e.g., elevator pitch, lightening talk, website summaries). Note: the RTC may plan to utilize these descriptions as the basis for multi-media outlets (e.g., YouTube videos, webinars, Twitter)
- Plans to share anticipated project-generated resources: e.g. specimen sharing, field sample sharing, development and distribution of analytical protocols/methodologies, data generated from toxicological (e.g. dose-response studies) and epidemiological studies(e.g. adding data to NIEHS and/or EPA data repositories)
- Plans to identify potential stakeholders for translating findings and/or identify sites that may be appropriate for piloting project technologies
- Plans to identify and communicate with stakeholders who would benefit from the outcomes/products of the research. Stakeholders may include federal government agencies, state/local government agencies, non-government organizations (NGOs), commercial sector, etc. For example, biomedical researchers could provide comments during open public comment periods for EPA's Integrated Risk Information System (IRIS) draft toxicological reviews and/or ATSDR's Toxicological Profiles and Public Health Assessments. Applicants may wish to consider monitoring public comment periods for federal documents from a variety of government agencies: EPA, ATSDR, NIEHS NTP, CDC, FDA, USDA, NOAA, USGS, DoE, DoD, etc (all of these agencies generate some documents relevant to NPL chemicals or exposures or exposure routes)
- Plans to coordinate with federal and/or state research laboratories undergoing similar/complementary research studies (i.e., EPA Office of Research and Development); see Section H for link.
 - About ORD: <http://www2.epa.gov/aboutepa/about-office-research-and-development-ord>
 - Strategic Research Action Plans: <http://www2.epa.gov/research/strategic-research-action-plans>; particularly the "Sustainable and Healthy Communities Strategic Research Action Plan" encompasses Superfund Research Program relevant research topics
- Plans to support risk management decisions based on completed studies on human health effects, mechanisms of toxicity, and toxicity pathways (mode-of-action)
- Plans to translate or quantify net health, well-being, environmental, and economic benefits resulting from application of a relevant remediation technology
- Plans to evaluate the interface of pharmacokinetic studies with pharmacodynamic models to describe key physiological and biological processes leading to adverse health outcomes
- Plans to coordinate with EPA or ATSDR on the results of experiments that can be used to provide screening toxicity values where toxicological data is missing from the scientific literature and/or adequate doses for dosimetry studies
- Plans for visits to EPA and/or ATSDR to give seminars and meet agency staff to learn first-hand about programs and potential data gaps, as well as identify future collaborations
- Plans to respond to stakeholders' request for feedback and advice on specific environmental/public health questions within Pls' areas of expertise
- Plans for validation of biomarkers and/or sensors (for example coordination with EPA or NTP regarding high throughput screening methods or coordination with technology transfer offices for validation of sensing platforms).
- Plans for translating research discoveries into public health interventions or risk communication tools (e.g. identify best practices, and validate, disseminate and implement existing resources

that translate the findings from environmental health disparities research into practice to improve public health)

- Plans for data and knowledge management to integrate complex information systems (e.g., development of data integration tools to broaden the interdisciplinary research potential for environmental health sciences; or development of publicly available resources and computational tools for integrating and analyzing environmental health data)
- Plans to participate in sample and data-sharing and development and implementation of reciprocal analysis networks between other SRP grantees (e.g., exchange of sediments to compare the effectiveness of remediation amendments to reduce the toxicity and bioavailability of contaminated sediments)
- Plans to assist field practitioners in site monitoring and remediation technologies with regard to developing, based on SRP-funded research project, standard operational procedures and quality control performance criteria for such technologies. (See “EPA Superfund and Technology Liaisons” (<http://www2.epa.gov/land-research/superfund-and-technology-liaison-program-fact-sheet>) for assistance in contacting field practitioners.) This may include transferring practical knowledge such as recommended measurements needed to ensure monitoring/remediation effectiveness, recommendations for cost efficiencies in terms of sampling, other nuances associated with the application of a technology, etc.
- Plans to develop communication strategies to address uncertainty in risk assessment associated with differences in species, gender, extrapolation of high to low dose, acute to chronic exposure, and *in vitro* to *in vivo* data
- Plans to coordinate with the CEC and the CEC’s impacted community to develop appropriate materials/activities based on the community’s need
- Plans for coordination with ToxCast efforts of EPA (e.g. nomination of cell assays, pathways of toxicity, etc.)
- Plans for participation in scientific advisory efforts for the National Research Council (NRC; <http://www.nationalacademies.org/nrc/>)

Section F. Community Engagement Suggestions

SRP considers the individuals and communities living near impacted sites as key stakeholders and recognizes the opportunity for SRP Center research and activities to achieve positive public health benefits through bidirectional interactions between the Center and impacted communities. The purpose of the SRP Community Engagement Core (CEC) is to direct best practices in community engagement for exposure prevention and intervention. For the purposes of this RFA, SRP refers to prevention and intervention as “basic biological, chemical, and physical methods to reduce the amount and toxicity of hazardous substances.” Through exposure prevention and intervention, the CEC empowers impacted communities to be full participants in decisions to reduce the amount and toxicity of hazardous substances whether in their homes, their schools, their community, and/or their environment.

Community Engagement Core activities build from research and expertise of the Center projects and cores. Although each community is likely to have specific needs, the following activities are suggestions to enable and promote community engagement and informed participation in SRP community engagement core activities and/or community engagement projects (if applicable).

Community Engagement Core Activities:

- Coordinating with local, state and Federal stakeholders to conduct community-based needs and exposure assessments for the purpose of identifying prevention and intervention strategies to reduce exposures
- Partnering with Tribes in determining exposure pathways relevant to their traditional and cultural practices and using these findings to develop culturally acceptable exposure prevention strategies

- The following community engagement activities may be effective means to support prevention and intervention strategies:
 - Training and education for community organizers and individuals in data collection and sampling methodologies (e.g., teaching community members how to use personal sensors or exposure assessment devices)
 - Assisting a community in accessing pertinent information regarding the scientific aims of the research, the meaning of the research findings, and the public health or policy implications of the research (e.g. helping an individual make choices about their own exposures/avoiding exposures; or helping communities with decision-making related to site management)
 - Capacity building for community members/organizations including workers and researcher training in cultural competency
- Coordinate with Center RTC to address community needs in outreach:
 - Providing scientific expertise in response to a community's questions
 - Developing/expanding programs to improve community's environmental health literacy related to Center research
 - Training for community members in how to translate materials into the community's native language or in language that is understandable and relevant to that local community
 - Developing and validating risk communication tools/methods tailored to the community partner
 - Providing "train-the-trainer" workshops for risk communication or information dissemination within community group
- Developing guidance to contribute knowledge of appropriate risk communication practices, etc.
- Developing tools for communication/community engagement such as crowd-sourcing data collection, use of phone applications, texting, or social networking media
- Attending EPA or ATSDR community involvement meetings related to the community of interest; coordinating with RTC and Training Core for opportunities for participation at community involvement meetings and/or opportunities for other Center-community interactions
- Establishing a plan for training opportunities for Center researchers/staff/trainees working with the community including, for example, training on cultural competency, bioethics, and on the basic principles and practices of Community-Based Participatory Research
- Applying lessons learned from engagement activities specific to one community to other community networks. Note: because SRP is not a site-specific program, it is expected that community engagement core and/or research activities, though targeting one community, would be generalizable to other communities and sites
- Establishing a plan for unanticipated opportunities for community engagement relevant to the Center activities – including notifying local networks, the SRP office, and leveraging strengths among the SRP network

Community Engagement vs. Community Outreach: The SRP expects the Community Engagement Core to develop a substantive bidirectional interaction with an impacted community and is distinct from what is sometimes referred to as “community outreach,” which would generally fall under the RTC’s role of “Information Dissemination to other End-users.” For example, participating in informal education outreach opportunities with high school students may be more appropriate as a research translation core activity; however, if the students are from the impacted community, this could be an appropriate activity for Community Engagement. Please consult with SRP Program staff for assistance in distinguishing between “Community Engagement” and “Community Outreach.”

Section G. Suggestions for Training Core Activities

The SRP requires applicants to include a Training Core to support graduate and postdoctoral level cross-disciplinary training in fields related to environmental health and environmental science/engineering. The SRP defines "trainees" within the core as graduate students and post-

doctoral researchers as either supported directly by the Center or performing research/activities that are supported by the Center.

The following are recommended Training Core activities:

- Providing training on best practices in [Responsible Conduct of Research](#)
- Conducting and promoting interdisciplinary research/activities among the trainees within the Center, and as appropriate, with other trainees from outside the Center
- Providing the trainees with opportunities to develop both the trainees' current research/activity programs, as well as their professional development
- Participating in activities which may include: serving in leadership/mentoring roles, presenting their research or activities to the Center's institution and/or outside organizations, and participating in workshops/conferences that promote professional development (e.g., resume or scientific writing, interviewing skills, and oral/poster presentation skills)
- Facilitating practical opportunities for coordination or collaboration among other grantees and for communicating research outcomes to diverse audiences (e.g., the public, their peers, and experts in the field) so that the trainees learn how to explain their work in a manner easily understood by the intended audience – whether the audience be the public or professionals in other areas of science
- Facilitating opportunities for grant writing and fellowship/externship/award opportunities (e.g. [KC Donnelly Externship](#); [SRP Wetterhahn Award](#))
- Hosting events within their Center to promote collaboration among the trainees (e.g., seminars or field days)
- Coordinating trainee participation in the Community Engagement and Research Translation Cores (e.g. attending EPA or ATSDR Community Involvement meetings relevant to trainees' research)

Section H. Other Resources:

- *P42 Funding Opportunities Webpage*: contains details about how to assemble the SRP P42 application (page limits, sections to include, forms to use) and provides a link to a free informational SRP funding opportunities webinar on December 14, 2015 (<http://www.niehs.nih.gov/research/supported/centers/srp/funding/rfa/index.cfm>).
- *SRP Search Tool*: SRP maintains a searchable website which includes access to currently-funded SRP grants and topics being investigated by SRP Centers (<http://tools.niehs.nih.gov/srp/search/index.cfm>). Applicants are encouraged to identify unique topic areas that are not currently represented among SRP Centers.
- *Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Priority List* website provides information on hazardous substances that are relevant to the US Environmental Protection Agency (EPA) Superfund Program and to the Agency for Toxic Substances and Disease Registry (<http://www.atsdr.cdc.gov/SPL/index.html>).
- *Superfund Remedy Report* (formerly called "Annual Status Report"): The SRR follows trends in remedy selection using past data going back as far as 1982. The SRR analyzes remedies selected or modified in 594 decision documents; includes brief project highlights related to green remediation, in situ bioremediation, and high resolution site characterization; and includes downloadable appendices with data for several key tables and figures in the report and new appendices that summarize all the remedy components. A link to the most recent report can be found at this website: <http://www.clu-in.org/asr/>.
- Next Generation Compliance calls for detection technologies that are easy to use: see environmental data collection for compliance: <http://www2.epa.gov/compliance/next-generation-compliance>
- Currently used analytical methods: Applicants may wish to check the National Center for Environmental Health's Division of Laboratory Sciences website to peruse recently developed laboratory methods for both preparative and analytic chemical methods currently used on NHANES samples (see Appendix 3 of current iteration of the National Exposure Report <http://www.cdc.gov/exposurereport/> for currently used methods; explore the website further for links to methods just developed for future analyses). Note: Both DLS/NCEH and NIST often

provide standards for particular analytes as part of their as part of their Laboratory Assurance and Standardization Programs; the use of such standards is helpful for validating methods and comparisons across laboratories.

- *NIEHS Partners for Environmental Public Health (PEPH)* is a network that brings together scientists, community members, educators, health care providers, public health officials, and policy makers in the shared goal of advancing the impact of environmental public health research at local, regional, and national levels. Resources useful for applicants, such as information about best practices for establishing partnerships as well as suggestions for assessing efficacy of community engagement and translation activities, can be found on their website: <http://www.niehs.nih.gov/research/supported/translational/peph/index.cfm>
 - *The PEPH Evaluation Metrics Manual* provides examples of tangible metrics that PEPH grantees and program staff can use for both planning and evaluation. Example logic models are used as a means to develop evaluation metrics for cross-cutting PEPH themes such as Partnerships, Leveraging, Products and Dissemination, Education and Training and Capacity Building. PEPH grantees (including all project partners) are the primary target audience for this document. A link to the evaluation manual can be found here: <http://www.niehs.nih.gov/research/supported/translational/peph/metrics/index.cfm>.
- *Stakeholder Points of Contact*: SRP recognizes the value of coordinating with Stakeholders during the application development process in order to maximize the relevancy of the proposed research. Although making contact with regional representatives is generally encouraged, it is particularly important that researchers proposing to work on Superfund Sites contact the site's EPA Remedial Project Manager as well as regional EPA and ATSDR contact persons. The following websites may be useful in finding appropriate contacts for the EPA and ATSDR within your region:
 - EPA Community Involvement Offices in each region: <http://www2.epa.gov/superfund/epa-regional-superfund-community-involvement-contacts>
 - EPA Superfund and Technology Liaisons facilitate the use of sound science and technology in decision making for hazardous waste programs: <http://www2.epa.gov/land-research/superfund-and-technology-liaison-program-fact-sheet>
 - The ATSDR Division of Community Health Investigations fulfills the Agency's directives at the regional level by staffing an ATSDR Regional Office within each of the 10 EPA Regional Offices. The ATSDR regional representatives provide the Agency a unique expertise that combines special technical and field experience from their assigned regions. Regional Directors may be found by accessing the appropriate link on this website: <http://www.atsdr.cdc.gov/dro/index.html>
- EPA Office of Solid Waste and Emergency Response's map of cleanup sites, <http://www2.epa.gov/cleanups/cleanups-where-you-live>
- Sustainability Initiatives: EPA's sustainability paradigm incorporates 3 pillars of environmental, social and economic issues. See more here: <http://www.epa.gov/sustainability/> and also, this link has a description of the Agency's research programs with an emphasis on sustainability: <http://www2.epa.gov/research/science-sustainable-future-epa-research-program-overview-2012-2016-0>
- EPA maintains a spreadsheet tool titled Spreadsheet for Environmental Footprint Analysis (SEFA) to quantify the environmental footprint of remediation activities. See: http://clu.in.org/greenremediation/subtab_b3.cfm.
- SRP's "Additional Resources" webpage provides links to information about EPA and ATSDR: http://www.niehs.nih.gov/research/supported/centers/srp/funding/rfa/rfa_resources/index.cfm

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